United States v. Brace et al., 17-cv-06, W.D. Pa.

Expert Report: Ecological Functions and Connections of Wetlands and Waters at the Marsh Site, Waterford, Erie County, Pennsylvania

Prepared for:
U.S. Department of Justice

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EXHIBIT
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1.0 INTRODUCTION

The United States brought a lawsuit under the Clean Water Act against Robert Brace, Robert Brace Farms, Inc. and Robert Brace and Sons, Inc. (collectively referred to as "Brace"), Civil Action Number 17-cv-06, W.D. Pa., in the U.S. District Court for the Western District of Pennsylvania. In connection with this lawsuit, the United States Department of Justice (DOJ) requested that I assess and provide my expert opinion on the existence, conditions, and functions of wetlands found on about a 20-acre tract of property located along the western edge of Elk Creek, between Lane, Sharp, and Greenlee Roads, in the townships of McKean and Waterford, Erie County, Pennsylvania (Tax Parcels 47-011-004-0-003.00 and 31-016-063.0-002.00 as identified by the Erie County Bureau of Assessment), subsequently referred to as the "Marsh Site" (Figures 1 and 2). DOJ also requested that I assess and provide my expert opinion on the connectivity of the Marsh Site wetlands and tributaries in the vicinity of the Marsh Site to Traditional Navigable Waters (TNWs).

[**NOTE: all figures appear in order in Appendix A to this report.**]

In formulating my opinion and preparing this report, I have evaluated and considered conditions at the Marsh Site both before and after Brace (referring to the current owner and/or his/its agents) reportedly altered conditions at the Marsh Site beginning in 2012 (Figure 2). I also have evaluated the hydrological and ecological connections between wetlands on the Marsh Site with Elk Creek, and Lake Erie, the TNW into which Elk Creek directly flows about 30 miles downstream of the Marsh Site. I conclude that wetlands were present *pre-disturbance* on the Marsh Site before being altered by Brace, and that the structure and function of wetlands on the Marsh Site and reach of Elk Creek adjacent to the Marsh Site have been severely altered – *post-disturbance* – causing negative impacts to the delivery of functions and ecosystem services to the immediate area, and to downstream waters. I also evaluated whether wetlands on the Marsh Site, either alone or in combination with similar wetlands in the region, significantly affect the chemical, physical and biological integrity of Elk Creek and Lake Erie. I concluded that the headwater wetlands of the Marsh Site and similarly situated wetlands within the watershed make important contributions to the ecological health, condition, and integrity of Elk Creek and Lake Erie. Finally, I have suggested a strategy and approach for restoring the wetlands and their associated functions and services on the Marsh Site that abut Elk Creek. The remainder of this report presents my in-depth findings and opinions to date.[1]

[1] I was retained the U.S. Department of Justice as an Expert to assess, discuss, and opine about wetlands on and near the Marsh Site and Elk Creek regarding the Brace case. My compensation rate is $150 per hour and is not dependent on the outcome of the case. I have not testified at trial or been deposed as an expert witness in the past 5 years.

2.0 SUMMARY OF FINDINGS AND OPINIONS

Based upon my review and analysis, I have made the following findings, and in my expert opinion, conclude the following about the Marsh Site:

2.1 Historical Perspectives on the Marsh Site using Aerial Photographs

A review of historic aerial photographs, maps, and reports shows that a small portion of the Marsh Site along Sharp Road was possibly used for farming activities from 1939 to 1968. The remainder of the Marsh Site appears to have been a wetland historically. The National Wetlands Inventory has mapped extensive wetland areas throughout the townships of McKean and Waterford, and the surrounding region, including portions along Elk Creek. The entire Marsh Site (the area west of Elk Creek bounded by Sharp Road and Lane Road) is mapped as wetland (Figure 1); PFO1SS1A (Palustrine Forested Broad-leaved Deciduous Temporarily Flooded/Scrub-Shrub Broad-leaved Deciduous Temporarily Flooded) in the southern portion, and PEM1E (Palustrine Emergent Persistent Seasonally Flooded/Saturated) closer to Elk Creek in the northern portion (accessed 17 October 2017). Elk Creek flows about 1,500 linear feet along the east border of the Marsh Site.

In summary, the examination of aerial photography from 1939 to 2016, shows the following:

1939-1968 – naturally vegetated except for a rectangular area along Sharp Road, which appears to have been cropped; a rectangular strip along Lane Road is less clear in the 1968 image, and thus, the specific composition of the vegetation in that area cannot to determined; Elk Creek maintained natural flow patterns and hydrologic connections to its floodplain (Figures 3 & 4).
1993 – natural vegetation is recolonizing the rectangular area along Sharp Road, although prior plow lines are still visible; remainder of the Marsh Site appear to be naturally vegetated consistent with occurrence of wetlands; Elk Creek appears to have been partially channelized, thus reducing connectivity with its floodplain (Figure 5).
2005-2011 – natural vegetation is now present throughout the entire Marsh Site, with the proportion of woody vegetation increasing during this interval. Elk Creek has regained some sinuosity of the channel, with meanders and backwaters, suggesting multiple flowpaths of hydrologic connectivity with the now heavily vegetated floodplain (Figures 6-9).
2013 – vegetation of all kinds has been removed from most of the Marsh Site, and downed logs and branches are evident; white PVC drainage tiles (i.e., pipes) also are evident in excavated ditches that contain water; the Elk Creek channel has become separated from the floodplain, and shows reduced natural sinuosity and connectivity; the main channel appears much straighter and more uniform in width, suggesting substantial alterations from the condition observed in 2011 and prior years (Figures 10-12).
2016 – herbaceous vegetation and shrubs are returning to the Marsh Site over the 3 years since the site was disturbed, but Elk Creek continues to display a well-defined, channelized course through the site with limited to no substantial connectivity with the adjacent floodplain and wetlands (Figure 13).

2.2. Findings of Prior Wetland Investigations at the Marsh Site

In 1989 and 1990, an EPA-led team conducted a field investigation of an area in and around the Marsh Site to determine whether and to what extent wetlands existed within the 30-acre area directly southeast of the Marsh Site (the “Consent Decree Area”) where wetlands had been cleared, drained, and ditched. The inspection team used the Marsh Site as a reference wetland to compare to the impacted wetlands in the Consent Decree Area. As part of the investigation, the team sampled a total of 40 points (4 in 1989, 36 in 1990) including one on the Marsh Site (Plot 1C, which met all 3 wetland parameters, and had strong hydric indicators) and compiled a narrative report that confirmed the presence of wetlands and disturbances to the wetlands in the Consent Decree Area.

A ground-level photograph taken in September 2012 from the Lane Road bridge looking downstream, by representatives of the PA Fish and Boat Commission showed extensive removal of vegetation and exposure of hydric soil (Figure 14). On 27 June 2013, representatives from EPA, U.S. Army Corps of Engineers and Pennsylvania Department of Environmental Protection visited the Marsh Site and reported that the Site had been cleared of vegetation, side-cast material from either ditches or the Elk Creek channel, or both, had been deposited onto the floodplain, and installation of PVC tiles had occurred. The team, Inspectors, Todd Lutte of USEPA and Michael Fodse of the U.S. Army Corps of Engineers, observed new growth of hydrophytic vegetation, which in portions of the Marsh Site that had been previously disturbed (Figures 12 & 15). Based on the wetland delineation data sheets from three samples points, all located on the Marsh Site, there was clear evidence of hydrophytic plants, soils with hydric characteristics, and surface hydrology. A site inspection report from the Pennsylvania Department of Environmental Protection also dated 27 June 2013 described similar findings.

2.3 Assessment of Ecological Functions and Ecosystem Services at the Marsh Site Wetlands, Adjacent Floodplain, Elk Creek Channel, Similarly Situated Wetlands in the Watershed

The Marsh Site wetlands and other similarly situated wetlands in the Elk Creek watershed, perform important ecological functions and ecosystem services for adjacent and downstream habitats and structures. Protecting natural wetlands throughout the Elk Creek drainage area and the creek's tributaries is critically important for storing and eventual slow release of floodwaters, which is recognized by local, state, and federal agencies and authorities responsible for the health, safety, and welfare of the citizens. FEMA designated the reach of Elk Creek along the Marsh Site and the adjacent floodplain a Flood Zone A, indicating the importance of these features being protected for their flood storage benefits (See Section 6.1, and Figures 59-60). Because of the flat terrain throughout this region, especially within the Lake Erie Coastal Plain, at times of high flow the local creeks and rivers overflow their banks and also push waters into their tributaries and adjacent wetlands. Without this considerable spatial network of highly connected rivers, streams, and wetlands to store excess water, flows rates increase and scouring occurs, increasing the amount of sediment, among other things, rushing downstream. Then, flooding in downstream towns becomes worse with a subsequent increase in potential harm to local residents and to the aquatic habitats of Elk Creek and Lake Erie.

Prior to disturbance, the wetlands on the Marsh Site formerly received some runoff from adjacent roads and parcels upslope. Thus, sediments from any earth disturbances, eroded channels, or pollutants (e.g., petroleum spills, anti-freeze, lawn fertilizers, pesticides, and other substances) contained in runoff from roads and lawns upslope of the Marsh Site have the potential to be trapped, chemically transformed, and thus treated in these wetlands before flowing into Elk Creek, and ultimately into Lake Erie. The trapping and transformation of sediments, pollutants, and excess nutrients in wetlands on the Marsh Site and similarly situated wetlands near the Marsh Site (see Figure 1), improve water quality for the receiving downstream waters, including Elk Creek and Lake Erie. Hydrologic alterations on the Marsh Site and in Elk Creek, however, likely have reduced the levels and extent of these valued functions and services.

Recent severe algal blooms occurring in Lake Erie are, in part, caused by excess nutrients flowing into the lake from tributaries within the drainage basin, such as Elk Creek. As reported by Kozacek (2014), new agricultural practices are the primary cause on the increasing frequency and intensity of algal blooms in Lake Erie. Other scientific and new reports explain this serious environmental problem:
(National Geographic: https://news.nationalgeographic.com/news/2014/08/140804-harmful-algal-bloom-lake-erie-climate-change-science/
New York Times: https://nyti.ms/2yF25qN
Scientific American: https://www.scientificamerican.com/article/harmful-algal-blooms-increase-as-lake-water-warms/).

Prior to disturbance, closed-canopy tree and shrub cover was present on the Marsh Site, plus a substantial area of emergent wetlands, and a floodplain connected hydrologically and biologically to Elk Creek, all of which contributed considerable ecological functions and ecosystem services, such as flood storage and desynchronization (i.e., slow release of floodwaters), infiltration of surface and near surface flows, nutrient cycling and removal of elements and compounds, carbon export into receiving water to support food webs, and maintenance of habitats for characteristic plant and animal communities.

2.4 Reference Wetlands in the Vicinity of the Marsh Site

On 17 October 2017, I looked for possible reference wetlands with which to compare to those on the Marsh Site. I sought wetlands on public lands or accessible private lands, where access was not an issue, and where the wetlands would likely be conserved in the future. Wetlands located along other tributaries of Elk Creek similarly situated to those on the Marsh Site were primarily under private ownership. I examined the National Wetlands Inventory (NWI) map for possible sites and chose two wetlands (#s7 & 8) on State Game Lands 109 about 3 miles east of the Marsh Site, on LeBoeuf Creek (Figure 37). I also examined data from three wetlands from the Riparia Reference Wetlands Database at the Pennsylvania State University (#s 220, 221 & 222). These natural wetlands also are located in the glaciated northwestern corner of Pennsylvania. They were first sampled in 2003 and again in 2013. The methodology used to sample these wetlands is similar to wetland delineation, but is more intensive, attempting to identify all plant species, and assessing potential wildlife habitat. Descriptions are based on data collected and archived in the Riparia Reference Wetlands Database (www.riparia.psu.edu).

The five reference wetlands (Figures 37-46) provide indications of how the structure and function of Marsh Site wetlands would appear if alterations of hydrology and vegetation had not occurred in 2012. Soil characteristics were similar to those at the Marsh Site, with the same mapped soil type found on the closest reference wetlands (#s 7 & 8), Canandaigua mucky silt loam, classified as a hydric soil in Erie County. The plant communities of reference wetlands were strongly hydrophytic and more diverse than the Marsh Site, which is expected given the altered hydrology and removal of vegetation at the Marsh Site. Reference wetlands had a wider range of wetland plant indicator status then the Marsh Site, which suggests the more naturalistic conditions of reference wetlands provide more varied ecological niches that support diverse floral and fauna communities. Reference wetlands, all with relatively undisturbed hydrology, were wetter than the post-disturbance wetlands observed at the Marsh Site. Water tables were closer to the surface and soils were saturated with a full set of hydric soil indicators. The hydrologic alterations of drainage tiles and ditches installed in the Marsh Site in 2012 are likely causing the somewhat drier conditions observed there. Restoration of the hydrology at the Marsh Site will help increase the wetness of wetlands there, and thus, provide a pathway to fully recover lost and degraded functions and services.

2.5 Post-disturbance Characteristics of the Marsh Site Wetlands and Connectivity to Elk Creek

Based on my desktop review of aerial photographs, NWI mapping, and reports about previous site visits, it is evident that wetlands with continuous surface connections existed on the Marsh Site prior to the disturbance in 2012. On 16 October 2017, I used standard methods to assess the characteristics of and approximate locations of wetlands on the Marsh Site based on conditions on the ground to compare with results of my desktop review. Despite fairly extensive human disturbances to the terrain and waters of the Marsh Site (see Figures 10, 11, 12, 14, 47, 48), all six Sample Points examined on 16 October 2017 (Figure 17) still had characteristics common to wetlands, including the presence of hydrophytic plants, hydric soil characteristics, and some evidence of surface and subsurface hydrology. There was some inconsistency between the strong evidence for hydric soils and the current vegetation, which showed a modest, not a strong, response by hydrophytic plants. That finding, plus the limited visual evidence of hydrology, suggests that the natural hydrologic regimes – surface water flows, groundwater discharges, and flooding potential – have all been disrupted by human-induced impacts to the Marsh Site and Elk Creek, especially for Sample Points 1, 2 & 3 (see Section 2.4 for an elaboration on these impacts). Despite those disturbances in 2012, all six Sample Points were currently determined to be wetlands, as they met all three wetland indicators; hydrology, hydric soils, and hydrophytic plants. The wetland characteristics of the six Sample Points appear to be negatively impacted by disturbances to the hydrology and vegetation of the Marsh Site, when compared to reference wetlands in similar landscape settings (see Section 4.4), but wetlands continue to persist in a diminished condition in October 2017 on the Marsh Site.

The Marsh Site topography slopes gently from west to east, then forms a near level floodplain adjacent to Elk Creek. As expected, conditions become wetter at the toe of the topographic slope and on the floodplain, where Sample Point Nos. 4, 5, & 6 were located. However, due to the observed disturbances to the site, ditching and installation of drainage pipes, plus dredging and side-casting of sediments from Elk Creek onto the riparian banks beginning in 2012, and perhaps more recently, the Marsh Site wetlands and floodplain are less connected to Elk Creek and are likely becoming drier. The increased depth of the Elk Creek channel means there is less opportunity for overbank flooding onto the floodplain and wetlands, and therefore, less hydrologic support for the wetlands present. These disconnections reduce opportunities to process water-borne nutrients, retain sediments from upland runoff, provide organic carbon to instream food webs, and support habitat needs of wetland-riparian wildlife (for example: swamp sparrow, red-winged blackbird; muskrat, mink streamside salamanders such as northern dusky and northern spring salamander; northern spring peepers, green frog; wood turtles, painted turtles).

The Marsh Site has surface and likely subsurface hydrologic connections to Elk Creek, a perennial stream with direct connections to Lake Erie, a TNW, as it flows through a series of stream channels, road culverts, wetlands, and other waterbodies (see Figures 49-57, 59-64). The characteristics of hydric soils observed on the Marsh Site suggest shallow groundwater is flowing down slope through the soil within about 1 foot for the surface. Because of these direct hydrologic connections between the Marsh Site and Elk Creek, the wetlands at the Marsh Site, along with similarly situated wetlands in the watershed, provide significant physical, chemical, and biological benefits to the water that flows from the Marsh site downslope and downstream of Elk Creek and Lake Erie, especially prior to earth disturbances by Brace. The cluster of NWI mapped wetlands on and near the Marsh Site exceeds the areal extent by *three times* that of other similarly situated wetlands within the Elk Creek watershed (see Section 6.1 and Figures 62-64). Thus, the wetlands on and near the Marsh Site are especially important in providing ecological functions and ecosystem services to the Elk Creek watershed and its inhabitants.

2.6 Impact of Disturbances on the Pre-disturbance Marsh Site Wetlands, Ditches, Streams; Other Similarly Situated Wetlands; Elk Creek; and Lake Erie

The wetlands at the Marsh Site, and other similarly situated wetlands in the cluster of wetlands around the Marsh Site (see Figure 1, Table 6) had, and still have, hydrologic and biologic connectivity to the floodplain and channel of Elk Creek where it forms the eastern boundary of the Marsh Site. Documented impacts from analyzing aerial photographs of the Marsh Site (Section 2.1 above) and from the 2013 site visit (Section 2.2 above) confirm that a series of activities, including cutting vegetation, land grubbing, ditching, installing plastic drainage pipes, dredging and side-casting material from the Elk Creek channel, all contributed to significant degradation of wetlands, the floodplain, and the stream channel. Structural alterations to vegetation and soils, reduced hydrologic connectivity, and reductions in habitat complexity contribute to degradation and loss of ecological functions and ecosystem services, including flood storage, carbon dynamics, nutrient transformations, sediment trapping, and habitat diversity. Negative impacts were clearly present locally at the Marsh Site, and can affect downstream aquatic ecosystems of Elk Creek, and the Lake Erie nearshore areas.

Human disturbances to wetland vegetation, hydric soils, and aquatic habitats of the Marsh Site and adjacent Elk Creek, beginning in 2012, have severely altered conditions that existed in 2011. The loss of shrub and tree cover along and near Elk Creek translates to a loss of habitats for a variety of aquatic and terrestrial species that require the presence of woody species (e.g., common yellowthroat, yellow warbler, green heron, northern catbird). Impacts to the Marsh Site (i.e., vegetation removal and grubbing, tilling of soils), including the floodplain and Elk Creek channel (i.e., ditching, grading, dredging, side-casting) have significantly degraded the wetlands, floodplain, and stream of this area.

2.7 Important Connections of Marsh Site Wetlands and Elk Creek to Lake Erie

The Erie Coastal Plain in Pennsylvania contains vitally important resources managed by the Pennsylvania Coastal Resources Management Program (CRMP) under authority of the federal Coastal Zone Management Act of 1972. Wetlands, floodplains, and contributing watersheds flowing through this coastal zone into Lake Erie are of special concern. The CRMP policy for wetlands is stated as: "*This policy involves the protection, enhancement and creation of coastal wetlands in order to maintain benefits for wildlife habitat, flood control, water quality, water flow stabilization and environmental diversity (biodiversity).*" (http://www.dep.pa.gov/Business/Water/Compacts%20and%20Commissions/Coastal%20Resources%20Management%20Program/Pages/About-the-Program.aspx, accessed 11 November 2017).

Elk Creek is one of the listed watersheds that flows into and through the Lake Erie Coastal Zone. The CRMP has a number of initiatives to conserve and restore these aquatic ecosystems, including a strategy to mitigate increased adverse cumulative and secondary impacts, and to expand the recognized coastal zone. The intent of the proposed coastal zone expansion is clear, to bring substantial and focused conservation and restoration activities to watersheds flowing into Lake Erie. The Marsh Site wetlands, with strong hydrologic connections to Elk Creek, a perennial stream with direct connections to Lake Erie, a TNW, are an important ecological component for maintaining those coastal resources in and around Lake Erie.

3.0 METHODS USED FOR REVIEW OF THE MARSH SITE

3.1 Overview of Methods

For the purpose of preparing this report, I examined the landscape setting and hydrological and ecological conditions at the Marsh Site, and connectivity with Elk Creek.

Technical guidance, provided originally by the 1987 Corps of Engineers Wetlands Delineation Manual (Corps & USEPA 1987), and modified by subsequent Regulatory Guidance Letters (RGLs), and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (U.S. Army Corps 2012), and other relevant information, was used to identify the presence of wetlands, and to delineate the boundaries of wetlands. When normal circumstances occur on a site, then all three parameters used to determine wetland occurrence are expected to be present – hydrology, hydric soils, and hydrophytic vegetation. Exceptions occur either when problem wetlands or atypical circumstances occur. The Corps' Regional Supplement (U.S. Army Corps 2012:114) lists the following difficult wetland situations, although others may exist:

- Lands Used for Agriculture and Silviculture
- Problematic Hydrophytic Vegetation
- Problematic Hydric Soils
- Wetlands that Periodically Lack Indicators of Wetland Hydrology
- Wetland/Non-Wetland Mosaics

In these situations, the investigator looks for evidence to explain deviations from the expected presence of the three wetland parameters: hydrology, soil and vegetation. "*In general, wetland determinations on difficult or problematic sites must be based on the best information available to the field inspector, interpreted in light of his or her professional experience and knowledge of the ecology of wetlands in the region.*" (U.S. Army Corps 2012:114).

On 16 October 2017, I chose and sampled the ecological characteristics of six points on the Marsh Site (Figures 2 & 17). The objective was to collect sufficient data to reach an independent opinion about the occurrence of wetlands on the Marsh Site and their connectivity to Elk Creek at the current time (October 2017), which is defined as *post-disturbance* (after the major land and water alterations by Brace in 2012). I also was tasked to consider the extent and condition of wetlands on the Marsh Site before the 2012 alterations; defined as *pre-disturbance*.

During sampling of all points, I was accompanied by Sarah Buckley (U.S. Department of Justice attorney), Katelyn Almeter (U.S. Environmental Protection Agency ecologist), and representatives of the Brace family who observed my procedures, but did not assist with data collection nor influence my findings in any way. To become familiar with the site, I walked an approximately u-shaped path from the western edge of Elk Creek at the Lane Road bridge crossing and uphill to Sample Points #1&2. I then turned north to the west-central portion of the site for Sample Point #3, then downhill to Sample Point #4 along the immediate riparian area along Elk Creek. I then walked upstream along Elk Creek to Sample Point #5 within the alder patch downstream of the Lane Road bridge crossing over Elk Creek. Sample Point #6 was accessed by walking along the stream from the Sharp Road bridge over Elk Creek, near the junction with Greenlee Road. Sample Point #6 was positioned to characterize the narrower, lower elevation area in the northern section of the Marsh Site.

The six points were arranged to document conditions throughout the different portions of the Marsh Site, primarily based on the proximity of Elk Creek: the gently sloping ground from southwest to northeast (U.S. Geological Survey Topographic Quadrangle; Figure 1), the presence of multiple soil types (Erie County Soil Survey (Figure 18)), and the observed vegetation patches on the ground. To examine soil chemistry, especially soil organic matter, I took three soil samples, one from each of three sites (Sample Points #s 1, 2, & 4). Analyses were conducted by the Penn State Agricultural Analytical Services Laboratory, University Park, PA.

The vegetation at each sample point was assessed using visual cover estimation within an approximately 3-m (10 ft) radius circular plot around the soil pit. Photographs, close-up and longer distance, were taken looking both east and west from each soil pit (see figures in Appendix A arranged by site). Dominant vascular plant species were identified whenever possible, but mid-October conditions of senescence (seasonal die back) and early frosts made identification of some species difficult. When identification of dominant species was not possible given the field conditions, and an unidentified species would be considered as one of the dominants, then its effect on the hydrophytic plant determination is noted for each Sample Point. Past disturbances at the Marsh Site resulted in normal circumstances not being present, which allows the investigator to consider how impacts to a site may have affected the determination of all three indicators -- hydrology, hydric soils, and hydrophytic vegetation -- being present or not. The Dominance Test was used to assess the presence of hydrophytic vegetation, whereby those species representing 50% of areal cover or more within a plot, individually or collectively, are considered dominant. Other plants with 20% cover or more, if not already included in the rank order of dominance, are added to the dominant list. Species identification and wetland indicator status ranks (obligate through upland) were confirmed using the U.S. Department of Agriculture Plants Database and two field guides. Using the Dominance Test, hydrophytic vegetation is considered to be present when the dominant plant species present, representing 50% or more of the cover, are either obligate (OBL), facultative wet (FACW), or facultative (FAC) wetland species.

Indicators of hydrology were assessed at each Sample Point using guidance from the USEPA and Corps manuals and noted on data sheets. Based on these observations about historic and current conditions, I considered the impacts of disturbances on ecological functions and ecosystem services for the wetlands of the Marsh Site, and downstream impacts to Elk Creek.

In addition to using the Cowardin et al. (1979) wetland classification system, which is used the NWI mapping, I classified each site by hydrogeomorphic (HGM) class or subclass. HGM classification relies more on water sources, water dynamics, and landscape position than the vegetation focus of Cowardin. Both are useful ways of characterizing wetland types.

Sources used to compile the results for this section included: indicators - U.S. Army Corps 2012:115-118; Dominance Test - U.S. Army Corps 2012:25; plant species identification and wetland indicator status - U.S. Department of Agriculture Plants Database (https://plants.usda.gov/); plant species identification - Newcomb's Wildflower Guide 1977, Tiner 1988; indicator guidance - U.S. EPA and U.S. Army Corps 1987, U.S. Army Corps 2012; Wetland Determination Data Form – Northcentral and Northeastern Region, U.S. Army Corps 2012 (see Appendix B for completed field forms); HGM classification, Brooks et al. 2011).

4.0. REVIEW OF MARSH SITE WETLAND CONDITIONS AND VERIFICATION OF WETLAND INDICATORS

4.1 Historical Perspectives on the Marsh Site using Aerial Photographs

To understand land use conditions on any parcel, it is important to understand the historic land uses that have occurred. I examined a series of dated aerial images found on the publicly available Google Earth site and older imagery provided to me by DOJ. I attempted to keep the full Marsh Site images and close-up images at similar scales for comparative purposes. A review of historic aerial photographs, maps, and reports shows that a small portion of the Marsh Site along Sharp Road was possibly used for farming activities from 1939 to 1968. The remainder of the Marsh Site appears to have been a wetland historically. The National Wetlands Inventory has mapped extensive wetland areas throughout the townships of McKean and Waterford, and the surrounding region, including portions along Elk Creek. Elk Creek flows about 1,500 linear feet along the east border of the Marsh Site.

The entire Marsh Site (the area west of Elk Creek bounded by Sharp Road and Lane Road) is mapped by NWI (Cowardin et al. 1979) as wetland (Figure 1); PFO1SS1A (Palustrine Forested

Broad-leaved Deciduous Temporarily Flooded/Scrub-Shrub Broad-leaved Deciduous Temporarily Flooded) in the southern portion, and PEM1E (Palustrine Emergent Persistent Seasonally Flooded/Saturated) closer to Elk Creek in the northern portion (accessed 17 October 2017). Using a hydrogeomorphic (HGM) classification system (Brooks et al. 2011), the three sample sites (Sample Points #1, 2, 3) are considered slope wetlands receiving a mixture of surface water and groundwater. Sample Points #4, 5, 6 are closer to the Elk Creek floodplain, and therefore, are considered riverine upper perennial (headwater) wetlands, influenced more by connectivity to Elk Creek.

1939 (B&W, obtained from DOJ; Figure 3) – The Marsh Site is clearly vegetated, but with evidence of cropping in a rectangular strip about Sharp Road, and a small area immediately along Lane Road. Elk Creek along the eastern boundary of the Marsh Site appears to have hydrologic connectivity with the adjacent floodplain, as multiple flooded backwater coves and depressions are shown connected to the stream channel. Multiple meanders are displayed along the channel, which would be expected of a naturally flowing perennial stream in relatively flat terrain that is present along this reach of Elk Creek.

1968 (B&W, obtained from DOJ; Figure 4) – As in 1939, the Marsh Site remains vegetated, and evidence of cropping in a rectangular strip along Sharp Road remains. The strip along Lane Road is less clear in this image, and thus, the specific composition of the vegetation cannot to determined. Elk Creek along the eastern boundary of the Marsh Site appears to maintain hydrologic connectivity with the adjacent floodplain, and display some meanders within the channel.

April 1993 (Google Earth, B&W; Figure 5) – The Marsh Site is clearly vegetated. There is residual evidence of straight lines (north-south) in a narrow rectangle along Sharp Road, which may be plow furrows from prior farming, but these now appear to be vegetated by natural flora, not food crops or cover crops. Elk Creek has fewer meanders by this year, suggesting it has been partially channelized, which may have included dredging to deepen the channel (not possible to discern this latter aspect from this photograph).

2005 (Natural color obtained from DOJ; Figure 6) – The Marsh Site vegetation continues to mature, developing some tree cover. There is no evidence of land disturbance along Sharp Road. Elk Creek shows a more variable channel width and more meanders than in 1993, and shows clear surface connections with inundated areas in the riparian corridor, as well as reaches with substantial natural vegetation consistent with the occurrence of wetlands. The floodplain of Elk Creek appears to have a relatively natural meander dynamic.

October 2011 (Google Earth, Color; Figure 7) – The Marsh site remained vegetated from 1993 through 2011. By 2011 there are trees with substantial canopies (clearly discriminated by the fall colors of foliage) over more than 50% of the site. Along the Elk Creek tributary and in the northern end, herbaceous vegetation (possibly with shrubs) dominates the site. Elk Creek has a more variable channel width than in 1993 and shows clear surface connections with inundated areas in the riparian corridor, as well as reaches with substantial natural vegetation, mostly likely aquatic species. Close-ups of the same imagery of the southeast corner and northern section of the Marsh Site, which are proximal to Elk Creek, show a mixture of plant species and lifeforms (i.e., herbaceous, shrub, and trees, the latter in the southeast corner) (Figures 8 & 9). These close-ups also show enhanced diversity and connectivity between the Elk Creek channel and adjoining floodplain and riparian corridor. The 2011 image, taken in October, clearly shows different tree and shrub species, distinguished by their variable colors. Patches of different shrub and herbaceous species can be distinguished throughout the Marsh Site, although precise identification is not possible at this scale of image. Submergent and emergent hydrophytes are evident in the flooded backwater areas along Elk Creek.

May 2013 (Google Earth, Color; Figure 10) – The vegetation of the Marsh Site has been grubbed, cleared, and removed. Bare soil is evident throughout the 20-acre site, except in the wettest southeast corner, where alder shrubs now dominate based on my site visit in October 2017. As in the 1993 photograph, linear plow lines (north to south) are evident in the west-central area along Sharp Road, although they appear to extend further downslope to the east in 2013. Additional marks that appear to be plow lines occur along the Elk Creek banks, including some that are curved as the equipment made sharp turns. In the southeast corner, where tree density was greatest in earlier imagery, there is evidence of logs and branches scattered on the ground, presumably from the trees that were cut down (Figure 11). White PVC drainage tiles (i.e., pipes) also are evident in excavated ditches that contain water (see Figure 47, close-up image of Figure 11, labeled). In that area, a slightly curved ditch parallel to Elk Creek appears full of water. Elk Creek has a more uniform width, with fewer hydrologic connections to the floodplain and riparian corridor. Besides loss of natural vegetation between 2011 and 2013, Elk Creek's hydrologic connectivity and spatially diverse morphometry are considerably reduced in 2013 compared to the 2011 imagery (Figures 11 & 12).

April 2016 (Google Maps, Color; Figure 13) – The most recent imagery from Google Earth or Maps shows some natural herbaceous vegetation returning to the Marsh Site; woody plants are not evident in this image. Ditches or altered natural channels are evident on either side of the still well-defined channelized stream course.

In summary, the examination of aerial photography from 1939 to 2016, show the following:
1939-1968 – naturally vegetated except for rectangular area along Sharp Road, which appears to have been cropped; rectangular strip along Lane Road is less clear in the 1968 image, and thus, the specific composition of the vegetation cannot to determined; Elk Creek maintained natural flow patterns and hydrologic connections to its floodplain (Figures 3 & 4).
1993 – natural vegetation is recolonizing the rectangular area along Sharp Road and Lane Road, although prior plow lines are still visible; remainder of the Marsh Site appears to be naturally vegetated consistent with occurrence of wetlands; Elk Creek appears to have been partially channelized, thus reducing connectivity with its floodplain (Figure 5).
2005-2011 – natural vegetation is now present throughout the entire Marsh Site, with the proportion of woody vegetation increasing during this interval. Elk Creek has regained some sinuosity of the channel, with meanders and backwaters, suggesting multiple flowpaths of hydrologic connectivity with the now heavily vegetated floodplain (Figures 6-9).
2013 – vegetation of all kinds has been removed from most of the Marsh Site, and downed logs and branches are evident; white PVC drainage tiles (i.e., pipes) also are evident in excavated

ditches that contain water; the Elk Creek channel has become separated from the floodplain, and shows reduced natural sinuosity and connectivity; the main channel appears much straighter and more uniform in width, suggesting substantial alterations from the conditions observed in 2011 and prior years (Figures 10-12).

2016 – herbaceous vegetation and shrubs are returning to the Marsh Site over the 3 years since the site was disturbed, but Elk Creek continues to display a well-defined, channelized course through the site with limited to no connectivity with the adjacent floodplain and wetlands (Figure 13).

4.2 Findings of Prior Wetland Investigations at the Marsh Site

In 1989 and 1990, an EPA-led team conducted a field investigation of parcels owned by Brace located east of Elk Creek, across from the Marsh Site to determine whether and to what extent wetlands existed at the site. They followed the methodology of the Corps of Engineers' 1987 Wetlands Delineation Manual. As part of the investigation, the team took 40 samples (4 in 1989, 36 in 1990), primarily throughout the Consent Decree Area, but one sample plot was located in the Marsh Site as a reference wetland (Plot 1C, which met all 3 wetland parameters, and had strong hydric indicators). They compiled a narrative report that confirmed the presence of wetlands and disturbances to the original set of wetlands. A narrative report (Field Investigation May 24, 1989, May 16-17, 1990 Potential Violation, Robert Brace), data sheets, and three ground photographs were provided to me for review by DOJ.

A ground-level photograph, taken in September 2012 from the Lane Road bridge looking downstream, by representatives of the PA Fish and Boat Commission was provided showing extensive removal of vegetation and exposure of hydric soil (Figure 14). A Photographic Evidence Log of photographs taken on Brace parcels in 2012 and 2013 as part of the Agency's investigation was provided (PFBC 2012). Photographs marked 006, 007, 008, and 010 were taken along the east bank of Elk Creek along the Marsh Site and clearly show the presence of PVC tile drains with outlets into Elk Creek. The locations of these tile drains are shown on an accompanying aerial photograph taken by Michael Fodse of the Corps on 13 November 2013.

A letter and aerial photographs from Brace dated 17 January 2013 (Brace letter 2013), which were provided to me by DOJ, confirmed that Brace "cleaned" the channel of Elk Creek and "installed" PVC tile drains throughout the Marsh Site in 2012. This is confirmed in the photographic record above, and in video evidence provided from a 2013 investigation (provided to me by DOJ, described below).

On 27 June 2013, representatives from EPA, U.S. Army Corps of Engineers and Pennsylvania Department of Environmental Protection visited the Marsh Site and reported that the Site had been cleared of vegetation, that side-cast material from either ditches or the Elk Creek channel, or both, had been deposited onto the wetlands in the floodplain, and that PVC tiles had been installed in the wetlands and were discharging into both the east and west banks of Elk Creek. The investigation was led by Todd Lutte (USEPA) and Michael Fodse (US Army Corps). Further background information was obtained from a report entitled Brace Site Visit, provided to me by DOJ. The aforementioned video clips show agency personnel walking along the Marsh Site side of Elk Creek, identifying and filming multiple outlets of PVC tile drainage network discharging into Elk Creek.

During the June 2013 inspection, new growth of hydrophytic vegetation was observed in portions of the site previously disturbed (Figures 15, Lane Road bridge). Based on the wetland delineation data sheets from three samples points, all located on the Marsh Site, hydrophytic plants were dominant, and soils showed hydric characteristics (i.e., chroma of 1 or 2, gleyed matrix, mottles). Surface hydrology was observed, so evidence of all three wetland parameters was present, indicating the presence of wetlands on the Marsh Site. Their Sample Point #1 was located near my Sample Point #6. Their other two points were located in the middle area of the Marsh Site. Heavy rains made obtaining additional soil samples difficult, and obscured some of the natural surface hydrology. A site inspection report from the same visit prepared by Scott Dudzic of the Pennsylvania Department of Environmental Protection (PADEP) dated 27 June 2013 described similar findings.

4.3 Assessment of Ecological Functions and Ecosystem Services at the Marsh Site Wetlands, adjacent Floodplain, Elk Creek channel, and Similarly Situated Wetlands in the Watershed

At each sample point for my 2017 inspection, I used routine methods, and followed guidance regarding atypical circumstances (due to the activities described in Section 4.2) from the Corps of Engineers' 1987 Wetlands Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (2012). At all sample points for my 2017 inspection (Figure 17), soil pits were dug to at least 18 inches with a diameter of about 8 inches, as is standard for wetland determinations and identifications. I conducted a field inspection of soil texture, using an accepted method known as texture by touch (Thien 1979). Soil types in the Marsh Site are displayed in Figure 18, with characteristics in Tables 1, 2, and 3. Dominant vegetation was identified to the finest taxonomic level possible within a 10-foot (3-meter) radius around the soil pit, which served as an approximate center point for the plot. Hydrologic conditions can be observed directly or be inferred by soil or vegetation characteristics or other indirect hydrology indicators. Both direct and indirect indicators were observed. Under the Corps manual (2012), the presence of at least one primary or two secondary indicators indicates that water has been present at or near the ground surface of sufficient duration to create hydric conditions.

<u>Description of Sample Points in Marsh Site parcel</u>**:**

<u>Sample Point #1</u> (Figure 17) – Located at (approx. lat-long: 41.9793548, -80.0456344), which is at the visual intersection of the gas well tank on Lane Road to the south, and the end of the tree row along the east side of Elk Creek downstream of the culvert on Lane Road. I chose this point because it was located upslope of the patch of alder shrubs in the southeast corner of the Marsh Site. The alder patch, later sampled as Sample Point #5, appeared to be quite wet, so I wanted to know the conditions upslope.

According to the Erie County Soil Survey, this point is located in Canandaigua mucky silt loam, which is listed as a strongly hydric soil in this county (Figures 17 & 18). The matrix (primary component) soil color was 10YR6/2 from 0-14 inches, darkening to 10YR6/1 from 14-18 inches. Mottles (secondary component) occupied about 10% of the soil in the upper 0-5 inches, increasing to about 30% from 5-18 inches, with color of 7.5YR6/8. Soil texture from 0-5 inches was smooth, and an extended ribbon of 2.0 inches, indicating this is a silty clay loam. From 5-18 inches the soil had slight grit, and after moistening, a ribbon extended to 1.5 inches, indicating a texture of clay loam. Based on later laboratory analysis, the organic matter content from a sample taken at a depth of about 8-12 inches was quite low at 0.9% (Table 3). In summary, the soil at Sample Point #1 showed hydric characteristics (i.e., low matrix chroma, the presence of redoximorphic features; Figures 19 & 20).

Herbaceous vegetation dominated the area around Sample Point #1 (Figure 21). The Dominance Test showed hydrophytic vegetation was present (bristly dewberry; 30% cover), late goldenrod (20%), plus reed canarygrass and woolgrass in the vicinity; all FACW wetland indicator status). The occurrence of multiple unidentified grass species without seeds present, however, made confirmation of the full complement of hydrophytic vegetation indicators uncertain. Wetland plant species with common names and scientific names are listed from all Sample Points and reference sites in Table 4 at the end of this section (see data forms in Appendix 2).

Sample Point #1 occurs at the lower portion of the hillslope (about 2% slope), from Sharp Road to Elk Creek, but with a slight convex landform. The only confirmed hydrologic indicators present at this site were oxidized rhizospheres, a primary hydrologic indicator,[2] which indicates active hydrologic influence of the current plant community. Since atypical circumstances occurred at Sample Point #1 due to site alterations of hydrology and vegetation, the presence of all three wetlands indicators is not necessary to determine if the site is a wetland where a plausible explanation for an unconfirmed indicator is found. There was not sufficient detail available for the layout of the tile drainage and ditch network to estimate quantitative impacts on the Marsh Site, nor are there any known hydrologic measuring devices on site. There is sufficient evidence, however, to indicate hydrology was present. Aerial photography shows that there was natural vegetation and standing water in the floodplain along Elk Creek in 2005 and 2011, suggesting a more natural hydrologic regime, sufficient to maintain hydric soils and support hydrophytic vegetation, was present pre-disturbances for at least 10 years. Therefore, in my opinion wetlands occur at Sample Point #1 at the present time, despite efforts to alter the hydrology and vegetation in 2012.

<u>Sample Point #2</u> – Located at (41.9792153, -80.0466794) upslope from Sample Point #1, on the upper one third of the hillslope, a similar distance from Lane Road. According to the Erie County Soil Survey, this point is located in Canandaigua mucky silt loam, which is listed as a strongly hydric soil in this county (Figures 17 & 18). The soil pit showed a histosol (black, highly organic soil which is a confirmed hydric soil type) with no mottling from 0-8 inches. From 8-17 inches the matrix color was 7.5YR6/1, and mottles of 10YR6/8, occupying about 30% (Figure 22). At about 17-18 inches in depth, rock fragments prevented further excavation. A soil sample was taken for analyses which results are shown in Table 1. Organic matter of this histosol was high, at 31.8%, as expected (Table 3).

[2] Only one primary indicator is necessary to confirm presence of the hydrologic indicator (Corps 2012).

The vegetation in the vicinity of Sample Point #2 consisted of a combination of herbaceous and shrub species (Figure 23). The Dominance Test was positive for hydrophytic vegetation at 67% wetland species. There were no definitive hydrologic indicators at this point. Since normal circumstances do not exist at Sample Point #2, due to site alterations of hydrology and vegetation, the presence of all three wetlands indicators is not necessary to determine if the site is a wetland where a plausible explanation for the unconfirmed indicator is found. There was not sufficient detail available for the layout of the tile drainage and ditch network to estimate quantitative impacts on the Marsh Site, nor are there any known hydrologic measuring devices on site. The presence of a histosol (highly organic hydric soil), however, is a strong indicator that hydric conditions are present, especially when a viable hydrophytic plant community is present. Based on observations and the presence of a histosol, which develops over extensive time periods when conditions are sufficiently wet, there is active hydrology on this portion of the Marsh Site. Therefore, in my opinion wetlands are present at Sample Point #2 at the present time, despite efforts to alter the hydrology and vegetation in 2012.

Sample Point #3 – Located at (41.9806992, -80.0470911) in a level area about 200 feet off Sharp Road. According to the Erie County Soil Survey, this point is located near the transition between Canandaigua mucky silt loam, which is listed as a strongly hydric soil in this county, and Red Hook silt loam (along Sharp Road), which is listed as a non-hydric soil (Figures 17 & 18). The soil pit suggested this is a transition area, with 5YR5/1 matrix from 0-10 inches, and mottles occupying 10% with a color of 75YR5/6. Oxidized rhizospheres were observed (and photographed, Figure 25) in the upper 9-10 inches. The soil texture was not gritty, and produced a ribbon of 1.5 inches, indicating this is a silty clay loam. From 10-18 inches the matrix color was a mixture of 10YR6/2 and 10YR4/4, with small areas (2%) of mottles of 5YR4/4 presenting redoximorphic features (Figure 24 & 25).

The vegetation in the immediate area of the soil pit for Sample Point #3 was dominated by herbaceous plants with scattered shrubs (Figure 26, Table 4). In the vicinity, there were pockets of elderberry and willow (typically wetland species), and quaking aspen in slightly higher elevation areas. The Dominance Test was positive for hydrophytic vegetation at 100% wetland species. The definitive hydrologic indicator at this Sample Point was oxidized rhizospheres, a primary indicator. Since normal circumstances do not exist at Sample Point #3, due to site alterations of hydrology and vegetation, plus past farming activity, the presence of all three wetlands indicators is not necessary to determine if the site is a wetland where a plausible explanation for the unconfirmed indicator is found. There was not sufficient detail available for the layout of the tile drainage and ditch network to estimate quantitative impacts on the Marsh Site, nor are there any known hydrologic measuring devices on site. Observations, however, show hydrology is present in sufficient quantity to support functional wetlands. Thus, there is evidence for the presence of all three wetland indicators (see data forms in Appendix 2). In my opinion wetlands are present at Sample Point #3 at the present time, despite efforts to alter the hydrology and vegetation in 2012.

Sample Point #4 – Located at (41.98072968, -80.0456731) and reached by walking straight downhill from Sample Point #3 to the riparian area of Elk Creek. Between points #3 and 4 were observed some wetland species (soft rush, woolgrass, reed canarygrass) and various species of goldenrod (Figure 27). Yellow-pond lily, an obligate wetland plant was observed within the Elk Creek channel, plus some unidentified submergent plant species. The soil survey mapped this area as a Wick silt loam, classified as a hydric soil (Figures 17 & 18). The soil within the soil pit was relatively uniform in characteristics. From 0-8 inches the matrix was 10YR3/1 with no mottles, with some characteristics of histosols. From 8-18 inches the matrix color was 10YR4/1, with mottles occupying 20% with a color of 2.5YR4/6. Small areas displaying redoximorphic features and oxidized rhizospheres were observed (Figures 27 & 28). Soil texture was not gritty, and a ribbon longer than 2 inches was produced by touch, indicating this is a silty clay. A soil sample was taken at 6-8 inches for laboratory analysis. The sample had an organic matter content of 5.4% (Table 3).

The surrounding herbaceous vegetation was dominated by reed canarygrass (95% cover; FACW) a wetland species, with some late goldenrod (15%; FACW), 5% thistle (no species identification), and trace amounts of blue vervain, a wetland species (FACW). The Dominance Test was positive for wetland determination at 100%. There was no woody vegetation (Figure 29). Hydrologic indicators included oxidized rhizopheres, a primary hydrology indicator, but there was no indication of overbank flooding at this location from Elk Creek. Thus, there was evidence for all three wetland indicators were present. Sparrows were observed along the riparian bank.

<u>Sample Point #5</u> – Located at (41.9799772, -80.0447607) in the alder patch adjacent to Elk Creek. To reach this point, I walked through several small linear ditches, and located the soil pit about 6 feet from a deeper ditch, with floating duckweed on the surface (Figure 30). The ditch held 12 inches of water, and the bottom was 18-20 inches below the top of bank, suggesting a local water table depth about 6 inches below the surface. This ditch is about 10-15 feet from Elk Creek. This point was mapped as a transition area between Wick silt loam (Elk Creek floodplain) and Canandaigua silt loam (further up slope) by the Erie Co. Soil Survey (Figures 17 & 18). In addition, there were natural surface drainage patterns through the alder patches. From 0-12 inches in the soil pit was a histosol with a color of 10YR2/1 with no mottles (Figure 30). From 12-18 inches the color was 10YR3/1 with more mineral content; 2-inch ribbon with sticky touch and no grit, indicating this was a silty clay. There were oxidized rhizospheres with a reddish color (7.5YR4/4), only along the root channels. Water seepage appeared in the bottom of the soil pit within a few minutes, at about the depth of the nearby ditch. Clearly this area shows strong hydric conditions across all three indicators. Elk Creek is within 20-30 feet of this site and has yellow pond lily and other submergent aquatic plant species (Figures 31 & 32). The Dominance Test was positive for wetland determination of the plant indicators with three dominant species (i.e., speckled alder, late goldenrod, silky dogwood), all FACW indicator status. All three wetland indicators were present at Sample Point #5.

<u>Sample Point #6</u> – Located at (41.9817111, -80.04611269) about 100 feet south of Elk Creek along the large bend in the creek in the northern section of the Marsh Site. The terrain is hummocky (raised plant mounds interspersed with lower elevation areas of less vegetated soil (in this case a sedge species)), indicating a likely wetland condition. This area was mapped on the soil survey as a Wick silt loam (Figures 17 & 18). From 0-7 inches in the soil pit the chroma was 7.5YR5/1, with mottles occupying 30% with a chroma of 7.5YR6/8. From 7-18 inches the

chroma was similar with mottles occupying 40% of the soil structure (Figures 34 & 35). The soil column consisted a very dense clay producing a ribbon of >2 inches that was relatively smooth, indicating it had the texture of a clay. Oxidized rhizospheres were observed and photographed in the soil profile. After about 15 minutes of digging the soil pit, water was seen in the bottom of the pit, and glistening (seepage of water) on the walls from 0-7 inches. All of this indicates strong influences of hydrology at the site from Elk Creek, with both surface water connectivity and shallow groundwater. Only herbaceous vegetation was found at the site with sedges occupying about 90% cover (mostly fox sedge, FACW), woolgrass (FACW) at 50%, and sharpwing monkeyflower at 20% (OBL) (Figure 36). An unidentified goldenrod occupied 30% (wetland status undetermined). The Dominance Test was positive for the wetland vegetation indicator. I determined that all three wetland indicators were present. A belted kingfisher flew overhead, likely preying on fish in Elk Creek. .

Table 1. Legend and characteristics of soil types of Marsh Site (USDA Web Soil Survey, Erie Co., PA).

Tables — Hydrologic Soil Group — Summary By Map Unit

Summary by Map Unit — Erie County, Pennsylvania (PA

Summary by Map Unit — Erie County, Pennsylvania (PA049)

Map unit symbol	Map unit name	Rating
Cc	Canandaigua mucky silt loam	C/D
CnB	Chenango gravelly silt loam, 3 to 8 percent slopes	A
CnC	Chenango gravelly silt loam, 8 to 15 percent slopes	A
FrA	Fredon silt loam, 0 to 3 percent slopes	B/D
PtB	Pompton silt loam, 3 to 8 percent slopes	A/D
RhB	Red Hook silt loam, 3 to 8 percent slopes	B/D
Wc	Wick silt loam	B/D
Totals for Area of Interest		

Table 2. Descriptions of Hydrologic Soil Groups from Web Soil Survey, Erie Co., PA.

Description — Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Table 3. Analytical Results from 2017 Soil Samples from Marsh Site.

Wetland soil sample point	Depth of sample (in.)	Organic matter (%)	Total phosphorus (ppm)	pH	Notes:
2017 Soil Samples					
#1	6-8	0.9	5	5.0	Silty clay loam
#2	6-8	31.8	16	6.6	Histosol
#4	6-8	5.4	26	5.5	Silty clay

Summary of wetland identification:
Based my observations of soils in standard wetland delineation soil pits (18-20 inches deep, 8 inches diameter), soils at all of the six sample points examined in 2017 at the Marsh Site showed characteristics of hydric soils. Soils clearly had hydric indicators, including low chromas (i.e., brightness or dullness of color based on standard Munsell color chart) and redoximorphic features (i.e., chemical and physical characteristics indicative of inundated, saturated, or fluctuating water table). The chroma of sample point soils were typically “1 or 2”, a strong indicator of hydric conditions for this region.

There were several characteristics of the sample points that surprised me. Sample Point #2 is slightly upslope of #1, yet the soil here was a histosol, a highly organic, high carbon soil typical of areas that are inundated or saturated near the surface over long periods of time. I would expect histosols to occur in flat terrain closer to Elk Creek. Because this area exists on a slope, the source of that water likely would be shallow ground water moving from the surrounding slopes (see Figure 1) toward Elk Creek. It is my considered opinion likely that the installation of drainage tiles and ditches in 2012 are effectively draining the area, such that the plant community returning after the 2012 cutting and grubbing of vegetation responded to drier conditions. The plants present, although having some affinity for wetland conditions, generally were not obligate species that might be associated with saturated soils. They were, however, consistently facultative wetland (FACW), a strong indicator of sufficient hydrology to develop wetland conditions. There were few indicators of hydrology in this vicinity, although I would have expected to observe several, given the presence of a histosol. My conclusion, then, is that a change in hydrology, from the result of recent drainage, caused this observed incongruence between the soil characteristics and the plant community.

At Sample Point #3, I expected soil and vegetation characteristics to reflect drier conditions, since this area had been plowed and presumably cropped in the past in the rectangular section along Sharp Road (see Figures 3-5). The soil matrix, however, had low chroma colors throughout, mottles, oxidized rhizospheres (indicative of very recent saturation or a fluctuating high water table causing water stress to the plant roots), and evidence of other redoximorphic features, all of which suggest a seasonally fluctuating water table. There were small patches of hydrophytic plants in the area. Here, I suggest that shallow groundwater moving west to east plays a role in creating wetland conditions in this area of the Marsh Site, despite past farming practices.

I expected the conditions at Sample Points #4, 5, and 6 to show the strongest indicators of wetland presence because they occur at the lowest elevations, closest to Elk Creek (Figure 17), and where wetland and floodplain inundation have occurred in the past (Figures 7-9). They did have definitive wetland indicators present, although the indicators were quite variable among the three points. The bottom of soil pits dug to 18 inches showed seepage and accumulating water at these sites, a strong hydrologic indicator. Hydrologic, soil, and plant indicators were all strong. I expected to see evidence of overbank flooding from Elk Creek as this seemingly occurred in the past (note standing water and natural channel features along Elk Creek in the 2011 aerial photograph (Figures 6-9)). Artificially deepening and/or dredging the channel of Elk Creek along the eastern edge of the Marsh Site, however, occurred in 2012 (see Section 4.2), which reduced or eliminated overbank flooding – a natural process – and has led to gradual drying out of the riparian corridor, with resultant changes in and loss of wetlands.

Therefore, in my opinion wetlands are present currently at all six Sample Points of the Marsh Site, despite efforts to alter the hydrology and vegetation in 2012. The areal extent of wetlands throughout the Marsh Site, however, is likely diminished due to these alterations.

4.4 Reference Wetlands in the Vicinity of the Marsh Site

On 17 October 2017, I looked for relatively undisturbed reference wetlands with which to compare to those on the Marsh Site. I sought similar wetlands on public lands or accessible private lands, where access was not an issue, and where the wetlands would likely be conserved in the future. There are NWI-mapped wetlands located along tributaries of Elk Creek upstream and downstream of the Marsh Site (Figure 1), but these are mostly under private ownership. When assessing the impact of alterations to natural wetlands, it is common practice to look for nearby similar relatively undisturbed wetlands to use as reference wetlands and to determine what characteristics and functions have been lost or degraded at the affected wetlands (e.g., U.S. Army Corps 2012). The Corps Regional Supplement for the Northcentral and Northeast Region (2012) provides guidance on approaches for making these comparisons in atypical situations, where human disturbances have occurred. For example, I used the following techniques to compare the wetlands of the Marsh Site to similar reference wetlands nearby:

"*1. Vegetation – The goal is to determine the plant community that would occupy the site under normal circumstances, if the vegetation were not cleared or manipulated.*

a. Examine the site for volunteer vegetation that emerges between cultivations, plantings, mowings, or other treatments.

b. Examine the vegetation on an undisturbed reference area with soils and hydrology similar to those on the site." (U.S. Army Corps 2012:116).

…

"*2. Soils …*

a. Examine NRCS soil survey maps and the local hydric soils list for the likely presence of hydric soils on the site.

b. Examine the soils on an undisturbed reference area with landscape position, parent materials, and hydrology similar to those on the site. (U.S. Army Corps 2012:117).

…

"*3. Hydrology – The goal is to determine whether wetland hydrology is present on a managed site under normal circumstances, as defined in the Corps Manual and subsequent guidance. These sites may or may not have been hydrologically manipulated.*

a. Examine the site for existing indicators of wetland hydrology. If the natural hydrology of the site has been permanently altered, discount any indicators known to have been produced before the alteration (e.g., relict water marks or drift lines).

b. In agricultural areas (e.g., row crops, hayfields, tree farms, nurseries, orchards, and others) examine five or more years of aerial photographs for wetness signature … (U.S. Army Corps 2012:117).

…

"*c. Reference sites with known hydrology. If indicators of hydric soil and wetland hydrology are present, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas whose hydrology is known. Hydrologic characteristics of wetland reference areas should be documented through long-term monitoring or by application of the procedure described in item 5b above. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the district or field office.*" (U.S. Army Corps 2012:127).

I examined the National Wetlands Inventory for possible similar reference sites and focused on State Game Lands 109 about 3 miles east of the Marsh Site, where LeBoeuf Creek meanders through an area bounded by the Perry Highway (Rt. 97) to the west and a railroad bed to the east, and beyond. LeBoeuf Creek is a tributary to the noted biologically diverse French Creek, south of Waterford. I also examined data from three wetlands from the Riparia Reference Wetlands Database at the Pennsylvania State University, #s 220, 221, and 222. These natural wetlands also are located in the glaciated northwestern corner of Pennsylvania, in the same physiographic region as the Marsh Site. They were first sampled in 2003 and again in 2013, with wetland characteristics persisting over that decade. The methodology used to sample these wetlands is similar to wetland delineation, but is more intensive, attempting to identify all plant species, and assessing potential wildlife habitat. Descriptions are based on data collected and archived in the Riparia Reference Wetlands Database. In addition, I reviewed relevant literature that shows typical hydrographs for relatively undisturbed wetlands, where saturation occurs for 14 days or more at 12 inches (30 cm) or less from the ground surface (Hychka et al. 2013). Hydrologic regimes of this nature produce the signature hydric soil indicators expected in many wetland types, including those found in landscape positions similar to those of the Marsh Site.

<u>Reference Wetlands on State Game Lands 109</u>:

Sample Site #7 (Reference Wetland) - Located at (41.999, -80.002) about 625 feet east of the junction of Perry Highway (Rt. 97) and Old State Line Road, a gated road into State Game Lands 109, and less than 3 miles from the Marsh Site (Figure 37). NWI classifies this wetland as a PFO/SS1E (Palustrine Forested/Scrub-Shrub Broad-leaved Deciduous Seasonally Flooded/Saturated), which is similar to how the Marsh Site is classified by NWI before disturbances occurred (Figure 38). This site is a riverine upper perennial wetland according to HGM classification, the same as the Sample Point #s 4, 5, & 6, occurring on a broad floodplain.

There is considerable herbaceous cover as well, primarily reed canarygrass (Figure 39). This wetland is in a relatively level area with hydrologic connections to headwater streams. The classified soil from the Erie Co. Soil Survey was Canandaigua mucky silt loam, the dominant soil at the Marsh Site. The matrix of the upper portion (0-7 inches) of the soil column was a histosol (7.5YR3/1) with no mottles. From 7-18 inches in depth the soil was gleyed with high organic matter content (2.5Y3/1) and no mottles (Figure 40). The smooth clay-like texture produced a ribbon in excess of 2 inches, suggesting it was a silty clay or clay. There was a high water table within 1 inch of the surface. Water-stained leaves were apparent in low spots. The vegetation included red maple and black willow in tree stratum, and northern arrowwood and black willow in the shrub layer. The herbaceous layer was dominated by reed canarygrass (100% cover), with bur-reed (5%), speckled alder seedlings, and goldenrod. The Dominance Test was positive for wetland determination of the plant indicators with two dominant species (i.e., reed canarygrass and black willow), both have FACW indicator status. There were additional wetland-dependent species, not dominants, with wetland indicator status of FAC, FACW, and OBL (see data form in Appendix 2). All three wetland indicators were present in reference wetland #7.

Sample Site #8 (Reference Wetland) - Located at (41.999, 80.002) about 500 feet south of Sampson Road off Perry Highway, and about 800 feet from the junction with Perry Highway (Rt. 97). This site is also on State Game Lands 109, and about 3 miles east of the Marsh Site (Figure 37). NWI classifies this wetland similarly as #7, a transition zone between PFO/SS1E (Palustrine Forested/Scrub-Shrub Broad-leaved Deciduous Seasonally Flooded/Saturated) and PEM/SS1C (Palustrine Emergent/Scrub-Shrub Broad-leaved Deciduous Seasonally Flooded), which is similar to how the Marsh Site is classified by NWI before disturbances occurred (Figure 41). By HGM classification, this site is a riverine upper perennial wetland, the same as the Sample Point #s 4, 5, & 6, occurring on a broad floodplain. There was some flooding of the site from a nearby stream, possibly from the fast-moving rainstorm that went through the region the afternoon of 15 October 2017. The floodwaters were clear, with no evidence of sediment. This wetland is in a relatively level area with hydrologic connections to headwater streams, and hummocky ground. The classified soil from the Erie Co. Soil Survey also was Canandaigua mucky silt loam, the same dominant soil as occurred at the Marsh Site. The matrix of the upper portion (0-5 inches) of the soil column was a histosol (7.5YR3/2) with no mottles. From 5-18 inches there was a mixture of organic muck and clay (7.5YR4/1) with no mottles, but there were oxidized rhizospheres near the surface with 5YR5/8 (bright orange) root channels, indicating considerable hydrologic stress (Figure 42). There was a high water table to the surface, but this was likely impacted by high water dammed by a road culvert on Sampson Road. Water-stained leaves were apparent in low spots. Hydrologic indicators were abundant, including surface water, high water table, soil saturation, watermarks on trees, water-stained leaves, oxidized rhizospheres, and buttressed tree trunks. The vegetation included red maple (FAC) and black ash (FACW) in the tree stratum, and sweet pepperbush (FAC) in the shrub layer. The herbaceous layer was dominated by tussock (upright) sedge (100% cover, OBL), with burreed (20%, OBL), reed canarygrass (20%, FACW), bluejoint (20%, grass, OBL), and traces of sensitive fern and a large-leaved mint, unidentified (Figure 43)**.** The Dominance Test was positive for wetland determination of the plant indicators with five dominant species all meeting the OBL, FACW, FAC indicator status (100%). There were additional wetland-dependent species, not dominants, all with wetland indicator status of OBL, FACW, and FAC (see data form in Appendix 2). All three wetland indicators were present in reference wetland #8.

Reference Wetlands from the Riparia Reference Wetlands Database:
Reference Wetland #220 (ENWR1) – Located (approximately 41.56811, -79.9800) on the Erie National Wildlife Refuge in Crawford County, PA, near Route 173, about 1 mile west of the Refuge Headquarters along Lake Creek, in a mainstem floodplain landscape position, according to HGM classification, along a larger river. NWI classified this site as PFO1E (Palustrine Forested, Broad-leaved Deciduous, Seasonally Flooded/Saturated, which is similar to wetlands of the Marsh Site (Figure 44). Few stressors were present. The Crawford County Soil Survey (Web Soil Survey) reports the soil is Carlisle muck, a very poorly drained hydric soil (A/D hydric group). Soils were histosols (expected for a highly organic muck), and similar throughout the site in 2003 having chromas of 10YR2/1 and no mottles. With different soil pits dug in 2013, matrix chromas were similar at 10YR2/2 or 3/1, but mottles were observed with chromas of 5YR4/6. A gleyed soil area was observed with matrix chroma of 2.5YR4/1, and mottles of 2.5YR6/6 or 5/8 at between 20-40%. Shrubs dominated, with no trees, and included speckled alder, black willow, northern arrowwood, silky dogwood, and swamp rose. There were about 40 herbaceous (or young woody) species present. Few invasive plant species were observed. The site was highly inundated in both 2003 and 2013, making sampling somewhat difficult. The site is influenced heavily by the flooding regime of Lake Creek, which is immediately adjacent. All three wetland indicators were present in reference wetland #220.

Reference Wetland #221 (Ball Road) – Located on private land (approximately 41.58786, -80.40367) near State Game Lands 214 by the Pymatuning Wetland Complex near Linesville, Crawford County, PA. This small wetland was not detected by NWI mapping (Note: western PA wetlands were mapped in the early 1980s using high altitude (1:80,000 B&W aerial photography, making detection of small wetlands difficult)). This site is considered a riverine headwater floodplain by HGM classification, dominated by shrubs. This wetland is along a secondary road, near Hartstown Road, and surrounded by cropfields (Figure 45). Soils had matrix chromas of 10YR3/1 or 3/2, and about 10% mottles with variable chromas of 5YR4/6, 10YR4/4, 5YR5/8, 7.5YR4/6 with obvious redoximorphic features. The texture was a silty clay loam. Soils were similar in 2003 and 2013 as expected. Some water was seen in the bottom of the 18-inch pits during both years, suggesting shallow groundwater was present, with possible connections to the stream. A small stream meandered through the site. Woody species included silky dogwood, northern arrowwood, green ash, pin oak, hawthorn, and black willow. About 40 herbaceous species were identified. Several invasive plant species were identified, but the plant community was strongly hydrophytic. All three wetland indicators were present in reference wetland #221.

Reference Wetland #222 (ENWR2) – Located (approximately 41.59611, -79.97683) on the Erie National Wildlife Refuge in Crawford County, PA, near the junction of Guy Mills Road (Rt. 27) and Boland Road near Mt. Hope, USGS Sugar Lake topographic quadrangle. This wetland is described by NWI as a PFO4C (Palustrine Forested Needle-leaved Evergreen Seasonally Flooded) (Figure 46). With regard to a hydrogeomorphic (HGM) classification, it is considered a topographic slope wetland on the edge of a saturated valley bottom, similar to Sample Points on the Marsh Site. There were few stressors in evidence at this site. Tree canopy closure was 70%, with 40% herbaceous cover due to the shade of conifers. Eastern hemlock, yellow birch, and black ash were common. The shrub community contained northern arrowwood, silky dogwood, speckled alder, and steeplebush. The herbaceous community was highly diverse with 66 species or distinct genera identified in 2003, with a similar number in 2013. Few invasive species were present. The overall plant community was strongly hydrophytic. The Crawford County Soil Survey (Web Soil Survey) reports the soil is Holly silt loam, a poorly drained hydric soil (B/D hydric group). Soils were histosols, saturated near the surface, with a chroma of 10YR2/1 and no brighter mottles; chroma and conditions remained similar between 2003 and 2013, as expected. All three wetland indicators were present in reference wetland #222.

Summary of Findings from Reference Wetlands:

The five reference wetlands selected provide indications of how the Marsh Site wetlands would appear if alterations of hydrology, soils, and vegetation had not occurred in 2012. Soil characteristics were similar to those at the Marsh Site, with the same mapped soil type found on the closest reference wetlands (#s 7 & 8), Canandaigua mucky silt loam, classified as a hydric soil in Erie Co. The plant communities of reference wetlands were strongly hydrophytic and more diverse than the Marsh Site, which is expected given the altered hydrology and removal of vegetation at the latter site. Reference wetlands had a wider range of plant indicator status then the Marsh Site, which suggests the more naturalistic conditions of reference wetlands provide more varied ecological niches that support diverse floral and fauna communities. Reference wetlands, all with relatively undisturbed hydrology, were wetter than the wetlands at the Marsh Site. Water tables were closer to the surface and soils were saturated with a full set of hydric soil indicators. The hydrologic alterations of drainage tiles and ditches installed in the Marsh Site in 2012 are likely causing the somewhat drier conditions there. Restoration of the hydrology at the Marsh Site will help increase the wetness of wetlands there, and thus, provide a pathway to fully recover lost and degraded functions and services.

Table 4. Common names, scientific names, and wetland indicator status of plant species found in the six Sample Points on the Marsh Site (#s 1-6), and two of the reference wetlands (#s 7 & 8).

	Scientific Name	Common Name	Wetland Indicator Status
Herbaceous			
	Alnus incana	Speckled alder	FACW
	Aster vimineus (renamed - Symphyotrichum lateriflorum)	Small white aster	FAC
	Calamagrostis canadensis	Bluejoint	OBL or FACW
	Carex stricta	Upright sedge	OBL
	Carex vulpinoidea	Fox sedge	OBL
	Juncus effusus	Soft rush	FACW
	Lemna minor	Common duckweed	OBL
	Mimulus alatus	Sharpwing monkeyflower	OBL
	Nuphar lutea	Yellow pond-lily	OBL
	Onoclea sensibilis	Sensitive fern	FACW
	Phalaris arundinacea	Reed canarygrass	FACW
	Rosa palustris	Swamp rose	OBL
	Rubus allegheniensis	Allegheny blackberry	FACU

	Rubus hispidus	Bristly dewberry	FACW
	Scirpus cyperinus	Woolgrass	OBL
	Solidago gigantea	Late goldenrod	FACW
	Sparganium americanum	American bur-reed	OBL
	Verbena hastata	Swamp verbena (Blue vervain)	FACW
Shrub			
	Clethra alnifolia	Sweet pepperbush	FAC
	Cornus amomum	Silky dogwood	FACW
	Cornus sericea	Red-osier dogwood	FACW
	Salix nigra	Black willow	OBL
	Sambuscus canadensis	Common elderberry	FACW
	Spiraea tomentosa	Steeplebush	FACW
	Viburnum recognitum	N. Arrowwood	FACW
Tree			
	Acer negundo	Box elder	FAC
	Acer rubrum	Red maple	FAC
	Betula alleghaniensis	Yellow birch	FAC
	Betula nigra	River birch	FACW
	Fraxinus nigra	Black ash	FACW
	Fraxinus pennsylvanicus	Green ash	FACW
	Populus tremuloides	Quaking aspen	FACU
	Quercus bicolor	Swamp white oak	FACW
	Salix nigra	Black willow	OBL
	Tsuga canadensis	Eastern hemlock	FAC

5.0 HYDROLOGIC CONNECTIVITY OF MARSH SITE WETLANDS AND ELK CREEK TO LAKE ERIE

Wetlands typically do not exist in isolation. They are hydrologically linked to other wetlands or waterbodies through surface water and groundwater connections. The ecological relationship between wetlands and other waters is influenced by factors such as regional and local hydrology, local topography, and past and current land uses. These factors may be investigated by collecting existing information, conducting field studies, and interpreting the results. An extensive literature review on the topic of physical, chemical, and biological connectivity of streams and wetlands was compiled recently with input from national experts for EPA (U.S. Environmental Protection Agency. 2015. Connectivity of streams and wetlands to downstream waters: A review and synthesis of the scientific evidence. Office of Research and Development. EPA/600/R-14/475F. 408pp.).

The wetlands occurring and previously occurring on the Marsh Site are connected to Elk Creek in several ways. Histosols, which were present in some areas of the Marsh Site, especially in flat topographic areas in the floodplain, are high carbon soils typical of areas that are inundated or saturated near the surface over long periods of time. Because western portions of this area exist on a slope, the source of that water likely would be, in part, shallow ground water moving from the surrounding topographic slopes toward Elk Creek. It is known that PVC tiles or pipes were installed in 2012 and are effectively draining the area by concentrating flow in pipes with outlets directly into Elk Creek (see Figures 47 & 48). Due to this artificial drainage, it is likely that the plant community colonizing after the 2012 cutting and grubbing of vegetation responded to drier conditions, and developed in a somewhat drier community. Also, soils observed were high in fine silt and clay content, which would hold water near the surface, making infiltration into a deeper water table very slow. Perching of wetlands above the area water table by underlying clay-based soils near the surface, which were observed, also could be expected. In addition, overbank flooding from Elk Creek onto the broad floodplain could either pool water in shallow depressions and concavities in the landscape, or maintain saturated soils when the Elk Creek flows were near or over the top of the streambanks. My conclusion, however, is changes in hydrology occurring since 2012 from the installation of drains and ditches, caused the observed incongruence between the soil characteristics (hydric) and plant communities (less hydrophytic than expected).

It is my opinion that the infiltrating surface water and shallow ground water naturally occurring on the Marsh Site are being collected in a system of PVC tile drains and ditches installed by Brace in 2012 throughout the Marsh Site (Brace letter 2012, PFBC Log 2012, Figure 47). Also, lowering of the water table and reducing the detention time of precipitation, runoff and/or meltwater on the site by draining it into this PVC tile drain network, means that the water table is lowered and fewer indicators of hydrology would be observed near the surface. When coupled with the dredging of the channel of Elk Creek, the water table is effectively lowered to below the rooting depth of most herbaceous hydrophytes. Tile drainage and ditching both create what are known as “cones of depression”, which means the local water table is pulled down (drawdown) to lower depths, thereby reducing the time plant roots spend in saturated soils (Figure 48). After the cutting and grubbing of vegetation and soils on the Marsh Site occurred in 2012, the returning plant species likely shifted to more upland species and fewer wetland species. This was evident in the six Sample Points I assessed in October 2017. Although post-disturbance, the six Sample Points currently have hydrophytic vegetation that meets the wetland vegetation indicator (mostly FACW ranked species). The pre-disturbance plant community likely would have had a wetter signature, with more obligate (OBL) wetland species and more diversity.

Soils, however, maintain evidence of past inundation and saturation for years, even decades, after the hydrologic inputs have been reduced or eliminated. The evidence I observed in the soil pits from the six Sample Points showed that all six were subjected to either saturation or a seasonally fluctuating water table in the past (and at the present) sufficient to produce obvious indicators of hydric soils, such as low chroma matrices and redoximorphic features. If these soils were “relic” hydric soils (hydric evidence persisting but not currently functioning), then the site would be effectively drained such that wetlands would not be supported. On the Marsh Site, this is not the case. There are still areas of wetlands showing a strong suite of indicators to confirm wetland occurrence (see Section 4.0). In addition, there were hydrophytic plant species within the plant communities in all six of the Sample Points, and active oxidized rhizospheres in the excavated soil from the pits, demonstrating current hydrologic stress on the plant communities. Thus, there remains sufficient water on the Marsh Site, for long enough periods of time, to support wetlands and wetland-dependent plant species despite efforts to remove the hydrologic influence by drainage and dredging by Brace.

Connectivity to Lake Erie:
On 16 October 2017, I followed the flow path of Elk Creek from the Lane Road culvert under Lane Road (Point 1) at the Marsh Site to its confluence with Lake Erie at Erie Bluffs State Park. The remaining points and associated photographs are listed in Table 5 below:

Table 5. Ground level and aerial images along Elk Creek from the Marsh Site to Lake Erie.

Point 1 looking downstream along Elk Creek at Lane Road, Waterford, PA (Figure 49).
Point 2 near the road bridge crossing of Elk Creek under Sharp Road, looking upstream (Figure 50).
Point 3 looking downstream off Greenlee Road (Figure 51).
Point 4 off Hamot Road looking upstream; stream bed rocky and relatively steep-sided, more incised than the reach of Elk Creek along the east border of the Marsh Site (Figure 52).
Point 5 crossing under Oliver Road, steep-sided gorge; bridge supported by gabions (Figures 53 & Figure 54 (aerial).
The river flow path was followed as it paralleled Dunn Valley road to the west. In McKean, took West Street under I-79 to intersection with Route 882.
Point 6 accessed bridge crossing at Pennsylvania Fish and Boat Commission river access parking lot; photograph looking upstream; river is shallow, at least twice as wide as upstream sections, with a rocky bottom (Figure 55).
Traveled along Route 882 west to Route 20, then Route 213, to Route 5.
Point 7 is a slack water reach within the Erie Bluffs State Park (part of the Great Lakes Seaway Trail), where at least eight persons were fishing (Figure 56). As per Google Earth image (Figure 57), this reach connects directly to Lake Erie in about 500 feet to a sand spit referred to as “The Mouth”, establishing permanent connectivity to a TNW.

My conclusion is that Elk Creek flows continuously beginning in a headwater stream upstream of the culvert at Lane Road all the way to Lake Erie, a Traditional Navigable Water (TNW). The channel is well-defined, flows through mixed habitats, including alder-dominated, riverine, scrub-shrub wetlands in the upper reaches, then passes through steeper riparian corridors with upland forests, agricultural fields, and suburban residences. The Elk Creek watershed becomes more urbanized as it flows west into Lake Erie near the towns of McKean, Girard, and Lake City. Although no fish collection data were obtained, several schools of minnows (Cyprinidae) were observed in Elk Creek about 300 feet downstream of the Lane Road culvert. The presence of fish in a waterbody is often an indicator of water permanence throughout the year.

6.0 ASSESSMENT OF PHYSICAL, CHEMICAL AND BIOLOGICAL FUNCTIONS THAT THE MARSH SITE WETLANDS, AND SIMILARLY SITUATED WETLANDS PROVIDE TO ELK CREEK AND LAKE ERIE

Decades of study have shown that wetlands provide many ecological functions and societal values (e.g., World Resources Institute 2005, Mitsch and Gosselink 2007, USEPA 2015). These benefits are often cited as a rationale for protecting wetlands through law and regulation. Recently, the term ecosystem services has become a popular way to express these combined ecological functions and societal values. Ecosystem services were listed globally for wetlands in the Millennium Report (World Resources Institute 2005). Subsequently, they were defined more generally as "*…the benefits of nature to households, communities, and economies*." (Boyd and Banzhaf 2007).

The Marsh Site wetlands consist of a variety of types that, when in healthy condition, provide numerous functions or ecosystem services, including floodwater storage (e.g., Figure 58), water quality treatment, and habitat complexity. Similar reference wetlands that I selected and visited within the surrounding landscapes are in better condition and exposed to fewer alterations. They support a broader suite of functions (because of exposure to fewer stressors), including surface and subsurface water storage, nutrient cycling and removal of elements and compounds, carbon export, and maintenance of characteristic plant and animal communities. Higher levels and more diverse functions would be anticipated in the Marsh Site wetlands, if alterations by Brace had not taken place.

The following sections describe the physical-hydrologic, chemical water quality, and biological habitat functions that the Marsh Site provided, and continue to provide in a more limited capacity for downstream waters and the environment, including Elk Creek and Lake Erie.

6.1 Physical - Hydrologic Functions: floodwater storage and desynchronization

In section 5.0 I demonstrated that Elk Creek as a first order, headwater tributary stream adjacent to the Marsh Site, flows continuously and directly without interruption to Lake Erie, a TNW. In the past, frequent flooding of Elk Creek onto its floodplain and into adjacent wetlands, upstream and downstream of the Lane Road bridge would have occurred. There is clear photographic evidence of alterations being made to the Marsh Site reach of Elk Creek around 1939 (Figure 3), 1993 (Figure 5), and in 2012 (Figures 10 & 47, PFBC 2013). Sometime between 1993 and 2011, the stream was either restored, or allowed to revert to a more natural riverine dynamic creating meanders, backwaters, and other natural features.

The most recent evidence from 2012 and 2013 shows heavy machinery creating ditches and installing drainage pipes (PFBC 2013, USEPA & Corps 2013, Figure 47), presumably in an effort to lower the water table in adjacent areas, including wetlands. There is evidence of dredging the Elk Creek channel, which likely widened its channel width, steepened its streambanks, and increased its depth. When such actions occur, they create an incised channel that is deeper and more disconnected from the adjacent floodplain and wetlands. Also, channelization straightens a stream reach, removing the typical, natural sinuosity. A dredged and/or incised stream channel moves water more rapidly downstream. This further isolates the stream channel from its floodplain and adjacent wetlands, and can result in drying of adjacent areas. Drainage pipes and ditches typically lower the adjoining water table resulting in less inundated and saturated soil within 18 inches (30 cm) of the surface, or deeper (see Figures 47 & 48). These actions, as performed by Brace in 2012, are detrimental to wetlands and the natural flood storage function.

These actions reduced the ecosystem's capacity to store water high up in the watershed, both in terms of amount stored, and timing of the storage (i.e., desynchronization or slow release). When this occurs, flood peaks are higher downstream, and floods are comprised of faster moving waters. Both tendencies can result in damage to downstream infrastructure (e.g., culverts, bridges, roads, buildings, stormwater facilities, sewage treatment facilities) and degradation of aquatic habitats (e.g., scour of bottom substrate removing fish and macroinvertebrate habitats, erosion of riparian banks causing release of excess sediments and loss of habitats).

I examined the Flood Emergency Management Agency's (FEMA) Flood Insurance Rate Map (Panel 385 for Erie Co., PA, dated 19 February 2014). Elk Creek headwaters, including the reach defining the Marsh Site's eastern boundary are denoted as Flood Zone A (Figure 59), which defines the 100-year floodplain (Figure 60). These maps are prepared to warn landowners (and set flood insurance rates) that demarcated areas have a risk of flooding at least once per year, and structures placed in these zones or activities occurring there can be subject to damage from flooding, and thus, should be kept clear. By negatively altering the Elk Creek channel and associated floodplain and wetlands, Brace potentially has increased the risk of flooding to both the local parcel and downstream areas.

In my opinion, alterations to the Marsh Site wetlands, including Elk Creek's floodplain, and Elk Creek's channel by Brace, are having a negative impact on both ecological functions and ecosystem services on adjacent and downstream habitats and structures. Protecting natural wetlands throughout the Elk Creek drainage area and the river's tributaries is critically important for storing and eventual slow release of floodwaters, which is recognized by local, state, and federal agencies and authorities responsible for the health, safety, and welfare of the citizens. Because of the flat terrain throughout this region, especially within the Lake Erie Coastal Plain, at times of high flow the local rivers overflow their banks and also push waters into their tributaries and adjacent wetlands. Without this considerable spatial network of highly connected rivers, streams, and wetlands to store excess water, flooding in downstream towns would become worse with subsequent increases in potential harm to local residents and to the aquatic habitats of Elk Creek and nearshore habitats of Lake Erie.

As can be seen by the three images displaying the flow path of Elk Creek from the easternmost headwaters westward to Lake Erie, the cluster of NWI-mapped wetlands on the Marsh Site and immediately adjacent is the largest wetland cluster along the entire length of Elk Creek (Figures 62, 63, and 64; all at same spatial scale). Although all headwater wetlands contribute incrementally to storage of floodwaters, as well as other important functions and services, the Marsh Site cluster is especially significant due to its larger areal extent, which is *three times greater in acreage* than six of next largest wetland clusters (Table 6; wetland cluster #s marked on red and orange circles on Figures 62 & 63). In NWI, mapped wetlands are represented as polygons, which are homogeneous patches of vegetation. Polygons can stand along or be contiguous with nearby wetlands. Aerial imagery used in the current portion of this version of the NWI was from 2011, the year before disturbance occurred at the Marsh Site (accessed 12 Dec 2017). Thus, the Marsh Creek wetland cluster (#1), having the largest areal extent of any cluster of wetlands immediately adjacent to the headwaters and mainstem of Elk Creek, makes them especially important for providing numerous and valued hydrologic, chemical, and biological functions and associated ecosystem services to Elk Creek and the nearshore areas of Lake Erie. All of the identified wetland clusters in Table 6 are located on tributaries of the Elk

Creek stream network, and thus, make similar contributions of water flow, water quality, and aquatic organisms to the mainstem of Elk Creek, and Lake Erie, the TNW into which Elk Creek flows.

Table 6. Acreage of 7 clusters of mapped NWI wetlands in the Elk Creek Watershed (Figures 62-64).

Wetland Cluster #	Mapped Wetland Acreage (number of mapped polygons)	General geographic location
1	218 ac (31)	Marsh Site cluster (north & south)
2	69 ac (15)	Tributary north of Marsh Site
3	37 ac (25)	North of McKean
4	61 ac (10)	McKean/Franklin Twps. (bndry).
5	30 ac (4)	Near Elk Creek Golf Course
6	19 ac (9)	Near Beechwood Golf Course
7	75 ac (10)	Franklin Twp.

6.2 Chemical - Water Quality Functions: nutrient cycling, pollutant and sediment trapping, and filtration

The impacts on hydrologic flow paths as discussed in Section 6.1 above will influence the chemical and water quality functions of the Marsh Site wetlands, floodplain, and Elk Creek channel. The water quality functions of wetlands and associated streams are delivered through multiple processes. The unique feature of wetlands, such as those on the Marsh Site and similarly situated wetlands in the Elk Creek watershed, where a narrow oxidized layer of soil (well oxygenated) overlays an anaerobic layer that is frequently saturated with water (poorly oxygenated), results in a combination of reactions that affect nutrient cycles and pollutant transformations. The paired reactions of nitrification and denitrification result in substantial removal of excess nitrogen from the ecosystem either as a released gas into the atmosphere, or in the formation of biomass held in plant roots, stems, and trunks. These same processes, usually enhanced by bacterial action, can decompose pollutants (such as petrochemicals) from complex, toxic molecules to simple ones used by plants, thus reducing pollutant loading to downstream waters (Mitsch and Gosselink 2007, USEPA 2015).

The trapping and transformation of sediments, pollutants, and excess nutrients (*material transport and transformation*) in wetlands on the Marsh Site and similarly situated wetlands in the vicinity, improve water quality for the receiving downstream waters, including Elk Creek and Lake Erie. Recent severe algal blooms occurring in Lake Erie are, in part, caused by excess nutrients flowing into the lake from tributaries within the drainage basin, such as Elk Creek, so wetlands throughout the Elk Creek watershed, but especially the Marsh Site cluster of wetlands, being the largest in area (Table 6), provide this important and valuable service of reducing nutrient loads to Lake Erie. Wetlands within the Elk Creek watershed serve to buffer the receiving waters of Elk Creek and Lake Erie from nutrient and sediment runoff originating from the substantial amount of agricultural land in the headwaters of Elk Creek and throughout the watershed (see Figure 37).

At the Marsh Site, before vegetation and soils within the wetlands on-site were disturbed in 2012, there were abundant (hundreds, possibly thousands of stems) trees and shrubs present (Figure 7). This substantial tree and shrub cover provided shade for herbaceous plants and kept water temperatures cooler, increased evapotranspiration rates, which also cooled waters, and increased topographic complexity that created microhabitats where decomposition and transformation reactions could occur. The dense tree and shrub cover at the Marsh Site, prior to disturbances, provided high stem density to slow the flow water down slope and through the wetlands and floodplain, as currently performed by similarly situated wetlands in the vicinity (Figure 65).

I located and investigated several reference wetlands on public lands (#s 7, 8), or from prior studies (#s 220, 221, 222) (see Section 4.4) to provide insight into how least disturbed reference wetlands could inform what had changed structurally and functionally following the reported and observed land use impacts at the Marsh Site. I did not pursue access to wetlands on private lands within the upper Elk Creek watershed due to long-term sensitivities about property rights in this area. The reference wetlands I did investigate all occur on public lands in the same geographic region. Past geologic history of glaciation, contributed to the abundant wetlands interconnected with other aquatic ecosystems throughout the northwestern region of Pennsylvania. Wetland abundance and density is much greater in the glaciated corners of Pennsylvania (northeastern and northwestern) than in the remainder of the Commonwealth. The five reference wetlands had similar vegetation structure, with all being classified by the National Wetland Inventory as Palustrine, Forested or Scrub-Shrub or Emergent (or combinations), and Saturated or Seasonally Flooded. Hydrogeomorphic classifications were likewise similar, being either riverine upper perennial (headwaters) or topographic slope wetlands.

The soils were similar as well, being in hydric soil groups in all cases. In the Crawford County reference sites they were comprised of histosols in some areas (e.g., Carlisle muck, #220), and silt loams in others (e.g., Holly silt loam, #222). The soil underlying reference Sample Points #7 & 8 was the same soil dominating in the Marsh Site, Canandaigua mucky silt loam, based on the Erie Co. Soil Survey classification.

Given the alterations to drainage patterns and lowering of the water table on the Marsh Site by ditching, installation of drainage pipes, and dredging the stream channel, the depth of the water table likely has increased and/or infiltration and ponding along the riparian corridor of Elk Creek has been reduced. I believe that if the Marsh Site had remained the same as observed remotely in 2011 (Figures 7-9), or had continued on a trajectory toward a fully vegetated, mixed type of wetland and floodplain complex, then the height of the water table and degree of saturation in soils would have been considerably wetter. The current presence of histosols, albeit partially disturbed, and redoximorphic features in most soil pits (low chroma, mottles, oxidized rhizospheres, etc.), plus wetland plants dominating some Sample Plot communities, show that the Marsh Site still has wetland components. Wetlands of the Marsh Site would likely have more pronounced wetland characteristics had they not been disturbed, such as more mature vegetation with obligate and facultative rankings, supported by larger areas of hydric soils.

All of these types of pre-disturbance characteristics would have enhanced not only the flood storage and habitat functional capabilities of the Marsh Site wetlands, but also increased their efficiencies in providing water quality functions. Post-disturbance at the Marsh Site, these associated functions are being reduced or eliminated, which results in a reduction in ecosystem services locally and further downstream in the Elk Creek watershed. Moreover, complete removal of these wetlands, if converted into active agricultural fields, would reduce these functions to zero, and negatively impact downstream waters even more than at present.

6.3 Biological - Habitat Functions: food web support and provision of habitat

6.3.1 Food Web Support

The biogeochemistry of wetlands is complex, but simply stated, for the once fully vegetated wetlands on the Marsh Site, where forest, shrub, and herbaceous plant communities were present as recently as 2011 (see Figures 7-9), the combination of hydric soils with abundant vegetation resulted in the accumulation and gradual release of organic matter (e.g., leaves, twigs, etc.) (Figure 61). The organic matter accumulated in the wetlands, where it was slowly decomposed primarily by microbial activity and soil invertebrates. In the next flush of water, organic carbon was exported into receiving water bodies such as Elk Creek. This process provides coarse and fine particulate matter that is consumed as food for aquatic life (e.g., zooplankton, benthic macroinvertebrates, amphibians, fish) (Mitsch and Gosselink 2007, USEPA 2015), which was in evidence in Elk Creek. Having a healthy community of aquatic life benefits macroinvertebrate and fish populations, not only in Elk Creek, but also in Lake Erie.

Some species of fish, such as rainbow smelt (*Osmerus mordax*), are important to the Lake Erie fishery. They spawn in the rivers that drain into Lake Erie, such as Elk Creek, where they feed on small aquatic organisms. The Elk Creek reach adjacent to the Marsh Site was assessed by PADEP for the 2016 Triennial Integrated Water Quality Monitoring and Assessment Report (303(d) list) (Figures 66 & 67). This reach was one of numerous points sampled for aquatic macroinvertebrates and water chemistry throughout the watershed. All streams of Elk Creek watershed appear to be in the same category, that is - Supporting Aquatic Life Use. This can be interpreted as Elk Creek has sufficient water chemistry and habitat to support a healthy community of aquatic macroinvertebrates. One reason Elk Creek is not impaired for this use is that wetlands throughout the watershed assist in reducing inputs of sediments, nutrients, and other pollutants. A healthy macroinvertebrate community contributes to a vibrant fish community since many fish species depend on invertebrates for food. It was noted that Elk Creek has a fish consumption advisory due to the presence of polychlorinated biphenyls (PCBs) from historic industrial discharges. In this case, the fish populations maybe relatively abundant and reproducing, but their tissues contain PCBs at a concentration unsuitable for frequent human use. Overall, however, Elk Creek is a relatively healthy watershed from the headwaters, like at the Marsh Site, all the way downstream to its outlet into Lake Erie.

6.3.2 Provision of Habitat for Terrestrial, Wetland, and Aquatic Species

The loss of shrub and tree cover along and near Elk Creek translates to a loss of habitats for a variety of aquatic and terrestrial species. As the vegetation leafs out, starting in May, the evapotranspiration (ET) rates, especially of shrubs and trees, increase substantially as a mechanism to promote photosynthesis in leaves, and thus, seasonal growth of the plants (Figure 61). The higher temperatures of summer contribute directly to evaporation of water from vegetation, land, and water surfaces, and stimulate transpiration from the vegetation. The increased ET rate and warmer temperatures draw down perched water tables in all but the wettest habitats. Without periodic precipitation, land surface and smaller waterbodies can become dry. Toward the end of the growing season in fall, temperatures cool, and transpiration rates of the vegetation are reduced as the leaves senesce and fall off. The cooler temperatures and the decreased ET rate, plus the likelihood of autumn precipitation, re-establish the perched or higher water tables. This cycle of seasonal precipitation and surface inundation or saturation near the land surface sustains regional hydrology sufficient to support wetlands year-round. In addition, intact vegetated wetlands provide habitats for a diversity of vertebrate and invertebrate species. The vertical structure provided by trees, shrubs, and ground cover, plus varying levels of soil inundation and saturation, create many ecological niches where a diversity of plant and animal species can find foraging, resting, and breeding habitats.

6.4 Summary of Physical, Chemical, and Biological Functions

In summary, disturbances to wetland vegetation, hydric soils, and aquatic habitats of the Marsh Site and adjacent Elk Creek have severely altered conditions that existed in 2011. Closed-canopy tree and shrub cover was present, plus substantial emergent wetlands, and a floodplain connected hydrologically and biologically to Elk Creek, contributed considerable ecological functions and ecosystem services, such as flood storage and desynchronization, infiltration of surface and near surface flows, nutrient cycling and removal of elements and compounds, carbon export into receiving water to support food webs, and maintenance of habitats for characteristic plant and animal communities. Table 7 (from Tiner et al. 2014:Table 12) provide a detailed listing of functions and services that probably occur on various wetland types, as classified on the NWI mapping for the Lake Erie watersheds from Pennsylvania. Although the headwaters of Elk Creek lie outside the current Lake Erie Coastal Zone, specific functions and services listed here would be expected from the pre-disturbance wetland types of the Marsh Site (marked with an * in Table 7). Impacts to the Marsh Site (i.e., vegetation removal and grubbing, tilling of soils, installing PVC drainage tiles), including the floodplain and Elk Creek channel (i.e., ditching, grading, dredging, side-casting) have significantly degraded the wetlands, floodplain, and streams of this area, and likely eliminated some functions, and severely degraded others.

Table 7. General relationships between wetlands in the Lake Erie watershed and ten functions. Predicted level of performance is also given for each function. (Tiner et al. 2014).

Function	
High or Moderate	Wetlands Predicted to Perform This Function
Surface Water Detention	
High	Wetlands along rivers, streams, and lakes and subject to flooding for more than 2 weeks; throughflow ponds; stormwater treatment ponds
*Moderate	Wetlands in same locations subject to brief flooding; other ponds (except some types, e.g., isolated impoundments)

Streamflow Maintenance

High	Headwater wetlands (except partly drained, impounded, and excavated types)
*Moderate	Altered headwater wetlands; seasonally flooded wetlands along rivers and stream

Nutrient Transformation

*High	Seasonally flooded or wetter vegetated wetlands
Moderate	Temporarily flooded or seasonally saturated wetlands; ponds with mixtures of open water and vegetation

Carbon Sequestration

*High	Seasonally flooded or wetter vegetated wetlands; wetlands on organic soil (bogs); aquatic beds
Moderate	Temporarily flooded or seasonally saturated wetlands; ponds (excluding some types, e.g., isolated impoundments)

Sediment/Particulate Retention

*High	Vegetated wetlands (excluding seasonally saturated types); throughflow ponds and associated vegetated wetlands; stormwater treatment ponds
Moderate	Nonvegetated wetlands (excluding seasonally saturated types); other ponds (with some exceptions, e.g., isolated impoundments)

Bank and Shoreline Stabilization

*High	Vegetated wetlands along river, and streams (excluding island wetlands)
Moderate	Vegetated wetlands along ponds

Fish/Aquatic Invertebrate Habitat

High	Aquatic beds; semipermanently flooded wetlands along lakes, rivers, streams, and ponds; shallow water zone of lakes; mixed open water/vegetated wetlands; ponds associated with semipermanently or permanently flooded vegetated wetlands
*Moderate	Seasonally flooded marshes along rivers, lakes, and streams; semipermanently flooded Phragmites marshes adjacent to open water; seasonally flooded-tidal forested and shrub wetlands mixed with emergent species; certain types of ponds (typically > 1acre)

Waterfowl and Waterbird Habitat

High	Semipermanently flooded vegetated wetlands; aquatic beds; lacustrine flats and shallow water; seasonally flooded marshes; waterfowl impoundments
*Moderate	Phragmites marshes contiguous to open water; estuarine shrub wetlands mixed with emergents; aquatic beds and ponds (>1 acre; excluding some types); seasonally flooded marshes (>1 acre) along intermittent streams and in depressions

*Wood Duck	Seasonally flooded or wetter forested and shrub swamps (not shrub bogs) along rivers and streams

Other Wildlife Habitat

*High	Vegetated wetlands >20 acres; wetlands 10-20 acres in size with 2 or more vegetated classes (except Phragmites); natural ponds
Moderate	Other vegetated wetlands

Unique, Uncommon or Highly Diverse Wetland Plant Communities

(unable to determine without additional studies**)**
Significant Wetlands on Presque Isle; lotic river fringe wetlands; lotic stream fringe wetlands (excluding those dominated by dead woody plants); lotic stream basin wetlands (Note: This function is intended to identify wetlands that may be different from the majority of the watershed's wetlands and focuses on vegetation, landscape position, and special modifiers applied in the classification process. It excludes any ditched, excavated, or impounded wetland and those with *Phragmites* as dominant or co-dominant.)

7.0 LAKE ERIE COASTAL PLAIN IN PENNSYLVANIA

The Erie Coastal Plain in Pennsylvania contains vitally important resources managed by the Pennsylvania Coastal Resources Management Program (CRMP) under authority of the federal Coastal Zone Management Act of 1972. Wetlands, floodplains, and contributing watersheds flowing through this coastal zone into Lake Erie are of special concern. The CRMP policy for wetlands is stated as: "*This policy involves the protection, enhancement and creation of coastal wetlands in order to maintain benefits for wildlife habitat, flood control, water quality, water flow stabilization and environmental diversity (biodiversity).*" (http://www.dep.pa.gov/Business/Water/Compacts%20and%20Commissions/Coastal%20Resources%20Management%20Program/Pages/About-the-Program.aspx, accessed 11 November 2017).

Elk Creek is one of the listed watersheds that flows into and through the Lake Erie Coastal Zone. The CRMP has a number of initiatives to conserve and restore these aquatic ecosystems, including a strategy to mitigate increased adverse cumulative and secondary impacts (see quote below), and to expand the recognized coastal zone. If the expansion is accepted by participating municipalities, the boundary would expand into Waterford Township where the Marsh Site is located and the headwaters of Elk Creek begin (Figure 61). The intent of the proposed coastal zone expansion is clear, to bring substantial and focused conservation and restoration activities to watersheds flowing into Lake Erie.

"Cumulative and Secondary Impacts

Cumulative and Secondary Impacts were considered a high priority during the last assessment and remained a high priority during this assessment. … Phosphorus loadings to Lake Erie and the desire to avoid habitat fragmentation remain a priority in the Lake Erie Coastal Zone. Recent harmful algal blooms have highlighted the need for additional nutrient control efforts in the watershed. Climate change may exacerbate the problems and present increased threats from these existing cumulative and secondary impact concerns. CRM has developed a *strategy to build capacity to address climate adaptation and resiliency that will help in planning to mitigate increased adverse cumulative and secondary impacts."* (PADEP, CRMP 2015)

The added attention focused on Lake Erie watersheds, including wetlands, has led to more frequent and more detailed wetland inventories in this region. The latest, published in 2014, used multiple sets of imagery (2005/06, 2009, 2011) to inventory and classify wetlands in this geographic region (Table 8, Tiner et al. 2014). The trend continues to show loss of wetlands in the Lake Erie Coastal Zone (Table 9, Tiner et al. 2014). The Tiner et al. (2014) report also seeks to identify potential restoration sites where conditions are suitable to create and restore wetlands that have been lost or degraded in the past.

Table 8. Recent tally of wetland acreage by type for Erie County (Tiner et al. 2014).

Erie County Total Acres	**40,606.59**
Palustrine Emergent Wetland	837.983
Palustrine Forested Wetland	4,070.712
Palustrine Scrub/Shrub Wetland	512.1749
Wetland Total Erie Co.	**5,420.87**

Table 9. Status and trends of wetlands in the Lake Erie Coastal Zone (Tiner et al. 2014).

LECZ:

Coastal Wetlands Status and Trends in LECZ Coastal Counties (Erie)		
Current state of wetlands in 2010 (acres)	78.7 sq. mi.	
Percent net change in total wetlands (% gained or lost)	from 1996-2010 -0.49%	from 2006-2010 -0.12%
Percent net change in freshwater (palustrine wetlands) (% gained or lost)	from 1996-2010 -0.49%	from 2006-2010 -0.35%
Percent net change in saltwater (estuarine) wetlands (% gained or lost)	from 1996-2010 N/A	from 2006-2010 N/A

How Wetlands Are Changing in LECZ Coastal Counties (Erie County)		
Land Cover Type	**Area of Wetlands Transformed to Another Type of Land Cover between 1996-2010 (Sq. Miles)**	**Area of Wetlands Transformed to Another Type of Land Cover between 2006-2010 (Sq. Miles)**
Development	0.37	0.17
Agriculture	0.09	0.02
Barren Land	0.05	0.03
Water	0.07	0.04

8.0 LIST OF REFERENCES CITED AND OTHER INFORMATION CONSIDERED FOR THIS REPORT

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OTHER INFORMATION CONSIDERED (all provided to Brooks by DOJ):

1. Complaint and Attachment A.
2. EPA0000058 – Photo of Marsh Site taken during 5/16/90 site visit by EPA
3. EPA0000060 – Photo of Marsh Site taken during 5/16/90 site visit by EPA
4. EPA0000062 – Photo of Marsh Site taken during 5/16/90 site visit by EPA
5. EPA0000220 – 1990 Field Investigation Report by EPA
6. EPA0000290 – 1990 Brace Site Photo Log by
7. EPA0000439 – Photos taken in 2012 and 2013 by PA Fish and Boat Commission 8. EPA0000465 – Letter from Robert Brace to EPA describing work on Marsh Site and attaching aerial with lines drawn where tile was installed.
9. EPA0000502 – June 27, 2013 EPA site inspection report
10. EPA0000516 – June 27, 2013 EPA site inspection photos
11. EPA0000527 – June 27, 2013 PADEP site inspection report
12. EPA0000545 – August 29, 2013 letter from EPA and Corps to Braces
13. EPA0000560 – Figure showing approximate location of Marsh Site
14. EPA0000561 – Wetland Map
15. EPA0000562 – Soils Map
16. EPA0000567 – Soils Map
17. EPA0000570 – NWI Map
18. EPA0000571 – Photo key to PA Fish and Boat Commission Log
19. EPA0000572 – 6/4/1977 Aerial
20. EPA0000573 – 5/10/1975 Aerial
21. EPA0000574 – 1939 Aerial
22. EPA0000575 – 1959 Aerial
23. EPA0000576 – 1965 Aerial
24. EPA0000577 – 1968 Aerial
25. EPA0000578 – 2004 Aerial
26. EPA0000579 – 2005 Aerial
27. EPA0000580 – 2010 Aerial
28. EPA0000581 – 2013 Aerial
29. EPA0000002 – Video taken during June 27, 2013 site inspection.
30. Photos taken by Peter Stokely during October 16-17, 2017 site inspection.
31. Macroinvertebrate and water chemistry sampling data from Pennsylvania Department of Environmental Protection, Assessment Section (Gary Walters, Chief), Harrisburg, PA; provided by DOJ.
32. Precon I (*Precon Dev. Corp., Inc. v. U.S. Army Corps of Eng'rs*, 633 F.3d 278, 2283-84 & 290-93(4th Cir. 2011)); provided by DOJ.

9.0 APPENDIX A – Marsh Site and Similarly Situated Wetlands – Mapping and Photographic Evidence

10.0 APPENDIX B – Wetland Data Forms from October 2017 Visit to the Marsh Site

11.0 MARSH SITE CONCEPTUAL WETLANDS RESTORATION PLAN

12.0 CV ROBERT P. BROOKS

9.0 APPENDIX A – Marsh Site and Similarly Situated Wetlands – Mapping and Photographic Evidence

Site Location

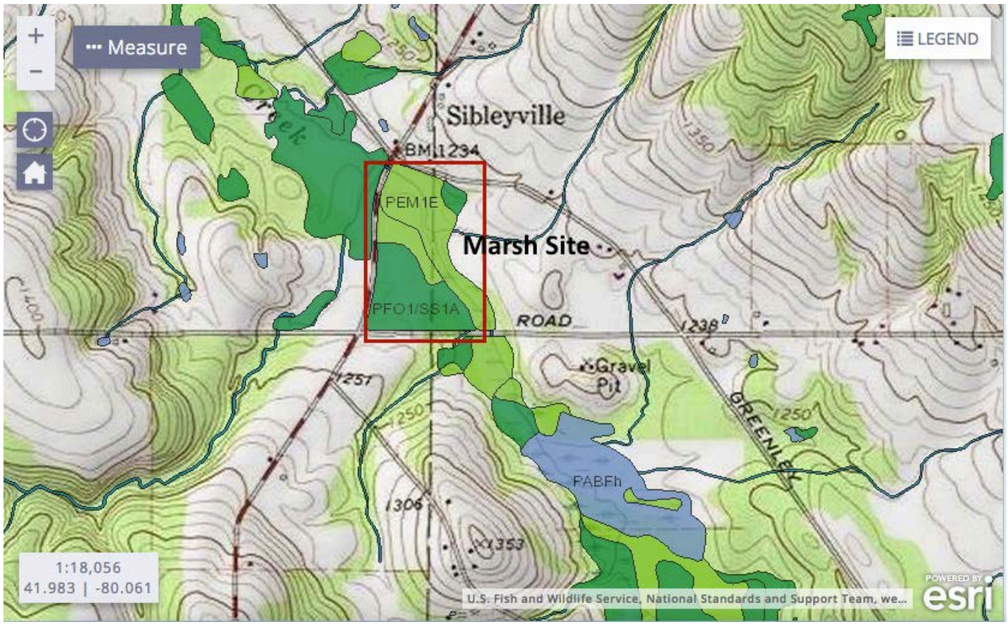

Figure 1. Location of the Marsh Site and vicinity in McKean and Waterford Townships, Erie County, PA (Obtained from DOJ complaint file).

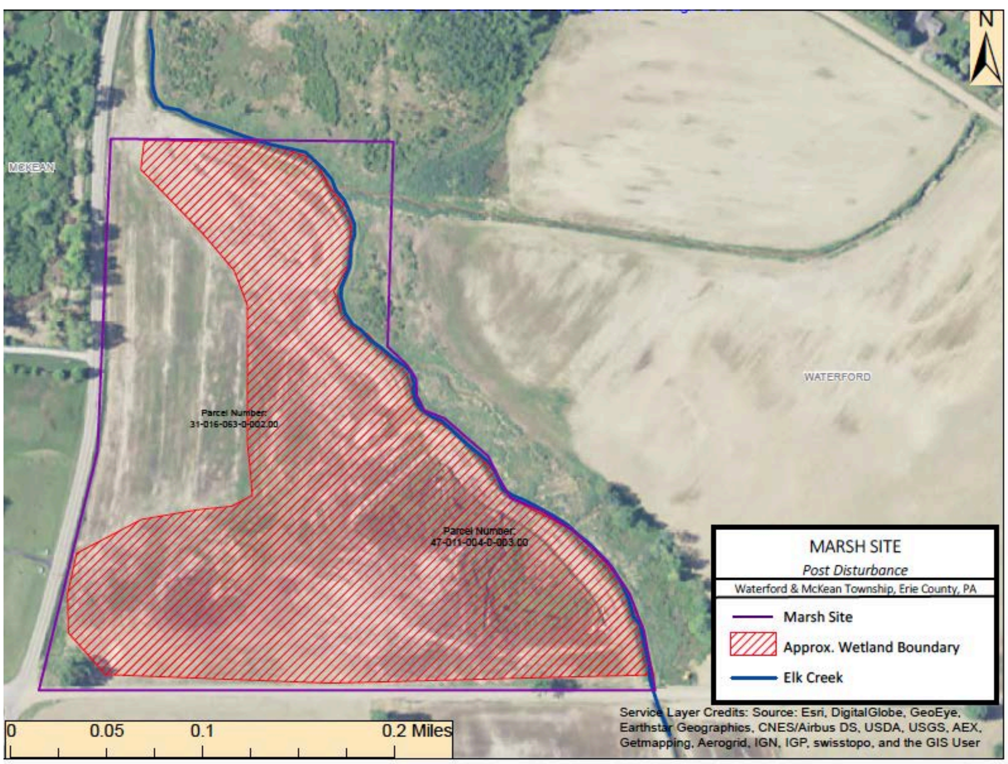

Figure 2. Portion of the Marsh Site post disturbance with approximate wetland boundary (red hatching) (DOJ Complaint Exhibit A).

Historic Aerial Photographs for the Marsh Site

Figure 3. 1939 aerial photograph of the Marsh Site (B&W; obtained from DOJ).

Figure 4. 1968 aerial photography of the Marsh Site (B&W, obtained from DOJ).

Figure 5. 1993 aerial photography of the Marsh Site (B&W; Google Earth).


Figure 6. 2005 aerial photography of the Marsh Site (natural color; obtained from DOJ).

Figure 7. October 2011 aerial photograph of the Marsh Site (natural color; Google Earth).

Figure 8. 2011 aerial photograph – close-up of southeast corner of the Marsh Site (Google Earth).

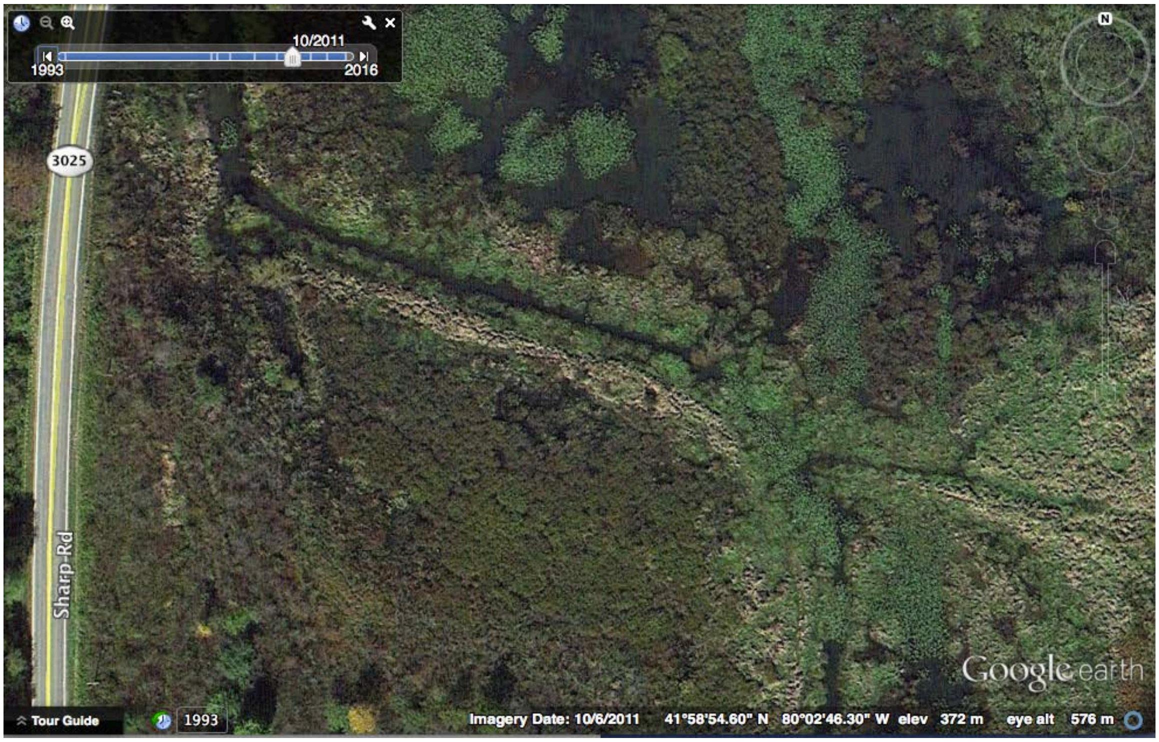

Figure 9. 2011 aerial photograph – close-up of northern corner of the Marsh Site (Google Earth).

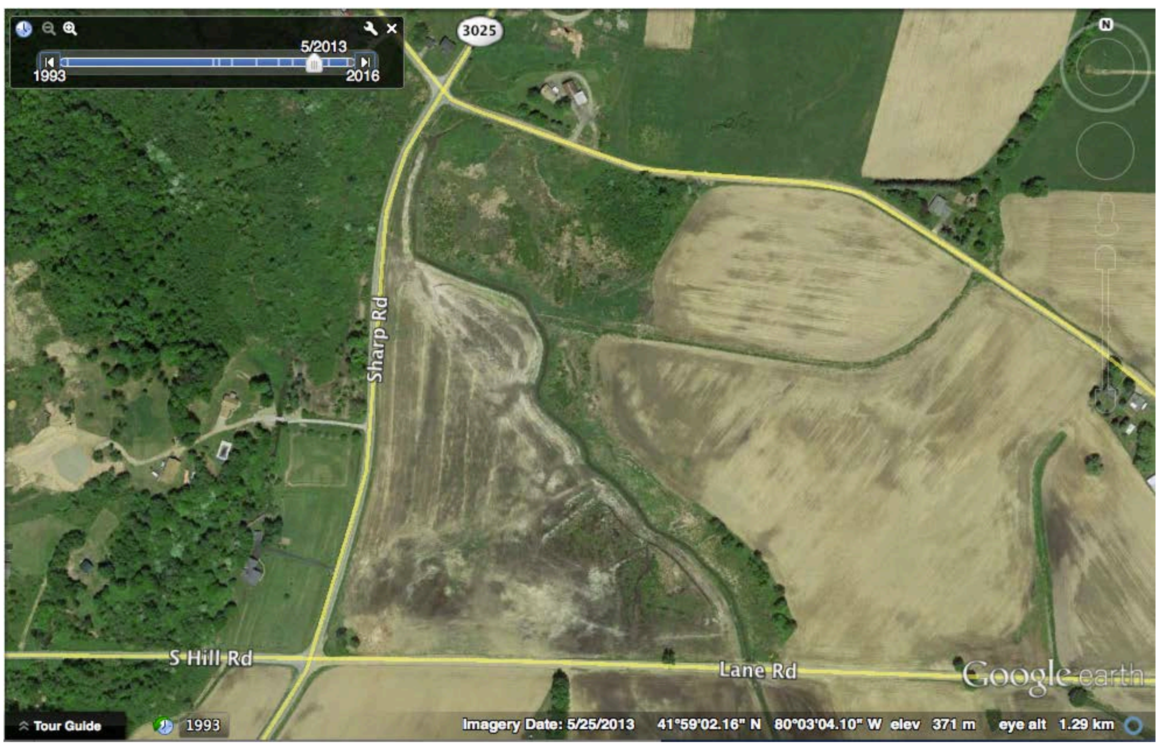

Figure 10. May 2013 aerial photograph of the Marsh Site (natural color, Google Earth) showing extensive disturbance of vegetation throughout site to bare soil, and alterations to the morphometry of Elk Creek.

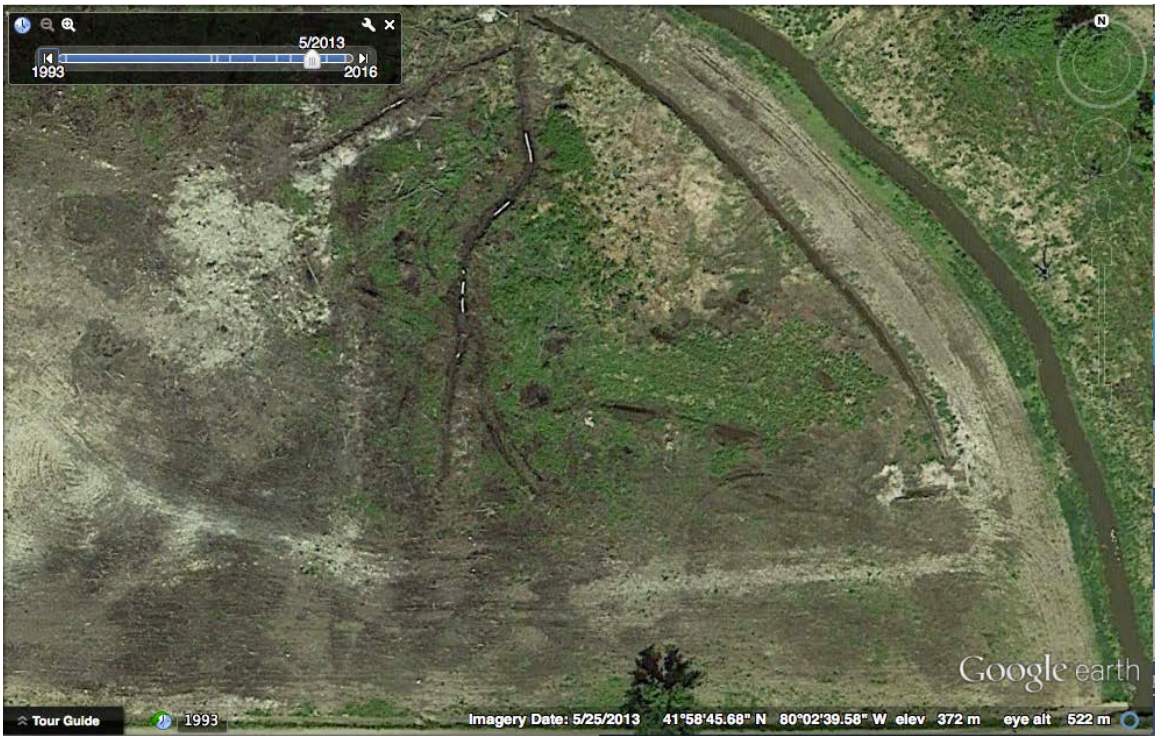

Figure 11. May 2013 aerial photograph of the Marsh Site (natural color, Google Earth) close-up showing extensive disturbance of vegetation throughout site to bare soil, scattered logs and branches on the ground, and alterations to the morphometry of Elk Creek.

Figure 12. May 2013 aerial photograph of the Marsh Site (natural color, Google Earth) close-up showing extensive disturbance of vegetation throughout site to bare soil, plow and grading lines, and alterations to the morphometry of Elk Creek.

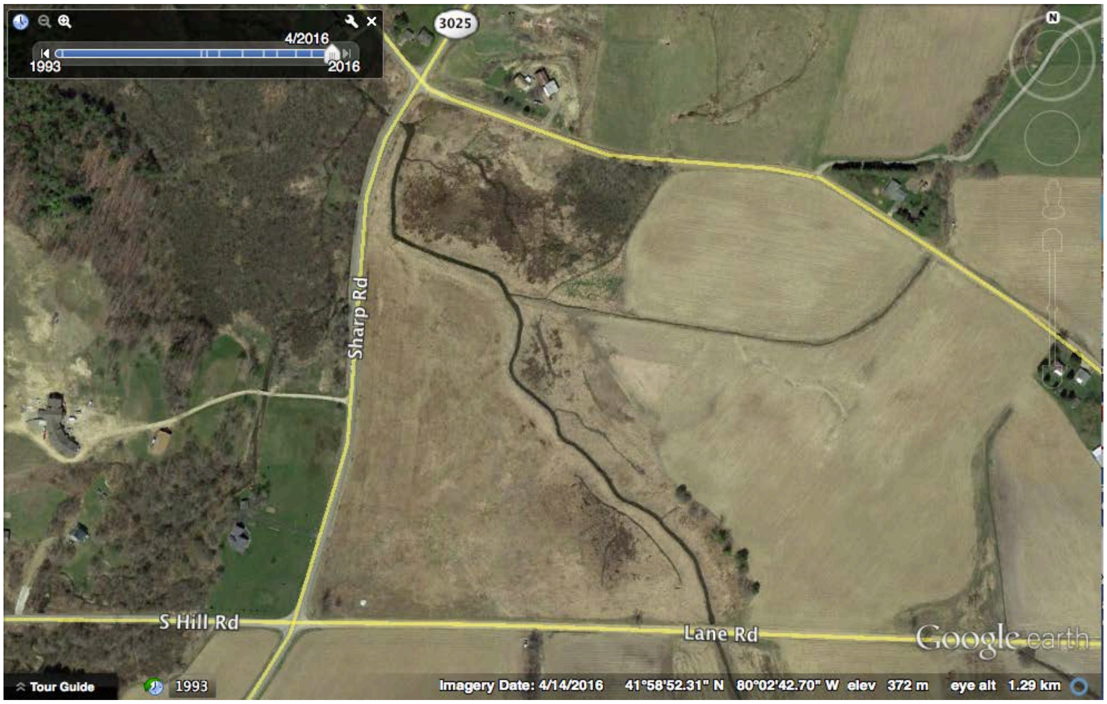

Figure 13. 2016 aerial photograph of the Marsh Site (natural color, Google Maps) shows some natural herbaceous vegetation returning to the Marsh Site; woody plants are not evident in this image. Ditches or altered natural channels are evident on either side of the still well-defined channelized stream course.

Alterations to Elk Creek at the Lane Road Bridge

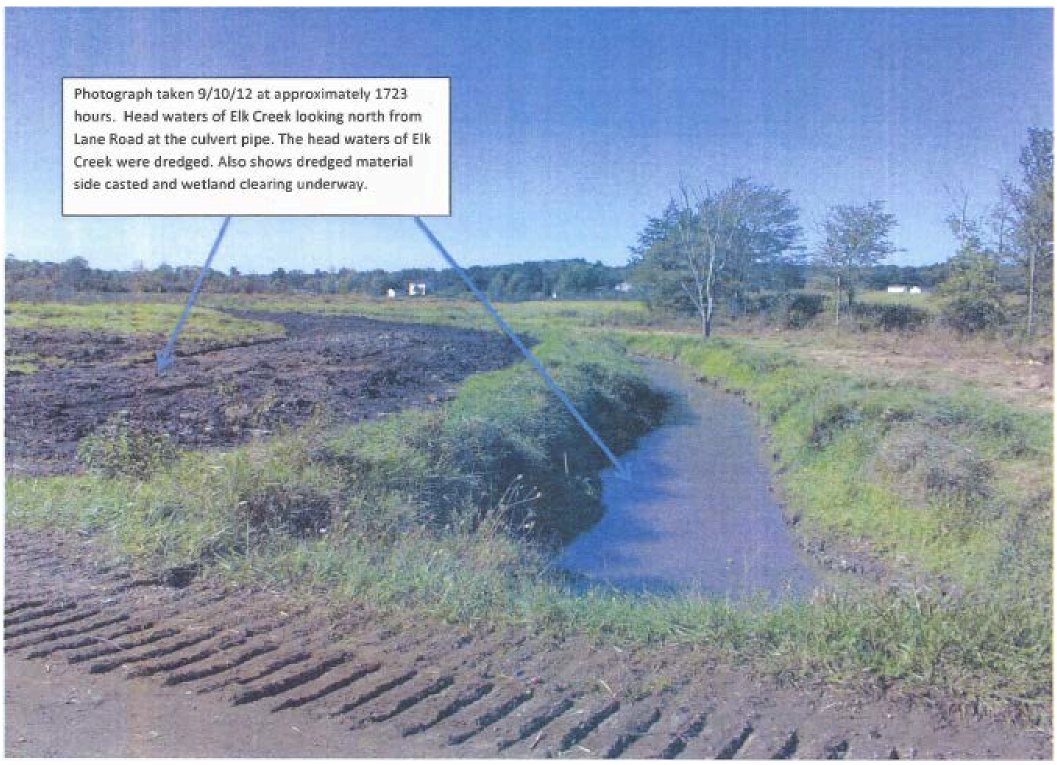

Figure 14. September 2012 photograph from Marsh Site inspection by Smolko; Elk Creek from Lane Road looking downstream (north) showing disturbed soils and side-casting from dredging Elk Creek.

Figure 15. June 2013 photograph from Marsh Site inspection by EPA; Elk Creek from Lane Road looking downstream (north) showing recovering herbaceous vegetation after soil disturbance in 2012, and channelized reach of Elk Creek.

Figure 16. October 2017 photograph from Marsh Site inspection by Brooks; Elk Creek from Lane Road looking downstream (north) showing recovering herbaceous vegetation after soil disturbance in 2012, and channelized reach of Elk Creek.

Sample Point Characteristics from the Marsh Site

Figure 17. Approximate locations of six Sample Points for wetland identification protocol superimposed on a 2015 image of the Marsh Site from ESRI (Brooks Oct 2017).

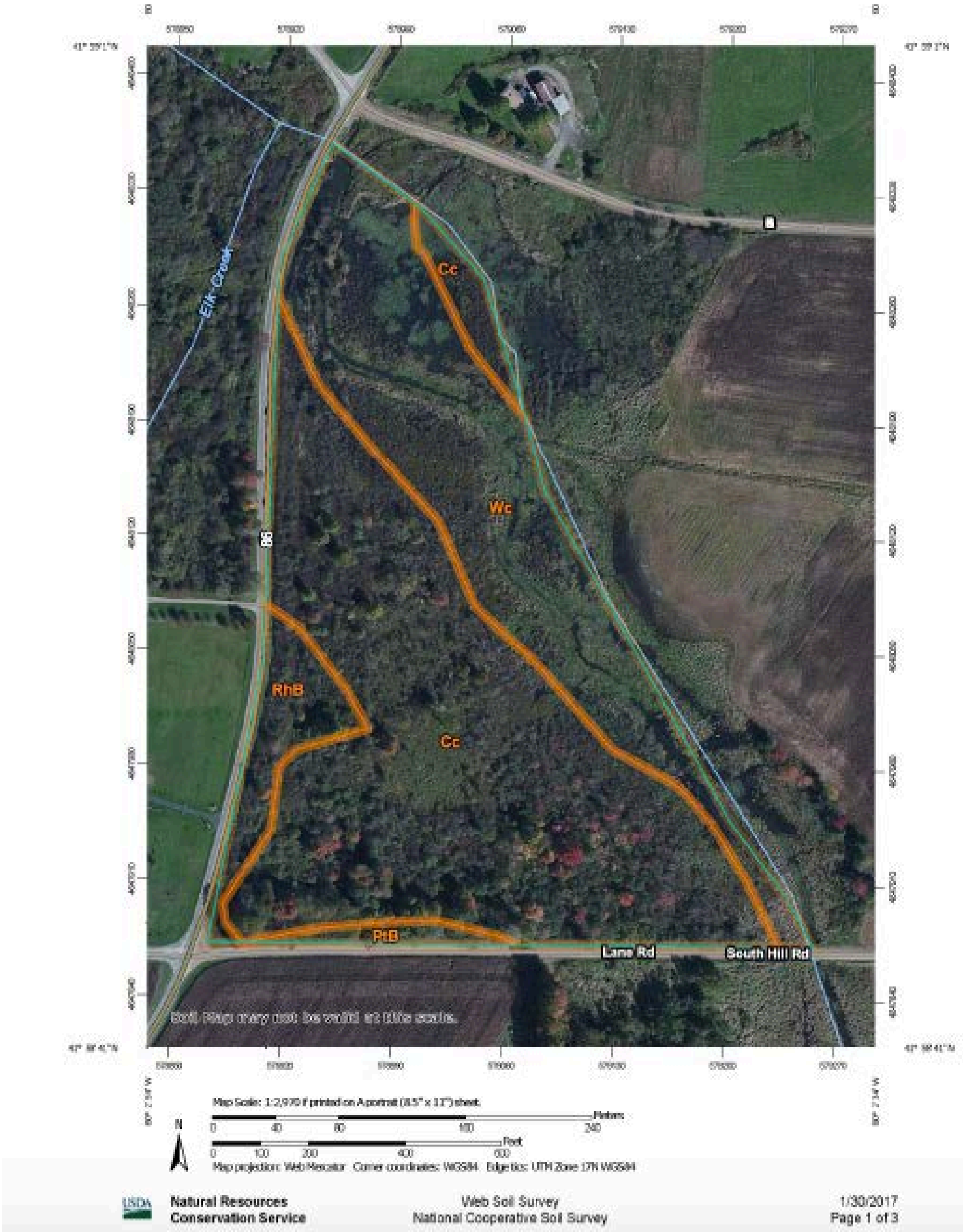

Figure 18. Natural Resource Conservation Service, Web Soil Survey (derived from Erie County Soil Survey), showing soil types on the Marsh Site; legend in Section 4.3 Table 1 of text. (I am using this figure from DOJ for consistency, but confirmed the same information from the Web Soil Survey.)

Figure 19. Marsh Site Sample #1 soil pit with profile (see text for description).

Figure 20. Munsell soil colors for Sample #1 showing hydric matrix, brighter mottles and oxidized rhizospheres (see text for discussion).


Figure 21. Vegetation for Sample #1 (looking west) (see text for description).


Figure 22. Marsh Site Sample #2 soil pit and profile (see text for description).

Figure 23. Marsh Site Sample#2 vegetation (looking west) (see text for description).


Figure 24. Marsh Site Sample #3 soil pit and profile, (see text for description).


Figure 25. Marsh Site Sample #3 oxidized rhizospheres, 9-10 inches depth (see text for description).

Figure 26. Marsh Site Sample #3 vegetation (looking east) (see text for description).

Figure 27. Marsh Site Sample #4 soil pit and profile (see text for description).


Figure 28. Marsh Site Sample #4 lower depth of soil pit and profile (see text for description).


Figure. 29. View of Marsh Site looking east over Elk Creek near Sample Site #4.

Figure 30. Marsh Site Sample #5 soil pit and profile (see text for description).

Figure 31. Marsh Site Sample #5 next to auxiliary duckweed-covered ditch flowing into Elk Creek.


Figure 32. Marsh Site Sample #5 speckled alder shrubs typical of patch near Elk Creek.


Figure 33. Elk Creek on Marsh Site near Sample #5 showing wetland and aquatic vegetation.

Figure 34. Marsh Site Sample #6 soil pit and profile (see text for description).

Figure 35. Marsh Site Sample #6 hydric soils: left – oxidized rhizospheres near surface; right – gleyed soil with mottles in lower portion of soil pit.

Figure 36. Marsh Site Sample Point #6 vegetation dominated by wetland plant species.

Reference Wetlands

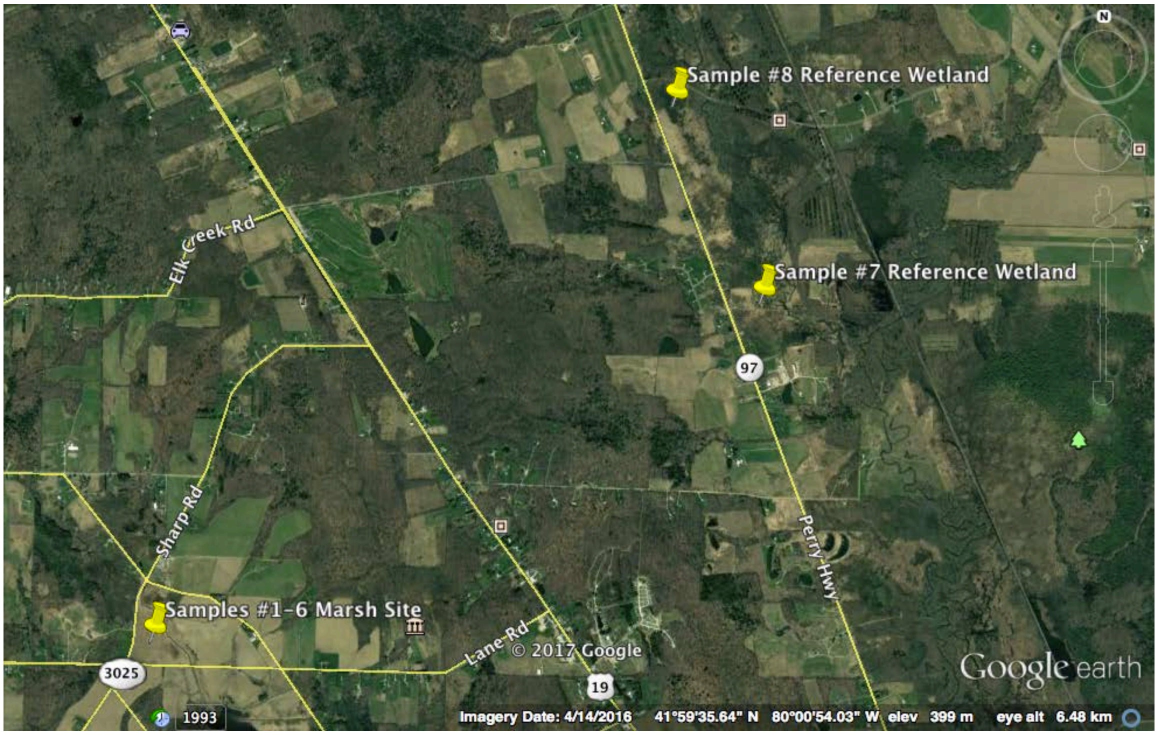

Figure 37. Location map (Google Earth) showing Samples #7 & 8 (Reference Wetlands SGL 109) relative to the Marsh Site with Samples #1-6, about 3 miles away.

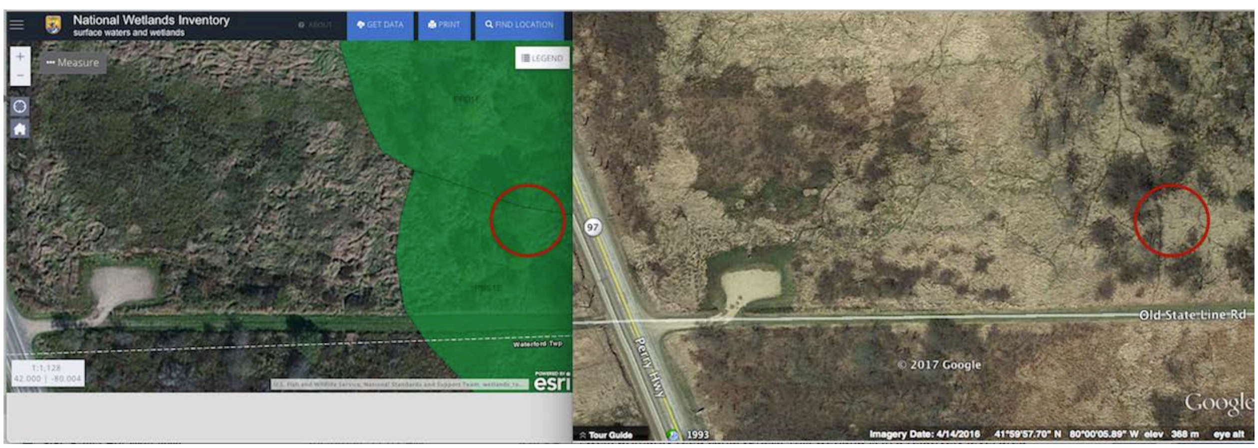

Figure 38. Sample #7 – Reference wetland State Game Lands 109 off Old State Line Road, National Wetland Inventory (left) and Google Earth image (right) (see text for description).

Figure 39. Sample #7 – Reference wetland State Game Lands 109 vegetation.

Figure 40. Sample #7 – Reference wetland State Game Lands 109 soil pit and profile.

Figure 41. Sample #8 – Reference wetland State Game Lands 109 off Sampson Road, National Wetland Inventory (left) and Google Earth image (right) (see text for description).


Figure 42. Sample #8 – Reference wetland State Game Lands 109 off Sampson Road soil pit and Profile (see text for description).

Figure 43. Sample #8 – Reference wetland State Game Lands 109 off Sampson Road vegetation (see text for description).

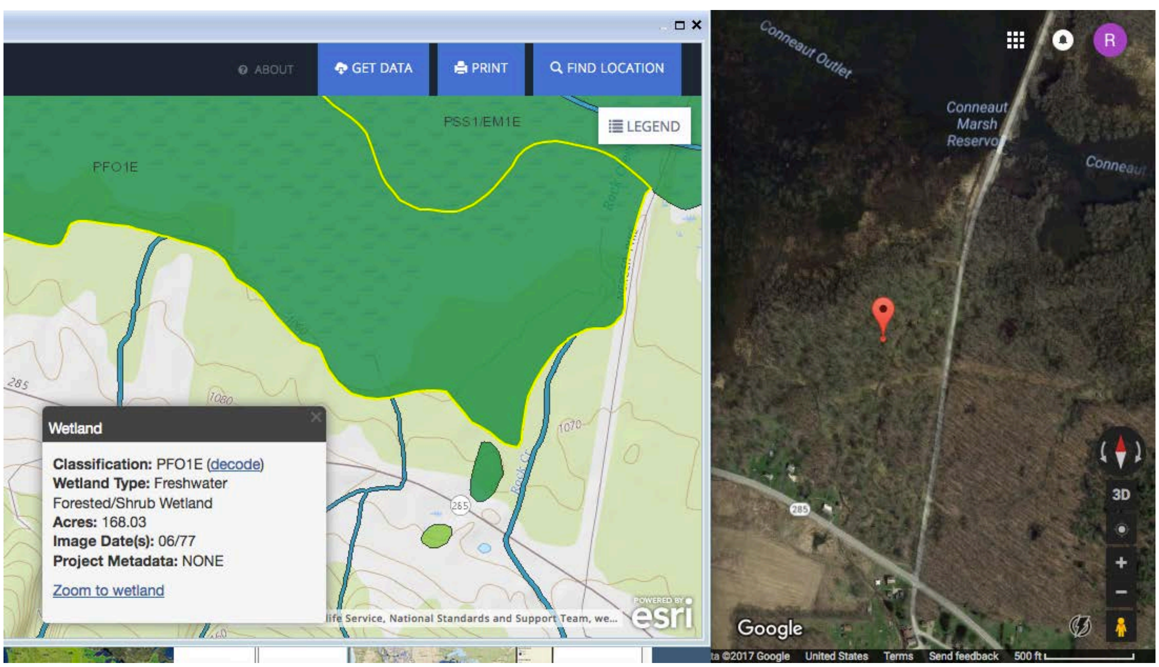

Figure 44. Reference wetland #220 – Erie National Wildlife Refuge, Crawford Co. PA, National Wetland Inventory (left) and Google Earth image (right).

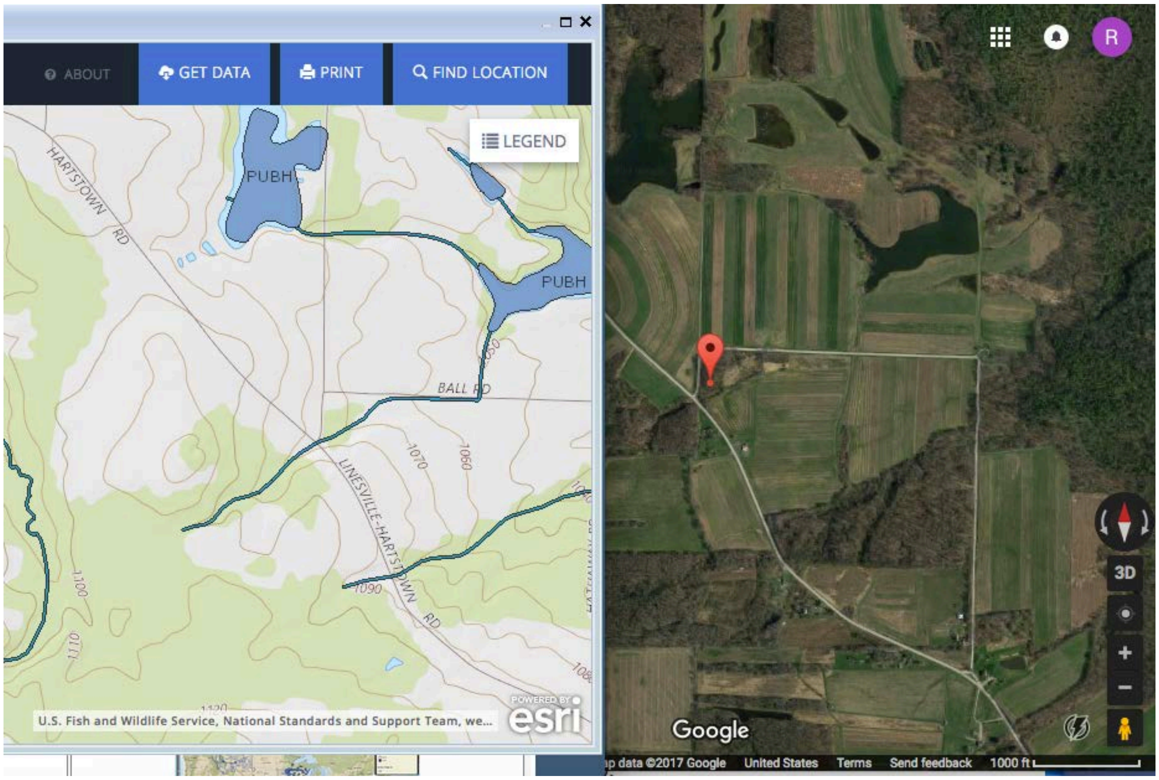

Figure 45. Reference wetland #221 – privately owned wetland on Ball Road, Crawford Co. PA, National Wetland Inventory (left) and Google Earth image (right).

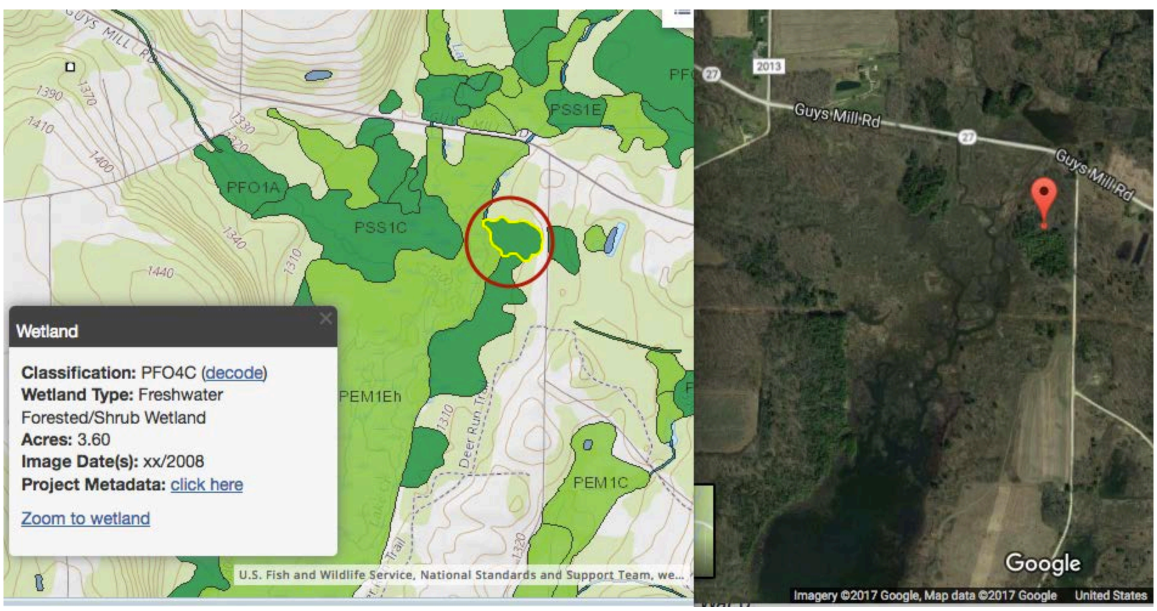

Figure 46. Reference wetland #222 – Erie National Wildlife Refuge, Crawford Co. PA, National Wetland Inventory (left) and Google Earth image (right).

Impact of Hydrologic Alterations to the Marsh Site

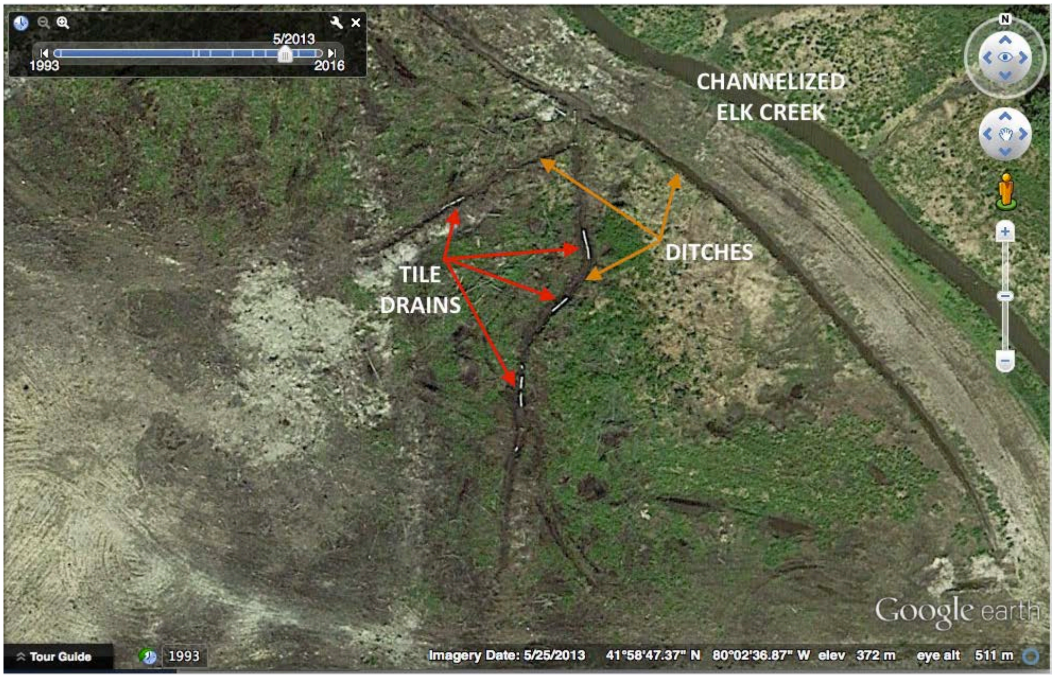

Figure 47 (close-up Figure 11). May 2013 aerial photograph of the Marsh Site (natural color, Google Earth) showing extensive disturbance of vegetation throughout site to bare soil, scattered logs and branches on the ground, plus labeled hydrologic alterations of tile drains (red arrows) and ditches (orange arrows) causing changes to wetlands in the floodplain of Elk Creek (near Sample Point #5).

ERDC/EL TR-12-1 116

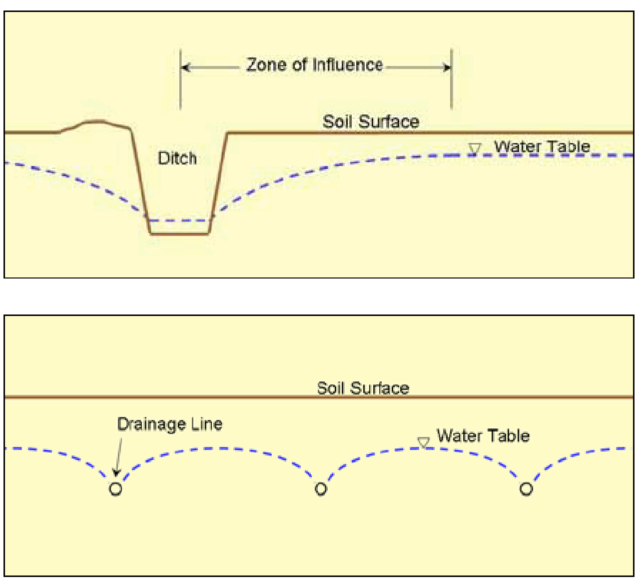

Figure 62. Effects of ditches (upper) and parallel subsurface drainage lines (lower) on the water table.

Figure 48. Illustration of impacts on wetlands hydrology by ditches and tile drains (from Corps 2012).

Hydrologic Flow Path of Elk Creek (images from field, October 2017, or from web sources)

Figure 49. October 2017 photograph from Marsh Site inspection by Brooks; Elk Creek from Lane Road looking downstream (north) showing recovering herbaceous vegetation after soil disturbance in 2012, and channelized reach of Elk Creek.

Figure 50. Elk Creek at Sparks Road bridge looking upstream.

Figure 51. Elk Creek, looking downstream at Greenlee Road bridge, northwest of the Marsh Site.

Figure 52. Hamot Road bridge looking upstream; stream bed rocky and relatively steep-sided, more incised than upstream portions of Elk Creek.


Figure 53. Elk Creek crossing under Oliver Road, steep-sided gorge; bridge supported by gabions.

Figure 54. Aerial view of Oliver Road bridge/culvert over Elk Creek flowing right to left beginning in lower right of this Google Earth image.

Figure 55. Elk Creek from bridge crossing at Pennsylvania Fish and Boat Commission river access parking lot off Route 882; photograph looking upstream; river is shallow, at least twice as wide as upstream sections, with a rocky bottom.

Figure 56. Slack water reach of Elk Creek near its mouth in Lake Erie within the Erie Bluffs State Park (part of the Great Lakes Seaway Trail), where at least eight persons were fishing.

Figure 57. This reach connects directly to Lake Erie in about 500 feet along a sand spit referred to as "The Mouth", establishing permanent connectivity to a TNW (Google Earth image).

Ecological Functions and Ecosystem Services of Wetlands of the Marsh Site and Similarly-Situated Wetlands

Figure 58. Example of overbank flooding of a similar sized stream where the stream is connected to the floodplain allowing frequent movement of water from the stream to the floodplain and from the floodplain back to the stream channel (Photograph by R. Brooks from central Pennsylvania).

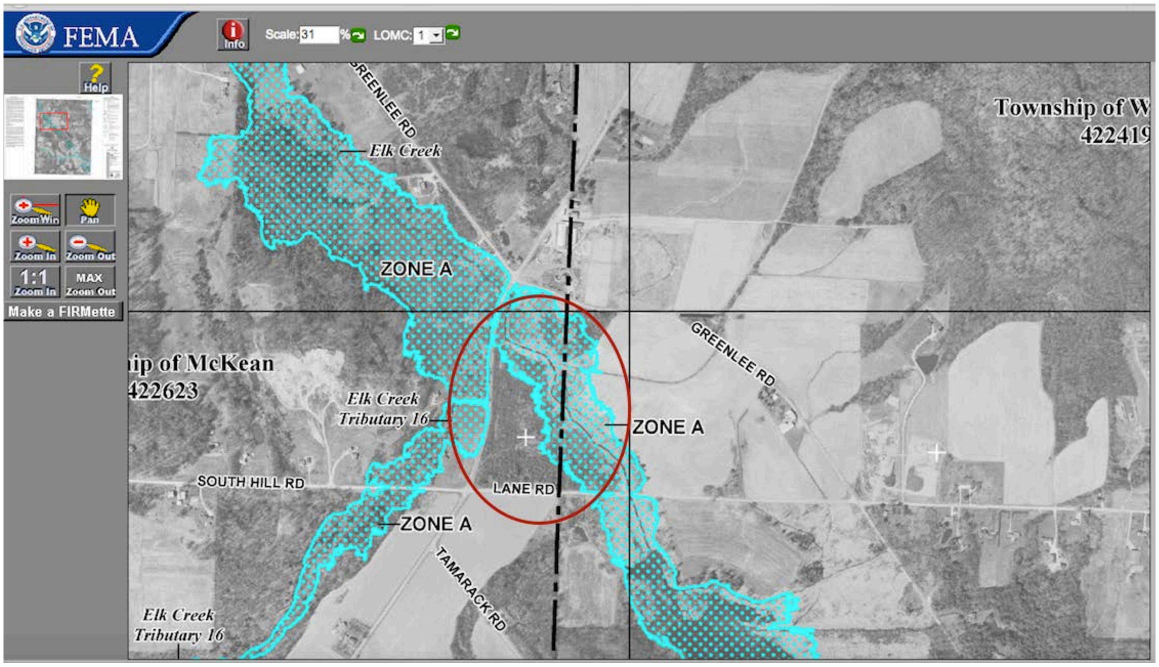

Figure 59. FEMA Flood Insurance Rate Map for McKean and Waterford Townships (Panel 385 Erie Co., PA) showing the Marsh Site (red oval) and adjacent Elk Creek as being in Flood Zone A.

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

Figure 60. Legend for FEMA Flood Insurance Rate Map for McKean and Waterford Townships (Panel 385 Erie Co., PA).

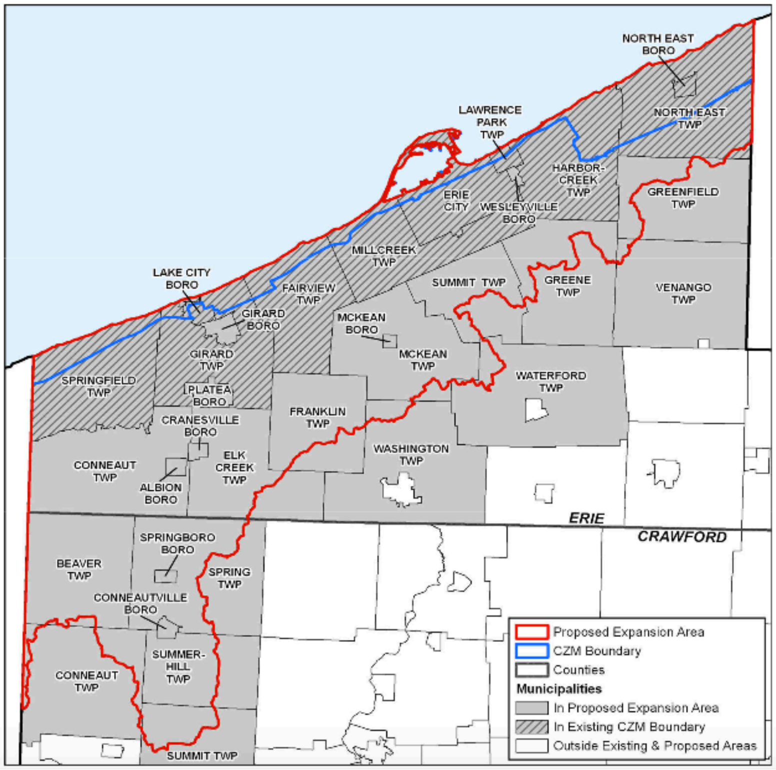

Figure 61. Current and proposed expansion of the Erie Coastal Zone boundary, showing potential expansion in Waterford Township, near the Marsh Site (PA CRMP 2017).

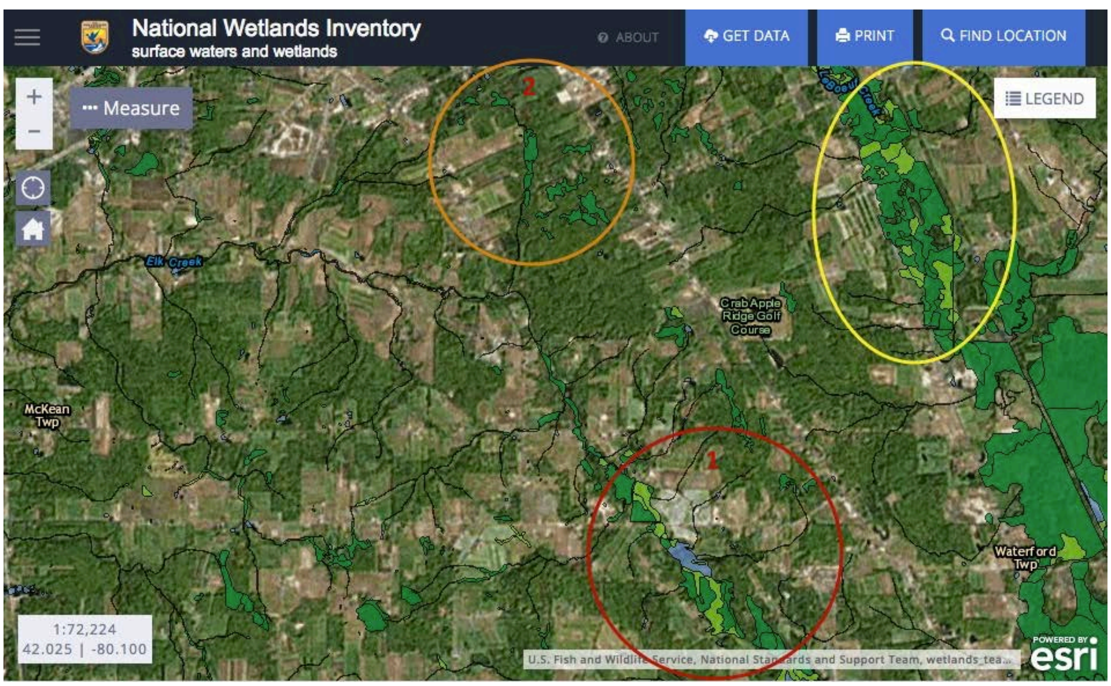

Figure 62. Elk Creek Watershed East showing concentration of headwater wetlands in the vicinity of the Marsh Site and Brace parcels (red circle), another concentration of headwater wetlands on an Elk Creek tributary (orange circle), and a concentration of headwater wetlands in the LeBoeuf Creek Watershed 3 miles to the east, used as reference wetlands (NWI+ Mapper, accessed 11-14-17).

Figure 63. Elk Creek Watershed Central showing five concentrations of headwater wetlands located on tributaries to the mainstem (orange circles)in the central one-third of Elk Creek watershed in the vicinity of McKean Township (NWI+ Mapper, accessed 11-14-17).

Figure 64. Elk Creek Watershed West showing fewer concentrations of wetlands along the meandering channel of Elk Creek, passing through the more urbanized Girard Township in the center portion of the image, then flowing west toward Lake Erie. Wetlands are located in the Lake Erie Coastal Plain in low elevation landscape, such as the area to the left of the image, but are sparse along the lower one third of the Elk Creek watershed (NWI+ Mapper, accessed 11-14-17).

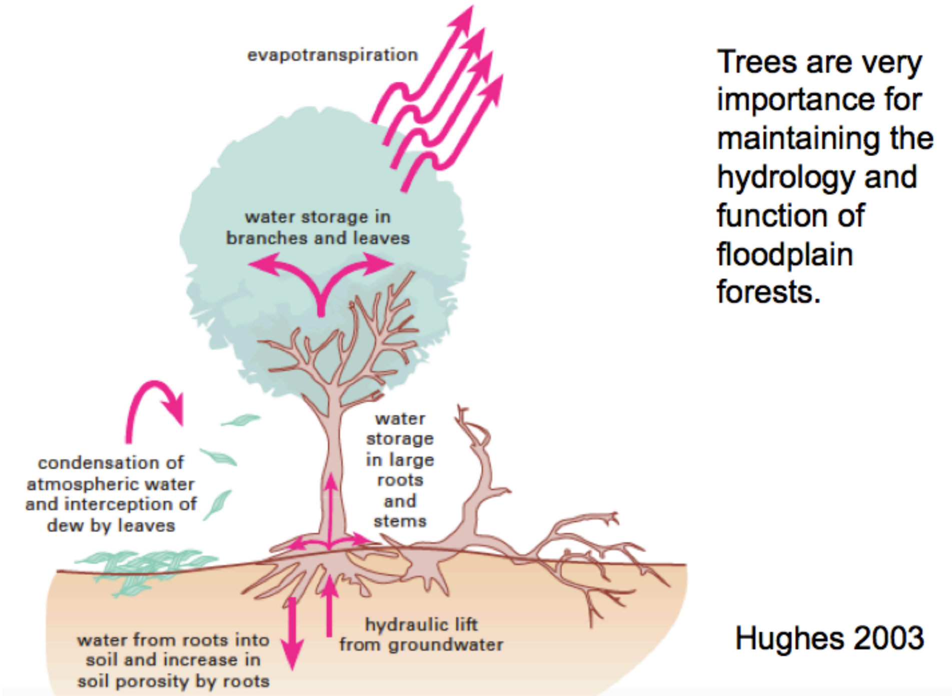

Figure 65. Diagram of ecological processes associated with trees in forested wetlands and floodplains.

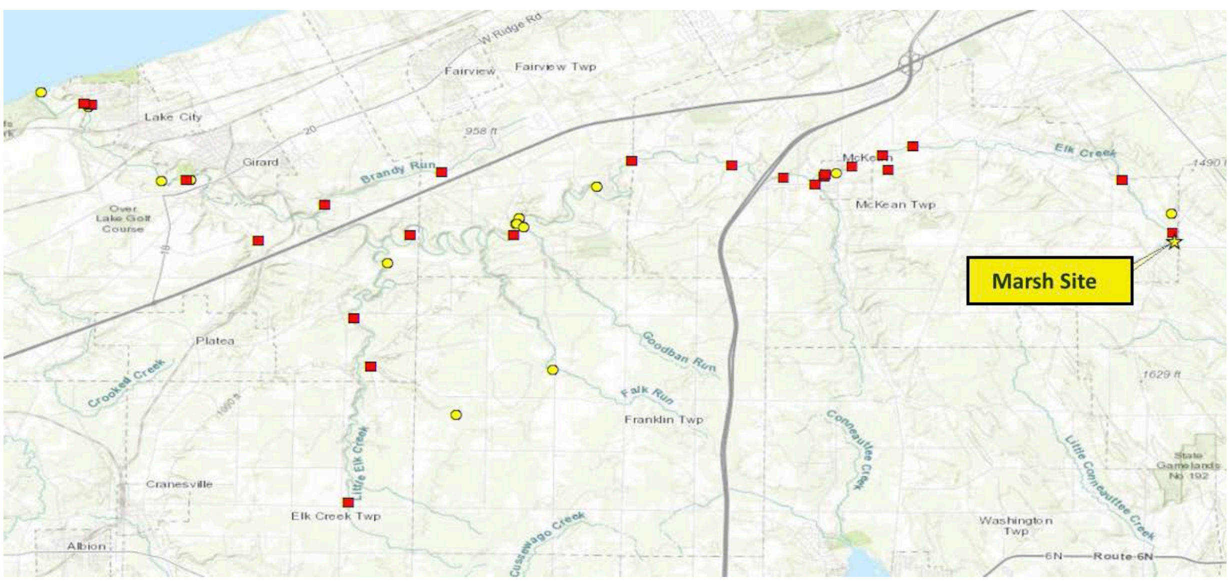

Figure 66. Map of Pennsylvania Department of Environmental Protection (PADEP) stream sampling sites for aquatic macroinvertebrates (yellow) and water chemistry (red) for the Elk Creek watershed.

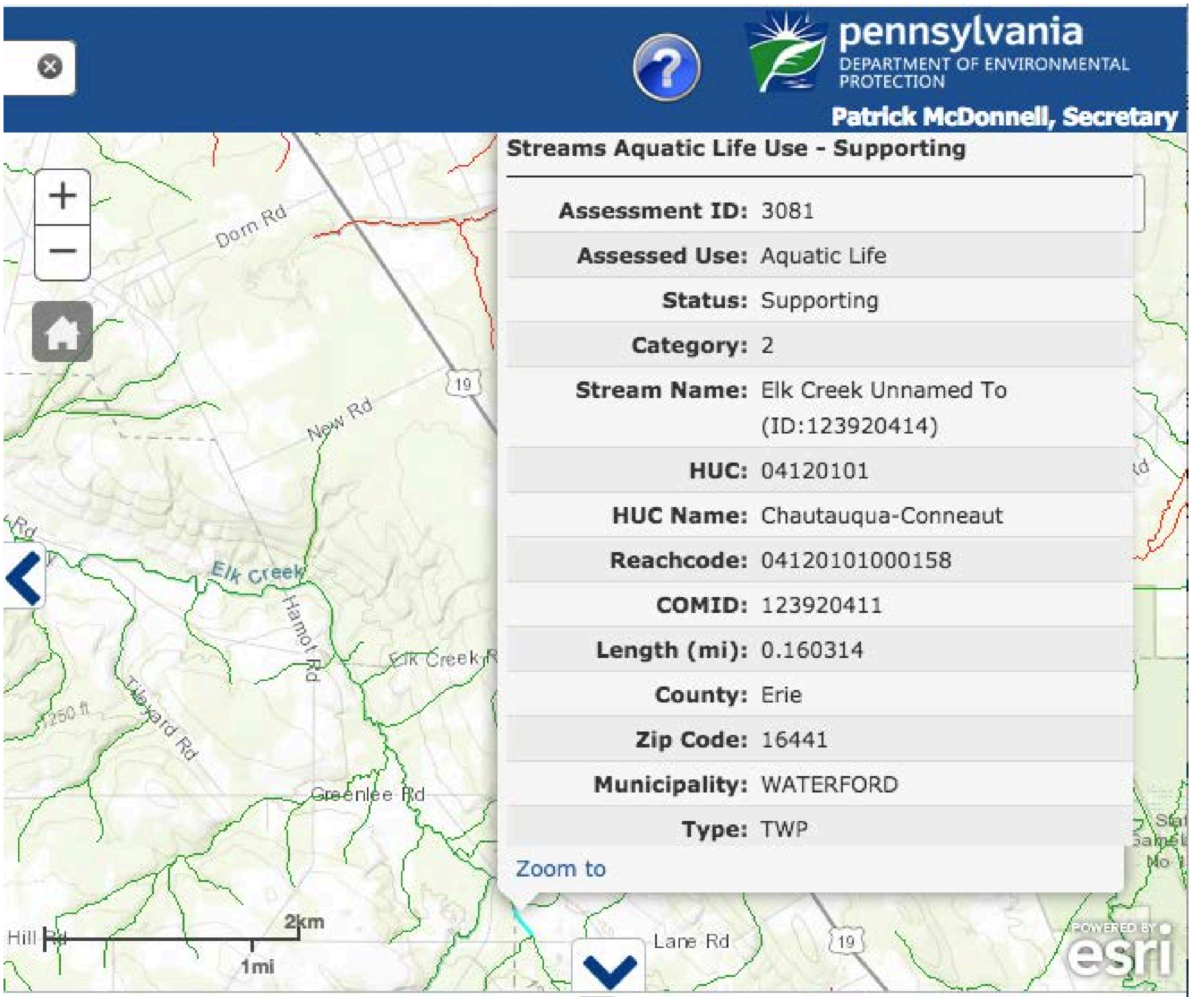

Figure 67. Elk Creek reach along the Marsh Site (see Zoom to arrow above) assessed by PADEP as Supporting Aquatic Life Use for the 2016 Triennial Integrated Water Quality Monitoring and Assessment Report (303(d) list). All streams of Elk Creek watershed appear to be in the same category.

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Brace Marsh Site City/County: Waterford Erie Co. Sampling Date: 10-16-17

Applicant/Owner: Robert Brace State: PA Sampling Point: #1

Investigator(s): Rob Brooks w/ Sarah Buckley w/ Katelin Ameter Section, Township, Range: Waterford

Landform (hillslope, terrace, etc.): ______ Local relief (concave, convex, none): convex Slope (%): +2%

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PFO1SS1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ___, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No ✗

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ___ w/ qualification	Is the Sampled Area within a Wetland? Yes ___ No ___
Hydric Soil Present?	Yes ___ No ___	
Wetland Hydrology Present?	Yes ___ No ___	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

Alterations to hydrology and vegetation in 2012; see expert report.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ✓ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No ✗	Depth (inches):
Water Table Present?	Yes ___	No ✗	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes ___	No ✗	Depth (inches):

see below

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

N/A

Remarks:

No hydro indicators here, except a few oxidized rhizospheres.

[see ~~image~~ Fig. 20]

VEGETATION – Use scientific names of plants. 3 m rail plot Sampling Point: #1

Tree Stratum (Plot size: none)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Sapling/Shrub Stratum (Plot size: none)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Herb Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. Poverty grass, other greens	80%	No spp id	?
2. Dewberry vines (bristly	30%	✓	FACW
3. Goldenrod (maybe Late Goldenrod ~~[illegible]~~ [illegible])	20%	✓	FACW
4. Bracken Fern	trace		NA
5.			
6. Reed canarygrass			FACW
7. in area			
8. Woolgrass patches			FACW
9.			
10.			
11. Area dominated by field species			
12.			
	= Total Cover		

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2+ (A)

Total Number of Dominant Species Across All Strata: 3+ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: > 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ______ No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0"								
	10YR 6/2			<10%				
5"				<10%				
	10YR 6/2		7.5YR 6/8	30%				
13"								
14"								
18"	10YR 6/1		7.5YR 6/8	30%				
				M				

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains.

[2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ✓ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: some stone chips

Depth (inches): 18"

Hydric Soil Present? Yes ✓ No ___

Remarks:

Soil texture by touch – 14–18" very slight grit, ribbon ~ 1.5" + (after moistening)

0"–5" – smooth, ribbon ~ 2.0+ in.

no water in pit

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Brace Marsh site City/County: Waterford Erie Sampling Date: 10-10-11

Applicant/Owner: Brace State: PA Sampling Point: #2

Investigator(s): Rob Brooks, Sarah Buckley, Katelyn Almeter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): hill slope Local relief (concave, convex, none): Concave area of slope Slope (%): ______

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PFO1SS1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ______, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ✓

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No	**Is the Sampled Area within a Wetland?** Yes ✓ No
Hydric Soil Present?	Yes ✓ No	
Wetland Hydrology Present?	Yes ✓ No	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

Alteration to hydrology and vegetation in 2012; see expert report.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ✓ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ______ No ✓ Depth (inches):

Water Table Present? Yes ______ No ✓ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ______ No ✓ Depth (inches):

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

NA

Remarks:

41.4792153 -80.0466794

Up slope of #1 - west parallel to Lane Rd.

Hydro. indicator ~~oxidized rhizospheres~~, histosols present.

VEGETATION – Use scientific names of plants.

Sampling Point: #2

Tree Stratum (Plot size: none)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
part of herb layer	= Total Cover		

Sapling/Shrub Stratum (Plot size:)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Red osier dogwood	5%		FACW
2. Quaking Aspen	5%		FACU
3. Willow - no id	5%		
4. Arrowwood, N.	5%		FACW
5.			
6.			
7.			
	= Total Cover		

Herb Stratum (Plot size:)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Goldenrod - some (Late golden)	80%	✓	FACW
2. Fox sedge - nutlets seen	70%	✓	FACW
3. Aster - no id	tr		
4. Blackberry, probably Allegh.	20%	✓	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		

Woody Vine Stratum (Plot size:)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ____ No

Remarks: (Include photo numbers here or on a separate sheet.)
3m radius plot

SOIL

Sampling Point: ________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0"	Black		na					
	histosol		na					
8"								
	7.5YR 6/1		10YR 6/8	30%				
17"								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ✓ Histosol (A1)
- __ Histic Epipedon (A2)
- ✓ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Dark Surface (S7) **(LRR R, MLRA 149B)**
- __ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- __ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- __ Loamy Mucky Mineral (F1) **(LRR K, L)**
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surfaca (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- __ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- __ Coast Prairie Redox (A16) **(LRR K, L, R)**
- __ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- __ Dark Surfaca (S7) **(LRR K, L, M)**
- __ Polyvalue Below Surface (S8) **(LRR K, L)**
- __ Thin Dark Surface (S9) **(LRR K, L)**
- __ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- __ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- __ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- __ Red Parent Material (F21)
- __ Very Shallow Dark Surface (TF12)
- __ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ________

Depth (inches): ________

Hydric Soil Present? Yes ______ **No** ______

Remarks:

clear 8" histosol, below - similar to #1 soil sample
took soil sample #2

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region #3

Project/Site: Brace Marsh Site City/County: Erie Co. / Waterford Sampling Date: 10-11-17

Applicant/Owner: Brace State: PA Sampling Point: #3

Investigator(s): Brooks, Buckley, Almeter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): flat - near high pt. Local relief (concave, convex, none): ______ Slope (%): ______

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PFO1 SS1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ___, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No ✓

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No	**Is the Sampled Area within a Wetland?** Yes ✓ No
Hydric Soil Present?	Yes ✓ No	
Wetland Hydrology Present?	Yes ✓ No	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

Alterations to hydrology and vegetation in 2012; see expert report.

HYDROLOGY

Wetland Hydrology Indicators: none on surface, except oxid rhizo

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches):

Water Table Present? Yes ___ No ✓ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches):

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

41.980699N -80.04709W - Walked ~~west~~ from #2, 90° turn north to concrete drive w/ ~~[illegible]~~ elec. pole - in line w/ #1 treeline

Pockets of elderberry & willow

" of quaking aspen - a bit higher elev

Middle of upland area (as designated)

VEGETATION – Use scientific names of plants. Sampling Point: #3

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Sapling/Shrub Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. Red osier dogwood	10%		FACW
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Herb Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. Goldenrod (Same), Late G.	40%	✓	FACW
2. Fox sedge	70%	✓	FACW
3. Dewberry, Bristly	40%	✓	FACW
4. Reed canarygrass	tr		FACW
5. Blackberry (Same) Allegheny	10%		FACU
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL Sampling Point: #3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0"								
	5YR 5/1		7.5YR 5/6	5-10%				
6"								
	10YR 6/2 + 10YR 4/4	highly mixed	5YR 4/4 (small redox areas	30%				
18"								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type:__________

Depth (inches):__________

Hydric Soil Present? Yes _____ **No** _____

Remarks:

Oxidized rhizospheres in upper 6" - photo taken
Not gritty, 1.5" ribbon - tested by touch

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Brace Marsh Site City/County: Waterford, Erie Co Sampling Date: 10-1/0-17

Applicant/Owner: Brace State: PA Sampling Point: #4

Investigator(s): Brooks, Buckley, Almeter Section, Township, Range:

Landform (hillslope, terrace, etc.): riparian area along Elk Creek Local relief (concave, convex, none): Slope (%):

Subregion (LRR or MLRA): Lat: Long: Datum:

Soil Map Unit Name: NWI classification: PFO1SS1A & PEM1E boundary

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No (If no, explain in Remarks.)

Are Vegetation ✓, Soil ___, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No ✓

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No	Is the Sampled Area within a Wetland? Yes ✓ No
Hydric Soil Present?	Yes ✓ No	
Wetland Hydrology Present?	Yes ✓ No	If yes, optional Wetland Site ID:

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

none, except oxid hydrograph

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches):

Water Table Present? Yes ___ No ✓ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches):

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

41.9815820 -80.0457581 – from #3, walked down slope

Elk Creek – photo – blue vervain

reed canarygrass' goldenrod along stream edge

connecting concrete drive to eastern most edge of alder patch on NE side of Elk Creek

Walking from #3:
- softrush
- goldenrod
- woolgrass
- reed canarygrass

– yellow pond lily + in stream

VEGETATION – Use scientific names of plants.

Sampling Point: ______

Tree Stratum (Plot size: none)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: none)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
Herb Stratum (Plot size: ______)			
1. reed canarygrass	95%		FACW
2. goldenrod (same) late G.	15%		FACU
3. thistle (photo)	5%		?
4. blue vervain	tr		FACW
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100% = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: #4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0								
	10YR 3/1		no mottles	—				
8"								
	10YR 4/1		2.5YR 4/6	20% small redox. areas – oxidized rhizospheres				
18"								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains.

[2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1) ?
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ✓ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type:____________

Depth (inches):____________

Hydric Soil Present? **Yes** ✓ **No** ____

Remarks:

Soil fairly uniform in color & texture

One 2×3" chunk of 10YR 5/1 w/ same reddish mottles

Texture by touch – 2"+ ribbon – smooth, no grit – below 8"

same above 8" – part histosol but probably silt loam

Took soil sample 0–8"

Saw and heard sparrows along Elk Creek

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Brace Marsh Site City/County: Waterford Erie Co. Sampling Date: 10-16-17

Applicant/Owner: Brace State: PA Sampling Point: #5

Investigator(s): Brooks, Buckley, Almeter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): ______ Slope (%): ______

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PFO1SS1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ______, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ✓

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No	Is the Sampled Area within a Wetland? Yes ✓ No
Hydric Soil Present?	Yes ✓ No	
Wetland Hydrology Present?	Yes ✓ No	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No ______ Depth (inches): in ditches & soil pit

Water Table Present? Yes ✓ No ______ Depth (inches): near bottom of soil pit even with ditch level

Saturation Present? (includes capillary fringe) Yes ✓ No ______ Depth (inches): 0-18"

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: 41.9199712 -80.0441606

No evidence of flooding above bank (despite heavy rainstorm 18hrs before)

Slight indication of oxidized rhizospheres. Soil saturated and water accumulating in bottom of soil pit.

VEGETATION – Use scientific names of plants.

Sampling Point: ____________

Tree Stratum (Plot size: none)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	____ = Total Cover		

Sapling/Shrub Stratum (Plot size: 3m)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Speckled Alder	70%	✓	FACW
2. Silky dogwood	20%	✓	FACW
3. Elderberry, Common	10%		FACW
4.			
5.			
6.			
7.			
	80% = Total Cover		

Herb Stratum (Plot size: ________)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Goldenrod (Canada) late	30%	✓	FACW
2. Small white aster	tr		FAC
3. Grass – no flower	5%		?
4. #2 Goldenrod – smaller, smooth	tr		?
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	60% = Total Cover		

Woody Vine Stratum (Plot size: ________)

	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	____ = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Some bare ground

SOIL

Sampling Point: #5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0"	Histosol		no mottles					
	~10YR2/1							
12"								Text by
								Touch ta- 2"+ ribbon
	10YR 3/1		minor reddish oxid					sticky, no grit
			only along root channels					
18"			~7.5YR 4/4					

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ✓ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ________

Depth (inches): ________

Hydric Soil Present? Yes ✓ No ____

Remarks:

Slight seepage bottom (18") of pit
Small ditch w/ duckweed to East - 2m away from pit
ditch 16-20" below grd. surface, ~12" deep w/ water
Small drainage pathways among Alder
Buck rub at ditch ~~edge~~ bank.

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Brame Marsh Site City/County: Waterford Erie Co. Sampling Date: 10-16-17

Applicant/Owner: Brame State: PA Sampling Point: #6

Investigator(s): Brooks, Bartley, Almitz Section, Township, Range: ______

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): ______ Slope (%): ______

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PEM1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ___, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ___ No ✓

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ___	Is the Sampled Area within a Wetland? Yes ✓ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ______

Water Table Present? Yes ✓ No ___ Depth (inches): about 12"

Saturation Present? (includes capillary fringe) Yes ✓ No ___ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

41.9815115 -80.0460615

Sample pt. after Elk Creek turns East along North edge of property – 3rd elec. pole – off stream about 30m.

VEGETATION – Use scientific names of plants.

Sampling Point: #6

Tree Stratum (Plot size: none)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Sapling/Shrub Stratum (Plot size: none)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Herb Stratum (Plot size: 3 m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Foxsedge or similar	90%	1	FACW
2. Goldenrod, smooth stem	30%	1	?
3. Wool grass	5%	1	FACW
4. Sun white aster	10%		FAC
5. "Brown" w/ seed heads	20%	1	OBL
6. ↑ (sample taken)			
7. Sharp wing Monkeyflower			
8. (Mimulus alatus)			
9.			
10.			
11.			
12.			
	= Total Cover		

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Kingfisher blow overhead

SOIL Sampling Point: ________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0"								close up photo
appears								oxidized rhizosph.
slightly more gray	7.5 YR 5/1		7.5YR 6/8	30%				Texture by touch
7"								2" + ribbon, smooth,
								dense clay - tight
Close up								
photo			7.5YR 6/8	40%				
taken	7.5YR 5/1							
18"								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ✓ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ______

Remarks:

Seepage of H_2O at bottom of pit (18") after 15 min, some glistening on pit in upper 0-7"

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Reference Wetland City/County: Greene Twp. Erie Co. Sampling Date: 10-17-17

Applicant/Owner: SGL 109 State: PA Sampling Point: #7

Investigator(s): R. Brooks Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): ______ Slope (%): ______

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PFO1/SS1E

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No	Is the Sampled Area within a Wetland? Yes ✓ No
Hydric Soil Present?	Yes ✓ No	
Wetland Hydrology Present?	Yes ✓ No	If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ✓ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✓ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No ______ Depth (inches): 1-2 inches

Water Table Present? Yes ✓ No ______ Depth (inches): within 1" of surface

Saturation Present? (includes capillary fringe) Yes ✓ No ______ Depth (inches): below 1" of pit depth

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

41° 59' 57.66" N / 80° 00' 06.71" W

41.999 -80.002

VEGETATION – Use scientific names of plants. Sampling Point: #7

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1. Tan Virginia			
2. Red Maple, Black Willow			
3. FAC FACW			
4.			
5.			
6.			
7.			
	______ = Total Cover		

Sapling/Shrub Stratum (Plot size: 3m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Willow, black	20%	✓	FACW
2. N. Arrowwood	5%		FACW
3.			
4.			
5.			
6.			
7.			
	______ = Total Cover		

Herb Stratum (Plot size: 3m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Reed canary grass	100%	✓	FACW
2. Sparganium americanum	5%		OBL
3. Goldenrod, Late			FACW
4. Spec. Alder	10%		FACW
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	______ = Total Cover		

Woody Vine Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	______ = Total Cover		

Remarks: (Include photo numbers here or on a separate sheet.)

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No

SOIL Sampling Point: #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0	histosol 7.5YR 3/1		no mottles saturated					
7"	Gley 2.5Y 3/1 High organic content		no mottles					
18								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ✓ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ✓ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type:______________

Depth (inches):______________

Hydric Soil Present? Yes ___ No ___

Remarks:

water in immediately, 1" from surface

ribbon > 2"; smooth

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Reference Wetland City/County: Greene Twp., Erie Co. Sampling Date: 10-17-17

Applicant/Owner: SGL 109 Sampson Stn (Rd) State: PA Sampling Point: # 8

Investigator(s): ______ Section, Township, Range: ______

Landform (hillslope, terrace, etc.): flat Local relief (concave, convex, none): ______ Slope (%): ______

Subregion (LRR or MLRA): ______ Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: ______ NWI classification: PFO/SS1E & PEM/SS1C

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No Hydric Soil Present? Yes ✓ No Wetland Hydrology Present? Yes ✓ No	**Is the Sampled Area within a Wetland?** Yes ✓ No If yes, optional Wetland Site ID: ______

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✓ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- ✓ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✓ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No ______ Depth (inches): 4 in deep

Water Table Present? Yes ✓ No ______ Depth (inches): to surface

Saturation Present? (includes capillary fringe) Yes ✓ No ______ Depth (inches): entire pit

Wetland Hydrology Present? Yes ✓ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

42.0?? -80.004 (approx.)

VEGETATION – Use scientific names of plants.

Sampling Point: #8

Tree Stratum (Plot size: 3m+)	Absolute % Cover	Dominant Species?	Indicator Status
1. Red maple 12", 3", 4"	20%	✓	FAC
2. Black ash 7"	45%		FACW
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Sapling/Shrub Stratum (Plot size: 3m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Shrub – Clethra alnifolia	5%		FAC
2. Sweet pepperbush			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		

Herb Stratum (Plot size: 3m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Carex stricta	40%	✓	OBL
2. Sparganium americanum	20%	✓	OBL
3. Reed canarygrass	30%	✓	FACW
4. ~~Agrostis~~ Calamagrostis canadensis	20%	✓	FACW
5. Sensitive fern	10%		FACW
6. Mint – lg leaf	4%		?
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		

Woody Vine Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 ~~4~~ (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✓ No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL Sampling Point: #8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0	Histosol							saturated to
	~7.5YR 3/2		no mottles	0				surface
								from high road
								culvert
5"								
mixture	7.5YR 4/1		no mottles					
of muck			oxid rhizosp					
& clay			5YR 5/8					
18"								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ✓ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ✓ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ✓ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)** +
- ___ Dark Surface (S7) **(LRR K, L, M)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ✓ **No** ___

Remarks:

Highly organic histosol, partial muck. Deeper, saturated mucky silt clay.

11.0 Brace – Marsh Site – Conceptual Plan for Wetlands & Stream Restoration

-General and Technical Recommendations-

Prepared by: Robert P. Brooks, Ph.D., Brooks Consulting

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Figure 68. Conceptually, wetland and stream restoration of the Marsh Site should be designed and constructed to reach vegetation communities and hydrologic regimes comparable to the pre-disturbance condition of the site (2011 aerial photograph – close-up of southeast corner of the Marsh Site (Google Earth)).

11.1 Background on Wetland Restoration

The most appropriate definition of restoration is provided by the nation's most distinguished scientific and engineering organization, the National Research Council (NRC). The NRC defines restoration as "…the establishment of predisturbance aquatic functions and related physical, chemical and biological characteristics." (Cairns 1988, Lewis 1989, National Research Council 1992:17, Restoration of Aquatic Ecosystems, National Academy Press, Washington, DC). This level of restoration is not always possible, and can be increasingly unlikely as the area and complexity of an ecosystem to be restored increases.

As confirmed by the National Research Council in 1992, and in several reports and papers issued since (NRC 2001, GAO 2002, Brooks et al. 2005), intact ecosystems associated with a restoration project should be allowed to remain intact. This premise was re-confirmed in the 2008 Mitigation Rule issued jointly by the U.S. Army Corps of Engineers and U.S. Environmental Protection Agency, which found that "…despite progress…there are still gaps in the science of restoration ecology" and that "the first step should always be to avoid impacting these important aquatic resources if possible." Thus, any areas of the Marsh Site that have reasonably intact ecological structure and function should remain as they are. In particular, the regrowth of vegetation post-disturbance from 2013 to the present should not be interrupted with extensive restoration activities over the entire 20-acre parcel. Rather, the focus should be on re-establishing the hydrologic regime of the wetlands. When the hydrology is restored, and because the site's hydric soils are relatively intact, conditions necessary to favor a more hydrophytic plant community should occur in the near future. With the re-establishment of all three wetland parameters – hydrology, hydric soils, hydrophytes – and their re-connection to the Elk Creek floodplain, the former set of wetland and stream functions and ecosystem services will gradually return with their associated set of benefits to the natural communities and human communities along the length of Elk Creek from the Marsh Site wetlands downstream to Lake Erie.

11.2 Restoration Objectives for the Marsh Site Wetlands

The guiding principles for determining the fate of the restoration of wetlands of the Marsh Site, should be based on the best science and practices available, within the context of appropriate policies and public needs. To do otherwise, is to condemn the overall project to a suboptimal conclusion. Located in the headwaters of Elk Creek, the Marsh Site and adjoining wetlands form the largest concentration of NWI-mapped wetlands in the watershed (see Figures 62-64). At nearly 20 acres, the large spatial extent of this project, requires addressing multiple objectives:

1) promote an increase diversity of wetland types and wetland plant communities within the site; and

2) ensure that critically important floodwater storage, infiltration, habitat, and other functions are maintained for the health, safety, and welfare of the surrounding communities and wildlife habitats.

Allowing natural hydrologic and vegetation processes to recover, and thrive as they were pre-disturbance, can help return the wetlands and stream of the Marsh Site to a highly functioning aquatic ecosystem. Before the hydrologic changes occurred in 2012, with the installation of ditches and drainage tiles, as well as the cutting and removal of vegetation throughout the Marsh Site, the successional stage of vegetation was on a trajectory to becoming forested wetlands approaching 20 years of age (see Figures 7, 8 & 9 in Appendix A). Some areas along the immediate floodplain along Elk Creek would be expected to have scattered trees, with herbaceous and shrub species dominating as seen in Figures 7, 8 & 9. A few areas had no trees, with only wetland-dependent, herbaceous ground cover. The cutting of trees, removal of stumps, and grubbing of soil that occurred in 2012 (see Figure 10, 11, 12) resulted in a lost opportunity to allow the Marsh Site to return to an extensive wetland floodplain with adjacent slope wetlands and mixed vegetation patterns. Suitable natural reference sites (i.e., site numbers 7, 8, 220, 221 & 222) are available to serve as design and performance models for the Marsh Site (see Section 4.4 for descriptions of reference wetlands surrounding the Marsh Site).

11.3 Retention of Qualified Wetland Professionals to Implement Restoration

To implement the restoration plan, Brace should be required to hire a highly-qualified wetland professionals experienced with the design, construction, and post-construction management and monitoring of comparable restoration projects. Use of a qualified wetland professionals to implement the wetland restoration will substantially increase the odds of a successful project. Thus, the team should be required to have the following members:

- Firm(s) with proven expertise in completing successful wetland and stream restoration/mitigation projects in the eastern U.S. Their principal responsibility would be for project planning, permitting, design, construction (primary or to hire and manage subcontractors).
- Third party technical expertise in the science and practice of wetland and stream restoration (preferred certification as Professional Wetland Scientists, but comparable disciplines possible (e.g., practical landscape architecture, ecohydrology with wetland expertise, stream restoration)). Their tasks would be to work with the primary construction contractor to optimize project design and construction, but also provide independent input on technical elements. Gathering data from identified natural wetlands in the area, to be used as reference sites, should be another task.

Brace's selection of a wetland professional should be subject to EPA's approval.

11.4 Concepts and Recommendations for Wetlands Restoration at the Marsh Site

As mentioned previously, effective mitigation and restoration project design and performance criteria is based on natural reference wetlands of a comparable type. Recent studies comparing mitigation and restoration projects to natural reference wetlands have shown that the majority of projects are not replacing wetland structures, functions, and services, and thus, improvements need to be made in the mitigation/restoration process. I recommend specific variables be obtained from the reference wetlands provided in this report to be used as design targets for restoration projects, which are then used again to evaluate performance. Data from an increasing number of reference wetlands will likely become available in the near future if plans for establishing a national Reference Wetlands Registry are completed (Gebo and Brooks 2012, Moreno-Mateos et al. 2012, Brooks and Gebo 2013, Brooks et al. 2016).

A mitigation/restoration process for the Marsh Site wetlands (or other ecosystems), includes these seven major steps (beyond the use of natural reference wetlands, which is essential) (Brooks 1993), which should be completed with EPA's approval:

1. Conduct a functional assessment of the wetland to be impacted, considering the functional needs for the region of interest. For the Marsh Site, this would be done by completing more detailed assessments of nearby reference wetlands with associated streams, and using historical imagery to reconstruct how the Marsh Site appeared prior to disturbances in 2012.

2. Set site-specific objectives for the project, as outlined above for this restoration plan.

3. Select and acquire access to a suitable site; in this case, the site is selected by default.

4. Design conceptual plans based on site conditions and project-specific objectives. These must be accomplished by trained professionals while considering the recommendations provided here as a starting point.

5. Prepare construction plans, specifications, and budgets. These must be prepared by trained professionals with wetland and stream restoration and/or mitigation experience.

6. Implement construction and maintenance activities. These must be conducted or at least guided by trained professionals with wetland restoration and/or mitigation experience.

7. Prepare as-built condition plans for baseline information (post-construction), and implement monitoring protocols for periodic performance evaluation reports. These must be prepared by trained professionals and provided to environmental agencies for review.

11.5 Site Morphometry.

Every restoration project has a unique site morphometry, specific characteristics of size, shape, depth, and slope, both before and after design and plans are undertaken. Conditions are based on landscape position, which in the case of the Marsh Site is a gently sloping topographic draining west to east. Slope wetlands present now, and those presumed to be present pre-disturbance are likely influenced by a shallow groundwater table seasonally near the surface. These slope wetlands blend into the relatively flat floodplain of Elk Creek that was channelized in 2012, but had a more natural meandering stream channel with clear hydrologic connections to floodplain wetlands before being altered. Detailed planning for the site's restoration will determine what design changes are needed.

11.6 Restoring the Hydrologic Regime at the Marsh Site Wetlands.

The water regime for a specific geographic location is the primary factor defining what type of wetland will form naturally, or be created for any given site. Before modifications were made to the Marsh Site in 2012, when ditches and tile drains were installed and Elk Creek was dredged and channelized, it is likely that the water table was at or near the surface for a considerable portion of the year throughout the floodplain and lower slopes. Thus, the primary objective for wetlands restoration will be to reverse the impacts of the ditch and tile drainage system by filling in ditches and blocking or removing drainage pipes, and re-establish Elk Creek's connections with the floodplain.

11.6.1 Hydrology and Soils: A major factor that must be addressed is whether to either selectively break each drainage pipe in multiple places to stop the lowering of the local water table or to excavate and remove the entire drainage pipe network. I recommend the former option, because removing the entire drainage pipe network will require extensive use of heavy equipment resulting in another series of disturbances to the Marsh Site, including creating temporary access roads, re-ditching, removal of pipes, returning soils to approximate original topographic contours, and replanting disturbed areas with appropriate wetland species. Alternatively, I recommend severing the drainage capability of the PVC tile network using modest sized, low ground pressure construction vehicles to avoid soil compaction (e.g., low ground pressure backhoe). Holes should be dug at the intersections of each branch of the PVC pipe network. At each intersection with PVC pipes, I recommend removing a 6-10 foot section of pipe, and shattering the inlet and outlet end of each length of pipe removed to stop future water flows. Pipes removed should be taken off site and be properly disposed. This should occur in at least three locations along each branch of piping to cutoff the drainage of water; lower slope near Elk Creek, toe of slope, and mid-slope. Any pipe junctions discovered during this process should be shattered as well. Holes dug to access drainage tiles can be backfilled with the soil excavated when removing pipes.

All ditches should be filled with a silty clay or silty clay loam, which are soil textures typical of the Marsh Site, again, to slow water movement. Gravel should not be used as a fill material, as this would foster rapid movement of water through the filled ditches. Care should be taken to minimize surface disturbances when driving and operating the equipment around the Marsh Site. Work should be performed during times when soils are nearly frozen or when conditions are at their driest, and preferably outside the main growing season, which is approximately June-September. The system of temporary roads allowing access to the ditch and pipe networks should be minimized to avoid the floodplain and wetter areas. Equipment should access the Marsh Site from the higher elevation sections of Sharp Road whenever possible and follow the existing pipe layout as much as possible. Since it appears that hydric soils remain over many portions of the Marsh Site, soil amendments, such as organic matter, are not needed.

11.6.2 Vegetation: There are currently small patches of woody shrubs present on the Marsh Site, but extensive areas dominated by trees and shrubs were removed during the 2012 disturbances. To restore some woody vegetation to the site, I recommend planting patches of shrubs and early successional trees at each of the disturbed patches where drainage pipes are removed (about 0.5

acre in 12 patches). Varied mixtures should be planted, including early successional wetland species of trees such as black willow (*Salix nigra*), pin oak (*Quercus palustris*), possibly river birch (*Betula nigra*), and shrubs such as northern arrowwood (*Viburnum recognitum*), silky dogwood (*Cornus amomum*), red-osier dogwood (*Cornus sericea*), elderberry (*Sambucus canadensis*), and steeplebush (*Spirea tomentosa*)
(for other species, see https://www.na.fs.fed.us/spfo/pubs/n_resource/flood/toler.htm).

Shrubs should be planted as live stakes (cuttings without roots) or container stock (typically 12-36 inches in height for 1-2 gallon containers). A mixture of planting approaches should be used to both increase success, but managed for reasonable cost and availability. Trees should be planted as container stock (typically 24-48 inches in height for 1-3 gallon containers). Although a mixture of planting approaches can be used, I recommend at least half of the acreage be planted (0.5 acre with patches of woody species) with containerized tree species to shorten the time necessary to produce shade and move toward maturing woody wetland patches. The cost of containerized trees ranges from $18 – 28 per individual tree (Go Native Tree Farm, www.gonativetrees.com). Recommended planting density for trees vary considerably from 200 to over 2,000 individuals per acre. I recommend a conservative density of 400 woody stems per acre. Any other disturbed areas (i.e., temporary roads, work areas along Elk Creek) should be seeded with wetland-dependent herbaceous species.

For herbaceous plantings, custom wetland seed mixes can be created to meet the needs of any project (e.g., Ernst Seeds, www.ernstseed.com, located near the Marsh Site in Erie County). Seeds for individual species of herbaceous grasses, grass-likes, and broad-leaved forbs, such as *Glyceria, Juncus, Carex, Eupatorium, Aster*, and *Acorus*, range in cost per pound from $66-280, with recommended seeding rates of 20 lbs./ac. Pre-packaged or custom seed mixes typically range from $50-100/lb (Ernst Seeds). A cost per pound of $100 was chosen to account for ancillary costs, such as fertilizer application.

I recommend selecting wetland species for the restoration from the Marsh Site Sample Points (Site Nos. 1-6) and from the nearby reference wetlands (Sites Nos. 7 and 8) to develop a suitably diverse planting list with a sufficient number of species (species richness) for herbaceous, shrub, and tree communities, and appropriate species for this region (see Table 4). Planting stock (e.g., seeds, cuttings, bareroot seedlings, "whips" or saplings, etc.) should be from sources that match the local phenotypes and genotypes of natural plant communities. It is best to use local varieties, rather than order plant material from other geographic regions. Sometimes local nurseries have, or are willing to produce (based on local collection of seeds and cuttings) sufficient quantities of plant materials to meet project needs. Usually they need at least one growing season to accumulate these materials. The volume of plant material needed for this site is modest.

For the purposes of this conceptual restoration plan, I assumed about 2.0 acres of the 20-acre Marsh Site would be disturbed during restoration activities, and need to be planted by seeding with appropriate mixes of wetland herbaceous species. The 2.0 acres includes 0.5 acre of patches where drainage pipes are removed (a minimum of 12 pipe removal locations estimated as 25-foot diameter circles each), 0.5 acres of temporary roads, and 1.0 acre along Elk Creek to accommodate filling in the dredged channel and re-establishing hydrologic connections with the floodplain. The same 0.5 ac of patches listed above should also be planted with shrubs and trees (Table 10). For an initial estimate of costs, I used 2016 price lists and advice from Ernst Seeds (Meadville, PA) and Go Native Tree Farm (Lancaster, PA), both of which are reputable and should have suitable native species with appropriate genotypes for Erie County. Costs listed (Table 1) are for planting stock only, and do not include mobilization, labor, monitoring, or maintenance associated with planting.

Table 10. Conceptual recommendations for acreage, planting or stocking density, and cost; assumes 2.0 acres of 20-acre Marsh Site will be planted as listed; see text for examples of species.[1]

Marsh Site (ac)	Herb. seed mix	Shrubs	Trees	Costs
2.0 ac	20 lbs./acre x $100/lb.			$4,000
0.5 ac x 0.75 = 0.375 x 400 stems per ac = 150 stems		150 stems x $16/container		$2,400
0.5 ac x 0.25 = 0.125 x 400 stems per ac = 50 stems			50 stems x $23/container	$1,150
Cost of plants				$7,550

Appropriate metrics for designing and assessing performance for the vegetation component of a wetland mitigation or restoration projects are discussed in Brooks and Gebo (2013), although recommendations are available in other publications, such as Biebighauser (2011). The Association of State Wetland Managers is planning to release by the end of 2017 a significant document addressing how to fix the shortcomings of current wetland restoration practices. A particularly useful set of metrics can be computed from the online Floristic Quality Index Calculator (FQAI) (http://www.mawwg.psu.edu/) for the Mid-Atlantic Wetlands Work Group (Chamberlain and Brooks 2016). Only a species list of plants is needed to derive useful values. This list can be generated from the natural reference wetlands, and then compared to both the proposed planting plan, and later, monitoring data as one way to gage success.

Typically, mitigation and restoration permits for wetlands specify metrics such as percent cover or stem density, and percent plant survivorship to assess performance, as well as a species planting list. Increasingly, this approach has not proven to lead to creation or restoration projects that come close to mimicking natural wetlands. A preferred method would be to develop a species list for planting based on the current plant community on site and the reference wetlands listed. Woody species planted as live nursery stock should be protected with tree/shrub tubes against deer and rodent browsing. Monitoring should include provisions to monitor survivorship over time, and to assess the existing plant community, plus plants germinating from seeding, and any new colonizers. Metrics such as the FQAI and invasive species cover should be used to assess the restoration success during each monitoring event.

[1] Prices from 2016 lists of Ernst Seeds and Go Native Tree Farm. Estimates are wholesale and conservative. Costs could easily increase by a factor of two or more once a final restoration plan and species list is negotiated, although bulk discounts may be available.

11.6.3 Restoration of Floodplain and Wetland Connections to Elk Creek: Evidence shows that pre-disturbance vegetation communities and the channel and floodplain of the Marsh Site and Elk Creek were displaying naturalistic conditions (Figures 7, 8, 9 & 66). By 2011, natural succession and hydraulic processes had formed a wetland complex comprised of diverse patches of hydrophytic plants and a meandering channel with hydrologic connections to the Elk Creek floodplain. Post-disturbance (after 2012), the following had occurred on the Marsh Site: cutting of vegetation, land grubbing, ditching, installing plastic drainage pipes, dredging and side-casting material from the Elk Creek channel. These activities contributed to significant degradation of wetlands, the floodplain, and the stream channel.

Restoration of the slope wetlands and vegetated portions of the Elk Creek floodplain are discussed in Section 11.7. Their interaction through surface water and groundwater connectivity is important to the functions and services of Elk Creek and downstream areas, to ensure that ecological and hydrological processes are maintained. Eliminating the ability of the drainage tile network to directly discharge into Elk Creek means that the slope and floodplain wetlands should have a wetter hydrologic regime, which will bring the plant community composition closer to that of reference wetlands. Likewise, filling in the ditch network, or converting them into more open backwater areas (as seen in Figures 7, 8, & 9), will enhance the functions and services provided, as discussed in Section 6.0. Post-disturbance, the Elk Creek channel became incised (deeper than it should be due to dredging), which causes less frequent flooding of the floodplain where water can to stored for hours or days, and be released slowly back into the channel as the threat of flooding declines. For Elk Creek to function properly, there needs to be better hydrologic connections between Elk Creek and the adjacent floodplain; several restoration options should be considered. The bottom elevation could to be raised such that the water in the channel is near or at the top of the riparian bank along both sides of Elk Creek within the Marsh Site. If this option is selected, the fill material for the channel should be a mixture of river gravel and sand, to provide stability for the substrate, and potential habitat for benthic macroinvertebrate communities that reside on the stream bottom. Alternatively, the riparian can be lowered in strategic places (especially where side-casting of material occurred). In addition, crossvane structures should be installed at a minimum of four locations along this reach of Elk Creek. Using stone or logs embedded in the banks, cross-vanes will both build up the bottom substrate of the channel and divert floodwaters into the floodplain (Figure 69).

The important function of floodwater storage and slow release helps protect downstream residents, infrastructure, and habitats. When substantial amounts of floodwater overflow the banks of a full stream channel and flow over the natural levee elevation of the riparian banks, this is known as *overbank flooding*. In addition, smaller flood events occur that do not exceed bank height. These are typically known as *flood flows*, where rising water levels in the stream channel flow into connected backwater and flat areas, which can be seen clearly in the 2011 aerial photograph (Figures 7, 8, & 9). These are important for maintaining saturated conditions with the floodplain and adjacent wetlands. The overall dimensions and shape of the restored channel of Elk Creek should exhibit more meanders than currently present in the post-disturbance channel, with connections to backwaters and shallow depressions in the floodplain, as portrayed in the 2011 aerial photographs (Figures 7, 8, & 9). The cost of restoring the floodplain and the wetland connection to Elk Creek is difficult to determine without the benefits of additional field visits.

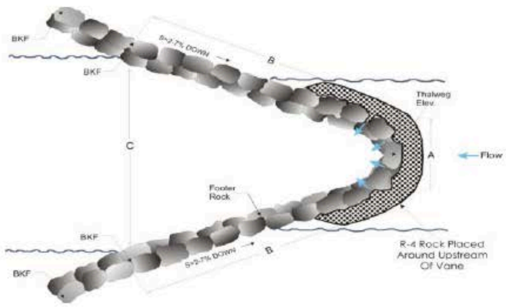

Figure 10. Diagram and photo of rock cross vane in Millbrook Marsh. Courtesy of T. Rightnour.

Figure 69. Sample stream and floodplain BMP to correct stream incision from excessive flows: Crossvane maintains low flow channel and pushes high water into floodplain during floods.

11.7 Monitoring, Management, and Assessment Plan

No mitigation and restoration project should proceed without a clear and funded plan to monitor, manage (e.g., fix construction issues, control invasive species, etc.), and assess performance of the project over time. Yet, this aspect is often missing, or when data are collected they are not used to understand the successes and failures of a project.

For the Marsh Site, I recommend an independent third party be contracted to conduct the monitoring, management, and assessment with clear reporting requirements to appropriate resource agencies. The length of the monitoring period should be at least 10 years. A typical sequence would be to monitor the site twice in years 1 and 2, then once per year in years 3, 5, 7, 10. Details of the monitoring plan should be developed in conjunction with the project designer or contractor, and include as-built plans and data post-construction to serve as the baseline condition. Comparisons to selected reference wetlands are expected, and should be required. The essential metrics needed to assess performance of the restoration over time should include, at a minimum, vegetation survival and composition measures, automatic water depth recording wells to determine how the water table rises and the flooding frequency increases after the drainage network is removed, and observational assessments of stream condition, before and after restoration (i.e., Stream Habitat Assessment, either from EPA's Rapid Bioassessment Protocol (Barbour et al. 1999) or Riparia's Stream, Wetland, Riparian Assessment (Brooks et al. 2009).

Overall costs are difficult to estimate without the benefit of more detailed field assessment. Estimates should include site survey, design, engineering components, and monitoring/assessment costs over time. With a site of this importance and complexity, an assurance of compliance should be guaranteed through either a bond or endowment managed by a local, independent entity. In addition, a permanent conservation easement on the Marsh Site should be required to ensure the wetlands remain protected, as is commonly done in most wetland mitigation banks and sites.

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12.0 - Appendix B – Curriculum Vitae

Robert P. Brooks, Ph.D.

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education

University of Massachusetts, Amherst	Wildlife Biology	Ph.D.	1980
	Wildlife Biology	M.S.	1977
Muhlenberg College, Allentown, PA	Biology	B.S.	1974

career summary

Robert P. Brooks is a nationally recognized leader in wetland science and policy. In 2017, he was elected a Fellow of the Society of Wetland Scientists. In 2013, he received the *National Wetlands Award for Science Research* sponsored by the Environmental Law Institute, Washington, DC. He became a Certified Professional Wetland Scientist in 1995, renewed in 2011. He has over 35 years of experience working in inland freshwater wetlands and riverine ecosystems. He is widely recognized for key research, education, and outreach contributions in the areas of integrating the ecology and management of streams, wetlands, floodplains, and riparian areas in a watershed context, wetland restoration and mitigation, development and application of wetland monitoring and assessment methods, developing and applying hydrogeomorphic models for multiple wetland types, and developing and applying habitat models and ecological indicators for wetland-riparian wildlife.

He was Founder of a research and outreach center at Penn State, Riparia (1993-present), and continues as Director. He has a remarkably long and consistent record of serving on wetland, water, and conservation committees and boards at all governmental and geographic levels. His tenure for many of these committees is approaching or exceeding a decade of service.

As a consultant, Dr. Brooks has worked for 30 years with agencies, corporations, utilities, citizen groups, and individuals concerning natural resources issues and management, with an emphasis on assessments of wetlands and streams, habitat assessment and modeling for wetland-dependent wildlife, and finding solutions to complex environmental and natural resource problems. He has shared his expertise, not only in the classroom, but through many outreach activities, workshops, and training events with agency personnel, wetland and stream assessment and restoration practitioners, and personnel from forestry, agricultural, mining, and development industries.

selected awards and certifications

- Elected Fellow of the Society of Wetland Scientist (2017)
- Ruby S. and E. Willard Miller Professorship in Geography (2015-2018), Penn State Geog.
- National Wetlands Award in Science Research (2013) - Environmental Law Institute
- Certified Professional Wetland Scientist (1995, renewed 2011) - Society of Wetland Scientists
- Faculty Outreach Award (2009) – Pennsylvania State University
- Certified Wildlife Biologist (1983) – The Wildlife Society

professional activities - University

As Director and Founder of Riparia (www.riparia.psu.edu, established 1993) - *where science informs policy and practice in wetlands ecology, landscape hydrology, and watershed management* - and as Professor of Geography and Ecology in the Department of Geography at the Pennsylvania State University, Dr. Brooks has developed a widely recognized wetland and wildlife research and education program.

- Recent research projects include:
  - integrating streams, wetlands, floodplains, and riparian areas in a watershed context
  - wetlands restoration and creation on altered and damaged landscapes
  - monitoring and assessment protocols for reference wetlands and mitigation projects
  - developing hydrogeomorphic models for riverine, depression, and slope wetlands
  - developing ecological indicator models for invertebrates, amphibians, and birds
  - habitat modeling for wetland-riparian and forest wildlife.
- Published 109 articles in peer-reviewed journals and proceedings; 17 books and book chapters; 100+ other publications; National Wetlands Newsletter (ELI), 4 invited editorials (2011-12), editor and author for Special Issue – Reference Wetlands (2016)
- Senior principal investigator on over 110 grants funded between 1981-2016, totaling over $30M.
- Director of Co-Director of six interdisciplinary and multi-institutional research projects, including the Atlantic Slope Consortium (USEPA), Watershed Characterization and Prioritization (USEPA), Bog Turtle Habitat Conservation Plan (USFWS), Best Management Practices for Agricultural Watersheds (USDA), and Center for Nutrient Solutions (USEPA).

- Served on numerous advisory boards and committees, and consulted with federal and state agencies, local municipalities, and industries. He has worked with agencies (e.g., U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Bureau of Mines, U.S. Fish & Wildlife Service, National Park Service, PA Department of Environmental Protection), corporations (e.g., coal mining, forestry, industrial development authorities, utilities), educational organizations (e.g., public schools, conservation organizations, citizen groups, land trusts), and individuals to address natural resource issues, deliver information, and solve environmental problems.

<u>selected professional service, beyond Penn State – local to international</u>:

- Pennsylvania DCNR Riparian Forest Buffer Advisory Committee member (2016-2017)
- Chesapeake Bay Program's Wetlands Expert Panel member formed to establish quantitative measures on the efficiency and efficacy of buffers for wetlands and streams (2014-2015)
- USEPA Scientific Advisory Board Review Panel member on the connectivity between streams and wetlands (2013-2014)
- USEPA-sponsored: Mid-Atlantic Wetlands Working Group (MAWWG), participating in two regional meetings/year (2002-2016); Director 2013-2017
- IUCN Otter Specialist Group – member; Editorial Board, Otter Specialist Group Bulletin (2011-2016)
- Louisiana Coastal Area Science Board – Invited member (2009-2011)
- Chesapeake Research Consortium, Board – Penn State Trustee (2007-2016)
- USEPA Office of Research and Development. Chair, Report on the Environment Expert Panel: Wetland Condition, 21-22 January 2008, Washington, DC. Final Report (2008)
- PA Dept. Environmental Protection
  Wetland Protection and Advisory Committee – Chair, elected (1996-2005)
- Halfmoon Twp. Planning Commission – member, served 16 years (1993-2010)
- Millbrook Marsh Nature Center Advisory Committee – founding member (1997-2016)

<u>current memberships in professional societies, offices held, editorial assignments</u>:

IUCN Otter Specialist Group, member; OSG Bulletin Editorial Board (2011 to present)

Society of Wetland Scientists - member, Certified Professional Wetland Scientist (1995, 2011), Associate Editor for Wetlands (2003-2005)

Association of State Wetland Managers – member

The Wildlife Society - Certified Wildlife Biologist (1983), Associate Editor for Journal of Wildlife Management (1989-91); member National, Section, and

Pennsylvania Chapters; Advisor to Penn State Student Chapter (1991-2000), Board Member PA Chapter (1991-1994), President PA Chapter (1993)

professional activities – Consulting

As a consultant, Dr. Brooks has worked for 30 years with agencies, corporations, utilities, citizen groups, and individuals concerning natural resources issues and management, with an emphasis on monitoring and assessments of wetlands and streams, and habitat assessment and modeling for wetland-dependent wildlife. Other projects have addressed issues and problems on conservation, restoration, and management of wetlands, streams, and riparian areas; wetlands mitigation and restoration; wetland identification and delineation; and assessing and managing riparian corridors.

Selected list of client projects:

Allegheny Power Service Corp. - wetland assessments, mitigation design and construction, hydro-electric plant impacts

Collins Pine/Kane Hardwood – develop forest wildlife management plan to meet international Forest Certification Standards

Electric Power Research Institute - design, construction, and monitoring of wetland treatment system

EPD, LLC – technical advising on development of a 9-county natural infrastructure analysis

Joseph A. Piccone, Inc. – prepared a biological assessment for bog turtles for mall project

Mintz Levin / General Electric - assessment & interpretation of riverine ecosystem restoration project

Ohio EPA – technical consultant to defend wetland rapid assessment methods (ORAM)

PA Dep. of Transportation - monitoring and design of statewide wetland mitigation projects

Shell Oil Company - natural resource damage assessment for muskrat, Gasconade River, MO

U.S. Department of Justice – wetlands consultant on civil case (Buffalo, NY)

U.S. Environmental Protection Agency - research plan reviews, authored books and chapters, Science Advisory Board panelist – connectivity of wetlands to streams

U.S. Fish and Wildlife Service - assessment of wetland and wildlife project plans, training of biologists

professional employment

2004-present - Principal, Brooks Consulting

2003-present - Professor of Geography and Ecology, Department of Geography Pennsylvania State University

1993-present - Director, Riparia (formerly Penn State Cooperative Wetlands Center)

1998-2003 - Professor of Wildlife and Wetlands, School of Forest Resources
1988-2003 - Partner, Water's Edge Technology, LLC
1986-1997 - Associate Professor of Wildlife Ecology, School Forest Resources
1985-1988 - Chairman, Wildlife & Fisheries Science, School Forest Resources
1983-1985 - Assistant Professor of Wildlife Ecology, School of Forest Resources
1980-1983 - Assistant Professor of Wildlife Technology, DuBois Campus
Wildlife Technology Program Leader (1982/83)
School of Forest Resources, Pennsylvania State University

selected training webinars, workshops, and courses designed and taught:

May 2016 - **Brooks, RP**, WL Daniels, and E Stein. Establishing Reference Conditions for Performance Standards and Long Term Monitoring Results: Soils, Hydrology and Vegetation. Association of State Wetland Managers Webinar, 10 May 2016, 450 attendees nationally.

May 2016 – **Brooks, RP** et al. Training for Stream, Wetland, Riparian Index Protocol and Sampling for CREP Assessments. Lecture and field training for Natural Resource Conservation Service and Mid-Atlantic State Foresters, 25-26 May 2016, Frederick, MD. Lead instructor.

May 2015 - **Brooks, RP**. Building a better wetland: Reference data and tools for enhancing wetland projects. USDA Natural Resources Conservation Service – Science and Technology Webinar 20 May 2015; 412 participants.

July 2014 - **Brooks, RP** and R Poeske. Restoring the natural functions of wetlands: Identifying common goals for advancing wetland restoration success. EPA/ASWM Wetlands Mitigation Workshop, held at the Annual Meeting of Society of Ecological Restoration, 28 July 2014, New Orleans, LA. Invited workshop, lead presenter.

April 2014 - **Brooks, RP** and R Poeske. Wetlands Mitigation Data Beta-Testing Workshop. Society of Wetlands Scientists, Mid-Atlantic Chapter meeting. 4-5 April 2014, State College, PA. Hosted meeting, conducted workshop, organized and led field trips.

June 2010 – **Brooks, RP** et al. Outreach workshop on Best Management Practices for Spring Creek Watershed, Centre County, PA. Workshop for local practitioners and citizens on research, survey, and management outcomes for the watershed. Riparia & CVI, State College, PA.

March 2008 - **Brooks, RP**. Pennsylvania Chapter 105 Water Obstruction and Encroachment Statewide Programmatic Meeting, 24-26 March 2008, State College, PA. Invited training on wetland classification, functional assessment, and field trip.

1998-2005 - Delivered periodic workshops, field trainings, and workshops to federal and state agency personnel in the Mid-Atlantic Region for technical assistance, monitoring and assessment, development of ecological indicators, and water quality assessment for wetlands. USEPA-OWOW and Mid-Atlantic States. **RP Brooks**, Principal Investigator and Lead Instructor.

May 1994, 1995, 1996 - Wetland Restoration and Creation for Mitigation – 2-, 3-, and 5-day courses offered by **Robert P. Brooks**, Water's Edge Technology, Inc., for Ralph Tiner, Institute for Wetland & Environmental Education & Research, Massachusetts and Rhode Island.

1991-1992 - Balancing Wetlands and Industrial Development - statewide seminar series delivered to industrial development corporations and authorities; manual and video included. **RP Brooks**, Principal Investigator and Lead Instructor.

July 1990 - A Corporate Approach to Wetlands Permitting and Assessment - one-day training course for the professional staff of the Allegheny Power System, PA. **RP Brooks**, Lead Instructor.

May 1990 - Jurisdictional Delineation of Wetlands in the Mid-Atlantic States - 5-day course offered by Lyndon Lee, National Wetland Science Training Coop., and Robert P. Brooks, Water's Edge Technology, Inc. on federal method. (Attended comparable 5-day course in 1989, NJ).

sample of recent technical or professional presentations (n = 160+): Presented by **Brooks**

6/17 **Brooks, RP**. Translating scientific studies into seaningful information for setting public policy. Society of Wetland Scientists Annual Meeting, 5-8 June 2017, San Juan, Puerto Rico. Invited oral presentation in ASWM Special Symposium.

1/16 **Brooks, RP**. The art and science of translating ecological indicators to ecosystem services for wetlands, streams, and riparian corridors. Bernard and Susan Master Moonlight on the Marsh Distinguished Lectures, 27-29 Jan 2016. Everglades Wetland Research Park, Naples, FL. Invited seminar speaker.

6/16 **Brooks, R**, D Faber-Langendoen, G Serenbetz, J Rocchio, K Walz, and E Stein. Establishing a national Reference Wetlands Registry for the USA. Society of Wetland Scientists Annual Meeting, May 31 – June 4, 2016, Corpus Christi, TX. Oral presentation.

6/16 Mazurczyk, T, and **RP Brooks**. Quantifying carbon storage in temperate freshwater wetlands. Society of Wetland Scientists Annual Mtg., May 31-Jun 4, 2016, Corpus Christi, TX.

4/15 **Brooks, R. Riparia's Reference Wetlands Intera**ctive Database: Rolling out data for practitioners and public use – the Mid-Atlantic Experience. Nature Serve Network Conference, 28-30 April 2015, Traverse City, MI. Invited speaker.

6/15 **Brooks, R**, S Yetter, M Nassy, J Bishop, H Ingram, C Regan, T Mazurczyk. The Art and Science of Translating Ecological Indicators to Ecosystem Services in Riparian Systems. Society of Wetland Scientists Annual Meeting, May 31-Jun 4, 2015, Providence, RI. Oral presentation.

1/14 **Brooks, RP**. Science informs policy and practice for wetlands protection and conservation. Delaware Wetlands Conference: Conserving Wetland Resources through Science and Education, 30 Jan 2014, Dover, DE. Invited plenary speaker.

3/14 **Brooks, RP**. Wetland Restoration: Why do wetland restoration and mitigation projects fail? Connectivity, Collaboration and the Application of Sound Science, Association of State Wetlands Managers, State/Tribal/Federal Coordination Meeting, 4-6 March 2014, Shepherdstown, WV. Invited panelist.

5/14 **Brooks, R**, D Wardrop, S Chamberlain, S Yetter, G Rocco, J Bishop, K Hychka, J Moon, and A Britson. Riparian Disturbance Hypothesis: Towards understanding and testing. Joint Aquatic Science Meeting, 18-23 May 2014, Portland, OR.

11/14 **Brooks, R**, N Gebo, and K Hychka. Seeking optima for wetland restoration and mitigation: ensuring we get there. Symposium: Quantifying Wetland Soil Properties and Functions in Restored and Natural Systems, International Annual Meeting, Soil Science Society of America, 2-5 November 2014, Long Beach, CA. Invited oral presentation for symposium.

recent selected publications (2002-2016)

Brooks, RP, D Faber-Langendoen, G Serenbetz, J Rocchio, ED Stein, and K Walz. 2016. Toward creating a national Reference Wetlands Registry. National Wetlands Newsletter 38(3):6-10.
(Editor of Special Issue with 4 papers).

Chamberlain, SJ, and **RP Brooks**. 2016. Testing a rapid Floristic Quality Index on headwater wetlands in central Pennsylvania, USA. Ecological Indicators 60:1142-1149.

Julian, JT, VA Gould, GW Glenney, and **RP Brooks**. 2016. Seasonal infection rates of *Batrachochytrium dendrobatidis* in populations of northern green frog *Lithobates clamitans melanota* tadpoles. Diseases of Aquatic Organisms 121:97-104. doi: 10.3354/dao03046

Calhoun, AJK, J Arrigoni, **RP Brooks**, ML Hunter, and SC Richter. 2014. Creating successful vernal pools: a literature review and advice for practitioners. Wetlands 34:1027-1038.

Miller, TA, **RP Brooks**, M Lanzone, D Brandes, J Cooper, K O'Malley, C Maisonneuve, J Tremblay, A Duerr, T Katzner. 2014. Assessing risk to birds from industrial wind energy development via paired resource models. Conservation Biology 28(3):745-755. DOI: 10.1111/cobi.12227

Brooks, RP, and DH Wardrop (eds.) 2013. Mid-Atlantic Freshwater Wetlands: Advances in Wetlands Science, Management, Policy, and Practice. Springer, NY. 441pp. (**author 11 chaps**.)

Brooks, R, K Havens, H Ingram, K Angstadt, D Stanhope, and A Jacobs. 2013. Creating a Unified Mid-Atlantic Rapid Assessment Protocol for Wetlands. Pages 9-26 in Chapter 2, Mid-Atlantic State Regional Wetlands Assessment Final Report. Pennsylvania State University and Virginia Institute of Marine Science. 121pp.

Cole, CA, CA Urban, P Russo, J Murray, D Hoyt, and **RP Brooks**. 2013. Herbaceous plant community composition in created wetlands over 7 years in northern New York, USA. Studies in the History of Gardens & Designed Landscapes: An International Quarterly 33(3):235-247. DOI: 10.1080/14601176.2013.830423

Osmond, D, **R Brooks**, S Yetter, R Carline, K Boomer, A Armstrong, R Stedman, D Meals, and G Jennings. 2012. Chap 20-Spring Creek Watershed, PA: National Institute of Food & Agriculture, Conservation Effects Assessment Project Watershed Project. 2012. Pp 321-336 in D Osmond, D Meals, D Hoag, and M Arabi (eds.). *How to Build Better Agricultural Conservation Programs to Protect Water Quality: National Institute of Food and Agriculture – Conservation Effects Assessment Project Experience*. Soil and Water Conservation Society.

Gebo, NA, and **RP Brooks**. 2012. Hydrogeomorphic (HGM) assessment of mitigation sites compared to natural reference wetlands in Pennsylvania. Wetlands 32:321-331.
Brooks, RP, MM Brinson, KJ Havens, CS Hershner, RD Rheinhardt, DH Wardrop, DF Whigham, AD Jacobs, and JM Rubbo. 2011. Proposed hydrogeomorphic classification for wetlands of the Mid-Atlantic Region, USA. Wetlands 31(2):207-219.

Wardrop, DH, AK Glasmeier, J Peterson-Smith, D Eckles, H Ingram, **RP Brooks**. 2011. Wetland ecosystem services and coupled socio-economic benefits through conservation practices in the Appalachian Region. Ecol. Applications 21(3):S93-S115.

Brooks, RP, TL Serfass, M Triska, LM Rebelo. 2011. Ramsar protected wetlands of international importance as habitats for otters. IUCN Otter Spec. Grp. Bull. 28(B):47-62.

Brooks, RP, and ER Brooks. 2011. Translating the *Rapanos* ruling into practice. National Wetlands Newsletter May-Jun:6-7.

Brooks, RP. 2011. Monitoring and assessing wetlands: How do we take advantage of becoming data rich? National Wetlands Newsletter Nov-Dec:8-9.

Brooks, R.P., S.E. Yetter, R.F. Carline, J.S. Shortle, J.A. Bishop, H. Ingram, D. Weller, K. Boomer, R. Stedman, A. Armstrong, K. Mielcarek, G. Constantz, S. Goslee, T. Veith, D. Piechnik. 2011. Analysis of BMP implementation performance and maintenance in Spring Creek, an agriculturally-influenced watershed in Pennsylvania. Final report to USDA, National Institutes of Food & Agriculture, Conservation Effects Assessment Project (CEAP), Washington, DC. 66pp.

Brooks, R, M McKenney-Easterling, M Brinson, R Rheinhardt, K Havens, D O'Brian, J Bishop, J Rubbo, B Armstrong, J Hite. 2009. A Stream-Wetland-Riparian (SWR) index for assessing condition of aquatic ecosystems in small watersheds along the Atlantic slope of the eastern U.S. Environmental Monitoring and Assessment 150:101-117.

Rheinhardt, RD, MM Easterling, MM Brinson, JM Rubbo, **RP Brooks**, DF Whigham, D O'Brien, JT Hite, and BK Armstrong. 2009. Canopy composition and forest structure provide restoration targets for low order riparian ecosystems. Restoration Ecology 17(1):51-59.

Rocco, GL, **RP Brooks**, RB McKinstry, and JF Thorne. 2008. Habitat Conservation Plan to establish conservation banks for the threatened bog turtle (*Glyptemys muhlenbergii*) in portions of Chester County, Pennsylvania and New Castle County, Delaware. Final Report to the PA Fish & Boat Commission and U.S. Fish & Wildlife Service, Habitat Conservation Planning Grant (4100016440). Penn State Cooperative Wetlands Center, Penn State University, 166pp.

Brooks, RP, GP Patil, S Fei, A Gitelman, WL Myers, ED Reavie. 2007. Next generation of ecological indicators of wetland condition. EcoHealth 4(2):176-178 (Editor: Special Section of EcoHealth featuring 6 papers on emerging wetland indicators).

Serfass, TL, **RP Brooks**, LM Rymon, and OE Rhodes, Jr. 2007. River otters in Pennsylvania, USA: Lessons for predator re-introduction. Proc. European Otter Conference, Returning the otter in Europe – Where and how? 30 June – 5 July 2003, Skye, Scotland, J. W. H. Conroy, G. M. Yoxon, A. C. Gutleeb, and J. Ruiz-Olmo (eds.). Journal of the International Otter Survival Fund 2:22pp.

Brooks, RP, DH Wardrop, and CA Cole. 2006. Inventorying and monitoring wetland condition and restoration potential on a watershed basis with examples from the Spring Creek watershed, Pennsylvania, USA. Environmental Management 38:673-687.

Brooks, RP, DH Wardrop, KW Thornton, D Whigham, C Hershner, MM Brinson, and JS Shortle (eds.). 2006. Ecological and socioeconomic indicators of condition for estuaries and watersheds of the Atlantic Slope. Final Report to U.S. Environmental Protection Agency STAR Program, Agreement R-82868401, Washington, DC. Prepared by the Atlantic Slope Consortium, University Park, PA. 96pp. + attachments (CD).

Miller, SJ, DH Wardrop, WM Mahaney, and **RP Brooks**. 2006. A plant-based index of biological integrity (IBI) for headwater wetlands in central Pennsylvania. Ecological Indicators 6:290-312.

Brooks, RP, C Snyder, and MM Brinson. 2006. Structure and functioning of tributary watershed ecosystems in the Eastern Rivers and Mountains Network: Conceptual models and vital signs monitoring. Natural Resources Report NPS/NER/NRR-2006/009. National Park Service, Philadelphia, PA. 88pp.

Walls, RL, DH Wardrop, **RP Brooks**. 2005. The impact of experimental sedimentation and flooding on the growth and germination of floodplain trees. Plant Ecology 176:203-213.

Brooks, RP, DH Wardrop, CA Cole, and DA Campbell. 2005. Are we purveyors of wetland homogeneity?: A model of degradation and restoration to improve wetland mitigation. Ecological Engineering 24(4):331-340.

Mahaney, WM, DH Wardrop, and **RP Brooks**. 2004. Impacts of sedimentation and nitrogen enrichment on wetland plant community development. Plant Ecology 175:227-243.

Campbell, DA, CA Cole, and **RP Brooks**. 2002. A comparison of created and natural wetlands in Pennsylvania, USA. Wetlands Ecology and Management: 10:41-49.

Cole, CA, **RP Brooks**, PW Shaffer, and ME Kentula. 2002. A comparison of the hydrology of wetlands in Pennsylvania and Oregon (USA) as an indicator of the transferability of hydrogeomorphic (HGM) functional models between regions. Environmental Management 30(2):265-278.