



AQUETONG CREEK RESTORATION PROJECT 2023 MONITORING REPORT

SOLEBURY TOWNSHIP, BUCKS COUNTY, PENNSYLVANIA

NOVEMBER 2023

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INTRODUCTION

The purpose of this annual monitoring report, the third of five, is to document the status and development of the Aquetong Creek Restoration Project located within Aquetong Spring Park in Solebury Township, Bucks County, Pennsylvania (Site; **Figures 1 and 2**).

The Aquetong Creek Restoration Project is situated within the former impoundment of Aquetong Lake, which was a 15-acre impoundment formed in 1870 by the construction of an earthen dam on Aquetong Creek. Solebury Township removed the dam that formed the Aquetong Lake impoundment in April 2015 via a controlled partial breach that drained the lake and re-exposed the lake bottom. The goal of the dam breach was to reduce thermal impacts on Aquetong Creek to support a high-quality, cold-water fishery. With the dam removed and the lake drained, a meandering channel formed through the exposed lakebed, connecting the upper and lower headwater sections of Aquetong Creek. The primary source of inflow to the headwater portion of Aquetong Creek is Ingham Spring, an artesian spring formed at the contact of two geologic formations, with a sustained flow rate of 2,000 gallons per minute (F.X. Browne, Inc. 2004). Aquetong Creek also receives flow from an unnamed tributary to Aquetong Creek that enters the Site from the north under Route 202. The tributary receives inflow from a detention basin located to the northeast of the Site, as well as a large pond to the north of the Site. There is supplemental inflow to Aquetong Creek in the form of stormwater runoff discharged from the adjacent developed areas located to the north and south of the Site.

Following the breaching of the former dam, a degree of stewardship was necessary to guide the early developmental stages of the former impoundment to enhance the establishment of desirable species and to foster the development of a productive surface water feature which will continue to maintain its population of brook trout. This project was implemented following Solebury Township's (herein referred to as "the Township") purchase of the Site. From the onset, the Township and its environmental partners recognized the unique environmental benefits of the cold-water spring and the possibilities associated with the reestablishment of Aquetong Creek through the breaching of the Aquetong Lake dam. Following the dam breach, the Township and its project partner, Bucks County Trout Unlimited, successfully transplanted 1,000 native Pocono brook trout to the re-established Aquetong Creek channel. Scientific monitoring of the new stream, commissioned by the Township, confirmed that, after a year, the transplanted trout population was reproducing.

In 2018, the Township completed its Strategic Master Plan for Aquetong Spring Park which expanded the objectives for the restoration of the former impoundment as part of the park design. The restoration efforts included the management of diseased forest, impoundment restoration (including stormwater management), and park improvements for recreation, education, and cultural components. Immediately downgradient of the former dam remnants was a forest comprised of mostly diseased green ash (*Fraxinus pennsylvanica*) and black walnut (*Juglans nigra*) trees. The Township removed these hazard trees in 2019 and re-established the area with other native species. The Township concurrently established an invasive species management program. The Township reused the removed trees within the park (with Pennsylvania Department of Environmental Protection (PADEP) approval) in conjunction with the stream restoration project constructed in 2020 as habitat and park features.

A PADEP-approved Restoration Waiver 16 (Authorization ID No. 1278424, dated October 23, 2019) (See Appendix IV) authorized the monitoring of the stream and wetland restoration areas and wetland creation areas in accordance with the Mitigation Plan narrative provided as S4 of the *Aquetong Creek Restoration Project Environmental Assessment Addendum*, dated June 2019, last updated September 2019. The restoration of the wetlands commenced in 2020 and included the enhancement of 1.09-acres of existing palustrine emergent (PEM) wetlands through floodplain re-connectivity, invasive species removal, subsequent installation of native herbaceous and woody plant material, and the creation of 0.25-acres of forested wetlands. The wetland enhancement and creation elements were designed to provide additional functions and values

File: P:\0388\Projects\038801\1\GIS\APRX\Aquetong Year 2 Monitoring Report.aprx, 11/6/2023, Drawn by tsrinivasan, Copyright Princeton Hydro, LLC.



NOTES:
1. Stream and project boundary are approximate.
2. Aerial imagery obtained through ArcGIS Online Bing Maps (C)
2023 Microsoft Corporation and its data suppliers.

AERIAL OVERVIEW MAP

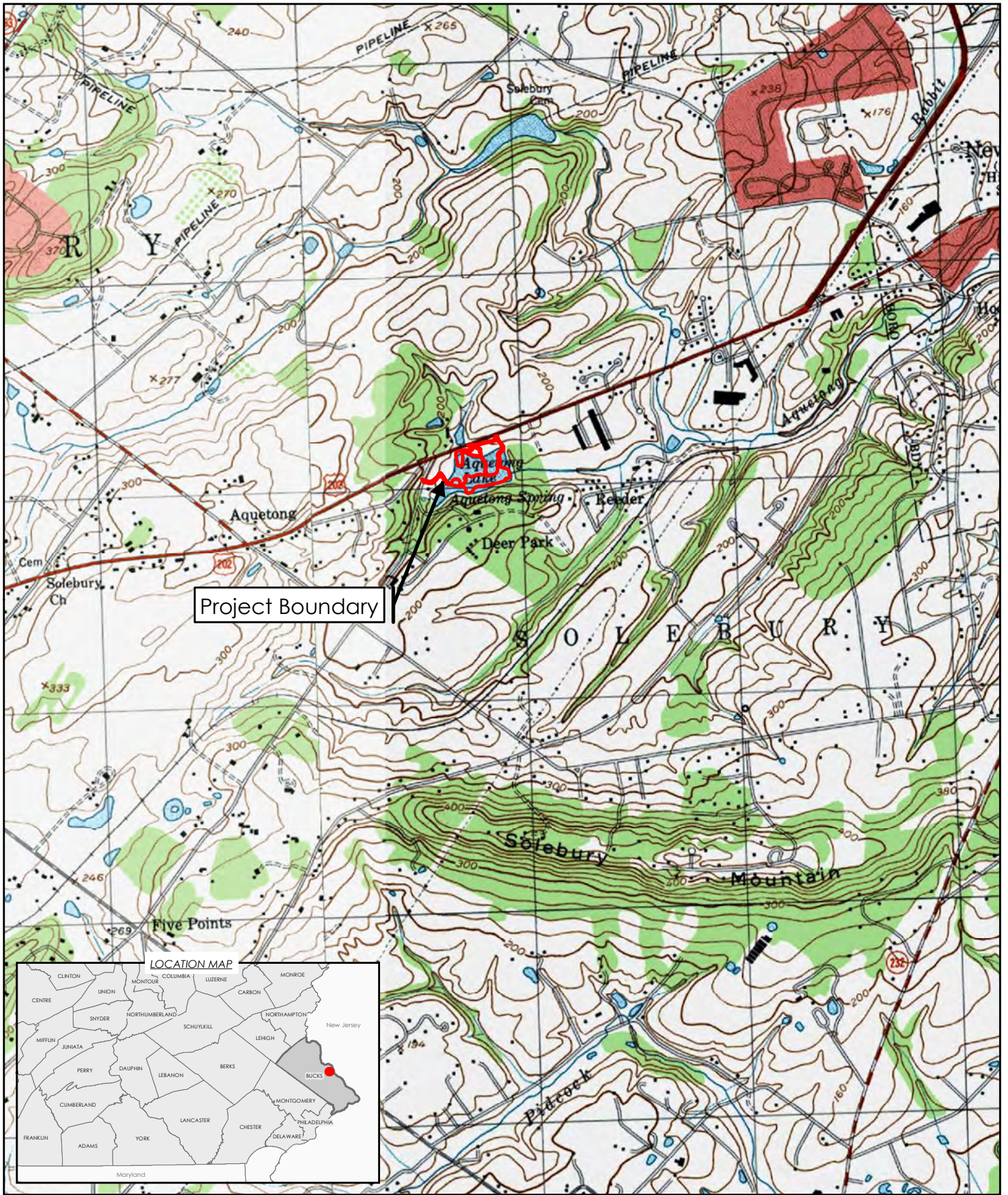
AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA



PRINCETON HYDRO
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Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet



- NOTES:
1. Project boundary obtained from Princeton Hydro planset titled "Aquetong Creek Restoration" dated 10/18/2019.
 2. USGS topographic digital raster graphic obtained from Terrain Navigator Pro, Lambertville and Buckingham, PA quadrangle.

USGS LOCATION MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
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when compared with the pre-existing degraded PEM wetlands. The creation of wetlands was necessitated via the permanent conversion of approximately 0.07-acres of the degraded PEM wetlands to open water; thus, 0.25-acres of wetlands designed to be forested were created in accordance with Chapter 105.20a(a)1 to compensate for the permanent areal loss of wetland. Additionally, the creation of 0.25-acres of forested wetland is in accordance with Chapter 105.20a(a)2 as the forested wetland was designed to provide additional functions and values when compared to the previously degraded PEM wetland. The resulting ratio was 3:1, greater than the required 1:1 wetland replacement criterion outlined in Chapter 105.20a(a)(1). The created wetlands are located adjacent to the permanently converted PEM wetlands in accordance with the Siting Criteria outlined in Chapter 105.20a(a)(3). Overall, the project resulted in a 0.18-acre net gain of forested wetlands on-Site.

This monitoring report presents data collected during the 2023 growing season, the Site's third full growing season after planting, to illustrate compliance and document the status and development of the project since monitoring was initiated in 2021. The data collected serves to steward the wetland's development moving forward. The information provided in this monitoring report includes the following: (i) a description of the general success of the Site at the time of inspection, (ii) an inventory of plant species present, (iii) a qualitative description of wildlife utilization, (iv) a determination of the percent areal coverage of vegetation, (v) color photographs, (vi) a Site plan indicating location and orientation of the photographs, (vii) and a description of adaptive management measures that were and/or need to be implemented to address potential problems or deficiencies identified during the inspection.



Figure 3. View of healthy installed woody species amidst a robust herbaceous stratum within the wetland enhancement area.

The goals for the wetland restoration project are to achieve at least 85% vegetative coverage by native, desirable hydrophytic species; to achieve at least 85% woody plant survivorship; minimize the areal coverage of undesirable, non-native species to the maximum extent practicable; and to stabilize the stream channel.



SECTION 1: PRE-CONSTRUCTION SITE ENVIRONMENT

Following the breaching of the dam and draining of Aquetong Lake, a meandering channel formed through the exposed lakebed sediment, connecting the spring to the reach of Aquetong Creek below the former dam. Sufficient sediment had accumulated in the former lake such that the meandering channel that re-formed following dam removal initiated the process of channel incision or “downcutting” (i.e., active erosion of sediment from a stream that results in lowering the elevation of a channel bed and reduces channel slope). The Site experienced downcutting, creek channel instability, and erosion of the former lake bottom. Certain sections of Aquetong Creek’s channel were unstable and underlain by additional erodible sediment. Further, the exposure of lake sediments following the dam breach facilitated the establishment of invasive species within portions of the former lakebed, negatively impacting the ecological functions and values of recently exposed floodplain wetlands and associated upland areas.

SECTION 2: DESIGN AND CONSTRUCTION

The restoration area is comprised of wetland creation and wetland enhancement areas. The wetland creation area consists of 0.25 acres (10,804 square feet) of palustrine forested (PFO) freshwater wetlands designed to replace the permanent loss and conversion of the adjacent degraded PEM wetland to open water. The creation area was designed to foster the development of a forested floodplain wetland adjacent to the stabilized stream channel. The wetland creation area is located adjacent to Aquetong Creek and its tributary (Appendix III, Photos 7 and 15). The wetland enhancement area is comprised of 1.09 acres (47,301 square feet) of PEM wetlands. The purpose of the wetland enhancement area is to enhance the biological and physical functions of the existing PEM wetlands on-Site, such as providing fish and wildlife habitat, enhancing the water quality of Aquetong Creek, providing flood storage, and controlling erosion along the streambanks. The wetland enhancement areas are located on portions of the western banks of the unnamed tributary to Aquetong Creek, and along both the northern and southern banks of Aquetong Creek (Appendix III, Photo 13).

The mitigation activities resulted in the creation of PFO wetland and enhancement of PEM wetland that currently possess and will continue to support a variety of native herbaceous and woody species. The wetland restoration area was designed to connect the stream more effectively to its floodplain in order to store floodwaters from Aquetong Creek and its tributary, which are the primary hydrologic sources for the wetlands on-Site. In addition to the project’s wetland creation and enhancement elements, the project focused on the establishment of a stable stream channel capable of passing various flow rates without being subject to erosion. Specifically, the restoration of the wetlands and stream channel serves to foster the Site’s capability of supporting a high-quality, cold-water aquatic community. Additionally, the project improves Aquetong Creek’s water quality via the stabilization of the stream channel.

A planting plan was devised for the 1.35-acre wetland restoration effort, and is based on the local plant assemblage, hydrology, and other Site conditions. In 2020, an initial native seed mix was applied, and 6,600 two-inch herbaceous plugs were installed throughout the wetland restoration area. The type, hydrologic indicator status, and quantity of herbaceous plant material that was installed in the wetland restoration area is provided in **Tables 1 and 2** below.



Table 1. Wetland Restoration Area Seed Mix

Botanical Name	Common Name	Indicator Status	Rate (lb/acre) ¹	Quantity (%)
<i>Bidens frondosa</i>	Devil's beggartick	FACW	1.00	5.0
<i>Calamagrostis canadensis</i>	Bluejoint grass	FACW	1.50	5.0
<i>Cinna arundinaceae</i>	Wood reedgrass	FACW	2.25	8.0
<i>Echinochloa muricata</i>	Rough barnyard grass	OBL	3.00	10.0
<i>Elymus virginicus</i>	Virginia wildrye	FACW	5.25	18.0
<i>Carex vulpinoidea</i>	Fox sedge	OBL	4.00	14.0
<i>Lolium multiflorum</i>	Annual rye	NL	4.50	15.0
<i>Panicum dichotoflorum</i>	Smooth panic grass	FACW	3.00	10.0
<i>Dichanthelium clandestinum</i>	Deertongue	FAC	4.25	15.0
<i>Persicaria pensylvanica</i>	Pennsylvania smartweed	FACW	0.75	3.0
<i>Verbena hastata</i>	Blue vervain	FACW	0.25	1.0
<i>Senna hebecarpa</i>	Wild senna	FACW	0.25	1.0

¹ Seed was spread over entire area (1.35 acres) at a rate of 30 pounds per acre.

Table 2. Wetland Restoration Area Herbaceous Plugs

Botanical Name	Common Name	Indicator Status	Planting Type	Quantity ¹
<i>Asclepias incarnata</i>	Swamp milkweed	OBL	2" Plug	300
<i>Carex comosa</i>	Longhair sedge	OBL	2" Plug	450
<i>Carex crinita</i>	Fringed sedge	OBL	2" Plug	500
<i>Carex lurida</i>	Shallow sedge	OBL	2" Plug	500
<i>Carex scoparia</i>	Broom sedge	FACW	2" Plug	600
<i>Elymus virginicus</i>	Virginia wildrye	FACW	2" Plug	600
<i>Eupatorium perfoliatum</i>	Boneset	FACW	2" Plug	250
<i>Helenium autumnale</i>	Common sneezeweed	FACW	2" Plug	400
<i>Iris versicolor</i>	Blueflag iris	OBL	2" Plug	350
<i>Juncus effusus</i>	Soft rush	OBL	2" Plug	600
<i>Leersia oryzoides</i>	Rice cutgrass	OBL	2" Plug	400
<i>Schoenoplectus tabernaemontani</i>	Soft-stem bulrush	OBL	2" Plug	500
<i>Scirpus cyperinus</i>	Woolgrass	FACW	2" Plug	550
<i>Smphyotrichum novae-angliae</i>	New England aster	FACW	2" Plug	300
<i>Verbena hastata</i>	Blue vervain	FACW	2" Plug	300

¹ The quantity of herbaceous plants is based on a planting density of 3 feet on center.

Additionally, a total of 710 woody plants (385 trees and 325 shrubs) were installed in the wetland creation and enhancement areas in 2020. The tree species included red maple (*Acer rubrum*, FAC), river birch (*Betula nigra*, FACW), American sycamore (*Platanus occidentalis*, FACW), swamp white oak (*Quercus bicolor*, FACW), pin oak (*Quercus palustris*, FACW), and black willow (*Salix nigra*, OBL). The shrub species included smooth alder (*Alnus serrulata*, OBL), red chokecherry (*Aronia arbutifolia*, FACW), common buttonbush (*Cephalanthus occidentalis*, OBL), silky dogwood (*Cornus amomum*, FACW), winterberry holly (*Ilex verticillata*, FACW), swamp rose (*Rosa palustris*, OBL), and pussy willow (*Salix discolor*, FACW). Woody material was installed in suitable habitat areas and were selected based on (1) being indigenous to the region, (2) providing either good cover or food for wildlife, and (3) having generally good to high survivorship. The type, wetland hydrologic indicator status, and quantity of woody plant material that was installed within the restoration areas are provided in **Tables 3 and 4**.



Table 3. Wetland Restoration Area Tree Installation

Botanical Name	Common Name	Indicator Status	Planting Type	Quantity ¹
<i>Acer rubrum</i>	Red maple	FAC	24" - 36" Container	20
<i>Betula nigra</i>	River birch	FACW	24" - 36" Container	40
<i>Platanus occidentalis</i>	American sycamore	FACW	24" - 36" Container	60
<i>Quercus bicolor</i>	Swamp white oak	FACW	24" - 36" Container	95
<i>Quercus palustris</i>	Pin oak	FACW	24" - 36" Container	95
<i>Salix nigra</i>	Black willow	OBL	24" - 36" Container	75

¹ The quantity of trees is based on a planting density of 10 feet on center.

Table 4. Wetland Restoration Area Shrub Installation

Botanical Name	Common Name	Indicator Status	Planting Type	Quantity ¹
<i>Alnus serrulata</i>	Smooth alder	OBL	24" - 36" Container	35
<i>Aronia arbutifolia</i>	Red chokecherry	FACW	24" - 36" Container	65
<i>Cephalanthus occidentalis</i>	Common buttonbush	OBL	24" - 36" Container	15
<i>Cornus amomum</i>	Silky dogwood	FACW	24" - 36" Container	65
<i>Ilex verticillata</i>	Winterberry holly	FACW	24" - 36" Container	50
<i>Rosa palustris</i>	Swamp rose	OBL	24" - 36" Container	30
<i>Salix discolor</i>	Pussy willow	FACW	24" - 36" Container	65

¹ The quantity of shrubs is based on a planting density of 10 feet on center.

SECTION 3: MONITORING METHODOLOGY

Vegetative cover of the wetland creation and enhancement areas was determined through the use of eight (8) permanent 1 x 1-meter quadrats. The area within each quadrat that lacked vegetation (hereinafter referred to as the "unvegetated area") was visually estimated in accordance with the *Ocular Estimation of Cover Technique* (USFWS, 1981). The total area of cover was considered to be the area that remained after excluding the areas determined to be unvegetated. Percent vegetative cover determined by this method is derived by subtracting the unvegetated area from the total area of each quadrat. The formula below was utilized to determine the percent vegetative cover by this method.

$$\text{Percent Vegetative Cover} = \{(\text{total area} - \text{unvegetated area}) / \text{total area}\} \times 100$$



All references to vegetative cover in this document are based on this formula. Subsequently, the vegetative cover provided by each species was visually estimated. Species that were present, but provided less than 1 percent cover, were indicated to be "P" (present). The species-by-species sampling data for each quadrat is provided in Tables 5 and 6. The estimates of total vegetative cover provided by this method are essentially relative values comparing the area within each quadrat that is covered by vegetation relative to un-vegetated areas within the quadrat. However, since plant cover can overlap, the total vegetative cover present in any given quadrat often exceeds the percent vegetative cover derived by the above referenced formula. The formula used above



provides a simple mechanism to portray the area within each quadrat that is covered by vegetation relative to meeting established regulatory objectives. The use of total vegetative cover, however, more effectively conveys the ecological development of the area since it considers the cover provided by each species. Total vegetative cover thus provides a mechanism to see the changes in cover that occur as the wetland matures and becomes more structurally complex.

SECTION 4: MONITORING INSPECTION

The monitoring inspection, the third of five, was conducted on September 29, 2023. The inspection included the evaluation of the eight (8) fixed monitoring plots which includes representative locations of both the wetland creation (4) and wetland enhancement (4) areas. Vegetative cover and woody survivorship of the wetland restoration areas was estimated and evaluated in accordance with the methodology detailed in Section 3.0. At the time of the inspection, the wetland restoration area exhibited 100% vegetative cover and 187.7% total cover. The monitoring plot data for the wetland creation and wetland enhancement areas are discussed in Subsections 4.1 and 4.2, respectively, below. In accordance with the *Aquetong Creek Restoration Project Environmental Assessment Addendum* (Princeton Hydro, 2019), a qualitative description of wildlife utilization of the wetland restoration areas is also provided in Subsection 4.6.



Figure 4. View of Aquetong Creek's banks that support well-established hydrophytic vegetation.



SUBSECTION 4.1 WETLAND CREATION AREA PLOTS

Four (4) quadrats were established in representative locations throughout the wetland creation area. At the time of the fall 2023 inspection, the wetland creation area possessed 100% vegetative cover and 198.8% total cover (Table 5), which is well above the 85% vegetative cover threshold stipulated by PADEP. Total cover increased by 45.9% between 2022 and 2023 and the plots possessed high total vegetative cover of desirable native hydrophytes. The increase in total percent cover between 2022 (136.6%) and 2023 (198.8%) is representative of a Site that is continuing on a positive developmental trajectory while also developing increased structural heterogeneity (Appendix III, Photos 4, 7, and 17).

Vegetative species richness in 2023 ($n = 16$) slightly declined from 2022 ($n = 20$); however, it should be noted that the species richness decrease was attributed to the absence of four undesirable, non-native and invasive species within the monitoring plots. For example, in 2022, 50% and 15% of the vegetative cover within the W-7 monitoring plot was comprised of common reed (*Phragmites australis*, FACW) and Japanese stiltgrass (*Microstegium vimineum*, FAC), respectively. In 2023, neither of these undesirable, non-native species was observed within the W-7 plot. Two other undesirable, invasive species not observed within the monitoring plots during the 2023 inspection included reed canarygrass (*Phalaris arundinacea*, FACW) and Japanese bristlegrass (*Setaria faberi*, UPL). In summary, although species richness decreased in 2023 within the wetland creation area, this is attributable to a decrease in non-desirable, invasive species.

The five (5) most prevalent species observed within the wetland creation area were tall blue lettuce (*Lactuca biennis*, FACU) (42.5%), Pennsylvania smartweed (*Persicaria pensylvanicum*, FACW) (33.8%), American sycamore (22.5%), common boneset (*Eupatorium perfoliatum*, FACW) (20.0%), and river birch (17.5%). Although tall blue lettuce was the dominant species within the wetland creation area at the time of inspection, the dominance of hydrophytic species with wetland indicator statuses of FACW and OBL indicates that the Site's floodplain and hydrologic connectivity to Aquetong Creek and its tributary is adequate to support hydrophytic plant species. Additionally, tall blue lettuce is a biennial species often encountered in floodplain settings subsequent to these types of restoration projects and, typically, its percent cover decreases over time as desirable native species coverage increases.

No barren areas were observed within the wetland creation area. The continued establishment of a diverse assemblage of native species throughout the wetland creation portions of the restoration project supports the position that the wetland creation areas possess suitable substrate and hydrology resulting in a structurally diverse plant assemblage. Further, the positive developmental trajectory is anticipated to continue moving forward, satisfying the established goals for the Site to be deemed a success.

The wetland creation area was largely devoid of undesirable, non-native species, as evidenced by the absence of reed canary grass, Japanese stiltgrass, and Japanese bristlegrass within the monitoring plots and the presence of stressed/stunted common reed individuals in small, scattered patches. The presence of these species, although minimal, predominantly occurred outside of the limits of the wetland creation areas. To address their presence, these species were targeted with an herbicide on September 6th and 7th, 2023 and October 24th, 2023 (see Section 4.4). The herbicide treatments during 2021 and 2022 have been successful as evidenced by the elimination of invasive species from the wetland creation monitoring plots. It is anticipated that the 2023 herbicide treatment will continue to prevent the re-establishment of undesirable invasive species within the restoration area.



Table 5. Wetland Creation Area Percent Vegetative Cover

Sampling Plot	Wetland Creation				Mean % Cover
	W3	W5	W6	W7	
Barren Soil	0	0	0	0	0.0
<i>Lactuca biennis</i>	60	50	0	60	42.5
<i>Persicaria pensylvanicum</i>	30	5	100	0	33.8
<i>Platanus occidentalis</i>	0	0	0	90	22.5
<i>Eupatorium perfoliatum</i>	30	0	0	50	20.0
<i>Betula nigra</i>	20	0	50	0	17.5
<i>Impatiens capensis</i>	15	25	0	20	15.0
<i>Leersia oryzoides</i>	10	40	0	0	12.5
<i>Elymus virginicus</i>	0	30	0	0	7.5
<i>Senna marilandica</i>	0	25	0	0	6.3
<i>Solidago canadensis</i>	0	10	0	15	6.3
<i>Helenium autumnale</i>	20	0	0	0	5.0
<i>Quercus bicolor</i>	15	0	0	0	3.8
<i>Echinochloa muricata</i>	5	5	0	0	2.5
<i>Cornus amomum</i>	0	5	0	0	1.3
<i>Verbena hastata</i>	5	0	0	0	1.3
<i>Chamaecrista fasciculata</i>	0	5	0	0	1.3
Percent Cover	100	100	100	100	100.0
Total Cover	210	200	150	235	198.8

SUBSECTION 4.2 WETLAND ENHANCEMENT AREA PLOTS

Four (4) quadrats were also established in representative locations throughout the wetland enhancement area. At the time of inspection, the wetland enhancement area possessed 100% vegetative cover and 180.3% total cover (**Table 6**), satisfying the requisite 85% vegetative cover threshold. Total cover increased by 16.7% between 2022 and 2023. The increase in total vegetative cover is indicative of the following: (1) a site that is on a positive developmental trajectory, and (2) the continued establishment of a diverse assemblage of native species throughout the wetland enhancement portions of the restoration project supports the position that the wetland enhancement areas possess suitable substrate and hydrology resulting in a structurally diverse plant assemblage.

No barren ground was observed, and all plots were well-established with a diverse native herbaceous plant community. All four (4) plots in the wetland enhancement area possessed greater than 100% total herbaceous cover. The species richness was high ($n = 21$); in 2022, species richness was higher ($n = 22$). Although the total number of plant species (n) decreased by one in 2023, it was noted that several species observed in 2022 were replaced by more desirable plant species not observed in 2022. For example, dotted smartweed (*Persicaria punctata*, OBL), small carpetgrass (*Arthraxon hispidus*, FAC), purpleleaf willowherb (*Epilobium coloratum*, FACW), purple loosestrife (*Lythrum salicaria*, FACW), tall goldenrod (*Solidago altissima*, FACU), and climbing nightshade (*Solanum dulcamara*, FAC) were observed in 2022. In 2023, none of these species were observed and were "replaced" by swamp smartweed (*Persicaria hydropiperoides*, OBL), devil's beggarticks (*Bidens frondosa*, FACW), fowl mannagrass (*Glyceria striata*, OBL), yellow nutsedge (*Cyperus esculentus*, FACW), and woodreed (*Cinna arundinacea*, FACW). It should be noted that the absence of previously observed undesirable, non-native species (i.e., small carpetgrass, purple loosestrife, and climbing nightshade) and colonization of desirable, native hydrophytic plant species within the 2023 monitoring plots is a positive sign that the hydrologic regime of the



wetland enhancement areas is improving in connectivity to Aquetong Creek and its tributary, which is adequate to support hydrophytic plant species.

The five most prevalent species were black willow (36.3%), swamp smartweed (*Persicaria hydropiperoides*, OBL) (22.5%), rice cutgrass (*Leersia oryzoides*, OBL) (20.0%), river birch (18.8%), and Pennsylvania smartweed (18.8%). Similarly to the wetland creation area, the dominance of hydrophytic species with wetland indicator statuses of FACW and OBL indicates that the Site's floodplain and hydrologic connectivity to Aquetong Creek and its tributary is adequate to support hydrophytic plant species.

Overall, the results of the third monitoring inspection indicate that the wetland enhancement area is on a positive developmental trajectory, given the high vegetative cover, species richness, and a plant community comprised of native and target hydrophytes. Further, the positive developmental trajectory is anticipated to continue moving forward, satisfying the established goals for the Site to be deemed a success.

Table 6. Wetland Enhancement Area Percent Vegetative Cover

Sampling Plot	Wetland Enhancement				Mean % Cover
	W1	W2	W4	W8	
Barren Soil	0	0	0	0	0.0
<i>Salix nigra</i>	0	15	80	50	36.3
<i>Persicaria hydropiperoides</i>	0	0	30	60	22.5
<i>Leersia oryzoides</i>	80	0	0	0	20.0
<i>Betula nigra</i>	0	0	0	75	18.8
<i>Persicaria pensylvanicum</i>	0	60	5	10	18.8
<i>Microstegium vimineum</i>	0	40	0	30	17.5
<i>Impatiens capensis</i>	0	20	10	0	7.5
<i>Pilea pumila</i>	5	0	25	0	7.5
<i>Bidens frondosa</i>	20	0	0	0	5.0
<i>Glyceria striata</i>	15	0	0	0	3.8
<i>Cyperus esculentus</i>	15	0	0	0	3.8
<i>Carex lurida</i>	0	10	3	0	3.3
<i>Carex lupulina</i>	0	0	10	0	2.5
<i>Scirpus atrovirens</i>	10	0	0	0	2.5
<i>Cinna arundinaceae</i>	0	0	0	10	2.5
<i>Phragmites australis</i>	5	0	3	0	2.0
<i>Cephalanthus occidentalis</i>	0	0	5	0	1.3
<i>Typha latifolia</i>	5	0	0	0	1.3
<i>Scirpus cyperinus</i>	5	0	0	0	1.3
<i>Verbena hastata</i>	0	5	0	0	1.3
<i>Juncus effusus</i>	5	0	0	0	1.3
Percent Cover	100	100	100	100	100.0
Total Cover	165	150	171	235	180.3

SUBSECTION 4.3 WOODY PLANT SURVIVORSHIP

As shown in **Table 7**, the woody plant survivorship of the entire wetland restoration area was 87.3%, which exceeds the 85% survivorship threshold stipulated by the permit.



Table 7. Wetland Restoration Area Woody Plant Survivorship

Botanical Name	Common Name	Quantity Observed	Quantity Observed	Survivorship (%)
<i>Acer rubrum</i>	Red maple	20	21	>100.0
<i>Betula nigra</i>	River birch	40	84	>100.0
<i>Platanus occidentalis</i>	American sycamore	60	87	>100.0
<i>Quercus bicolor</i>	Swamp white oak	95	72	75.8
<i>Quercus palustris</i>	Pin oak	95	60	63.2
<i>Salix nigra</i>	Black willow	75	172	>100.0
<i>Alnus serrulata</i>	Smooth alder	35	14	40.0
<i>Aronia arbutifolia</i>	Red chokecherry	65	10	15.4
<i>Cephalanthus occidentalis</i>	Common buttonbush	15	7	46.7
<i>Cornus amomum</i>	Silky dogwood	65	42	64.6
<i>Ilex verticillata</i>	Winterberry holly	50	6	12.0
<i>Rosa palustris</i>	Swamp rose	30	4	13.3
<i>Salix discolor</i>	Pussy willow	65	41	63.1
Total		710	620	87.3

The species with the highest survivorship (>100%) were red maple, river birch, American sycamore, and black willow. Survivorship increased from 85.1% in 2022 to 87.3% in 2023. The aforementioned species exceeding 100% in survivorship (i.e., black willow, red maple, American sycamore, and river birch) continued to colonize the Site with each species possessing greater stem numbers than was initially installed. For example, seventy-five (75) black willow saplings were installed, but one hundred and seventy-two (172) viable black willow saplings were observed in 2023.

While mortality was noticeable for some of the installed woody species between 2021 and 2023, this is not unexpected as a species' ability to establish and proliferate on any given site is driven by a myriad of environmental conditions. These observations are typically magnified during the first few years of establishment where any individual species' ability to adapt to a Site becomes evident early in this process. The fact that the Site possesses greater than 85% survivorship of installed woody species supports the position that both the substrate and hydrology are sufficient to support woody species acclimated to a wet hydrologic regime. If additional woody species plantings are warranted moving forward, selected species would only include those that have shown an aptitude for this Site's underlying environmental variables. However, since the Site's installed woody species survivorship exceeds the stipulated threshold, supplemental plantings are not warranted at this time.



Figure 5. A healthy installed red chokecherry (*Aronia arbutifolia*, FACW).

SUBSECTION 4.4 UNDESIRABLE PLANT SPECIES

As outlined within the wetland creation and wetland enhancement discussions above, while undesirable non-native species were observed within the wetland restoration plots, the presence and vegetative cover within the plots decreased significantly when compared to the 2022 growing season. Specifically, only common reed and Japanese stiltgrass were observed within the monitoring plots in 2023 whereas common reed, Japanese stiltgrass, purple loosestrife, Japanese bristlegrass, small carpetgrass, and reed canarygrass were observed within the plots during the previous growing season. Additionally, the patches of reed canarygrass, Japanese stiltgrass, and Japanese bristlegrass and common reed that were located outside of the monitoring plots, but within the wetland restoration areas, have decreased in areal cover and were observed to show signs of stress and stunted growth.

Overall invasive species cover significantly decreased within the wetland monitoring plots between 2022 (28.8%) and 2023 (2.5%) (**Tables 5 and 6**). While a limited number of invasive species were present, they were not ubiquitous, with certain plots having higher instances of undesirable species cover. For instance, in 2022, wetland enhancement area plot W-8 had high vegetative cover of Japanese stiltgrass (70%) and low vegetative cover of common reed (5%) under a desirable river birch (40%) and black willow (55%) canopy. In 2023, black willow canopy cover slightly decreased to 50%; however, river birch canopy cover significantly increased to 75% and native hydrophytic herbaceous species such as swamp smartweed (60%), Pennsylvania smartweed (10%), and woodreed (10%) colonized the monitoring plot and its surrounding areas which created less available space for Japanese stiltgrass (30%) to establish. The 2023 herbicide treatment and the continuing development of the river birch and black willow canopy contributed to the decline in undesirable species vegetative coverage.

Additionally, in 2022, wetland creation area plot W-7 possessed 50% common reed and 15% Japanese stiltgrass vegetative cover under a desirable American sycamore canopy cover of 80%. In 2023, American sycamore canopy cover increased to 90% and a desirable variety of native herbaceous plants colonized the plot and its surrounding areas, ultimately eliminating available space for invasive species to establish within (i.e., common reed and Japanese stiltgrass cover was absent). The significant reductions in invasive species areal coverage



within these plots and associated wetland areas are anticipated to continue as vegetation on Site continues to mature, reducing the amount of direct sunlight reaching the understory and herbaceous plant layers.

In addition to the undesirable non-native species listed above, the following undesirable non-native species were observed in small numbers scattered around the Site: watercress (*Nasturtium officinale*, OBL), yellow iris (*Iris pseudacorus*, OBL), multiflora rose (*Rosa multiflora*, FACU), autumn olive (*Elaeagnus umbellata*, NL), and charlock mustard (*Sinapis arvensis*, NL).

To address the presence of undesirable non-native species, Princeton Hydro targeted these species with an herbicide application on September 6th and 7th, 2023, and October 24th, 2023. It is anticipated that these efforts will (1) prevent the continued establishment of undesirable non-native species, and (2) facilitate continued development of desirable native species. Additionally, as the installed woody material continues to mature, it is anticipated that the presence of undesirable non-native species will concomitantly reduce in areal coverage as they generally require a full sun regime to proliferate. The continued need for implementation of adaptive management efforts related to the presence of undesirable non-native species will continue to be monitored moving forward with additional herbicide applications targeting these species on an as warranted basis.

SUBSECTION 4.5 SOILS AND HYDROLOGY

As outlined by the U.S. Department of Agriculture (1988), “a hydric soil is a soil in which the surface horizons are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions.” Hydric soils have a water table at less than 1 foot from the surface for a significant period, typically a week or more, during the growing season (U.S. Army Corps of Engineers, 1987).

The project has been designed to support wetland creation and enhancement areas, and to enhance the floodplain and hydrologic re-connectivity associated with Aquetong Creek and its tributary (See Appendix III, Photos 11 and 15). The planting plans were informed by on-Site hydrology. Specifically, most plants targeted for and installed within the wetland restoration areas are classified as facultative (FAC), facultative wetland (FACW), or obligate (OBL). Currently, the herbaceous species present within the seed mix are well-established, especially in the periodically inundated zones of the wetland creation area which suggests that the hydrology is adequate to support hydrophytic plant species (See Appendix III, Photos 7 and 17). The existing wetland areas are supporting obligate hydrophytes, including hop sedge (*Carex lupulina*, OBL), jewelweed, pussy willow, black willow, swamp smartweed, shallow sedge, and rice cutgrass (See Appendix III, Photos 3, 4, 9, 14, and 17). The initial establishment of hydrophytic vegetation within the wetland creation and wetland enhancement areas supports the position that a suitable wetland hydrologic regime is present within the Site.

SUBSECTION 4.6 WILDLIFE UTILIZATION

During the Site inspection conducted on September 29, 2023, fewer avian, fish, amphibian, mammal, and insect species were visually and/or audibly observed compared to prior years. This was due to the prevailing weather conditions, which included heavy rain and wind with high stream flows. Given these conditions, the reduced levels of animal activity are not surprising as wildlife activity is reduced during inclement weather.

Despite the inclement weather, a variety of avian and mammal species were still observed utilizing the Site, particularly within the wetland restoration areas. During the Site inspection, the most commonly observed avian species was Common Yellowthroat (*Geothlypis trichas*), which were observed utilizing the shrub and canopy strata within the wetland restoration area along Aquetong Creek for foraging and sheltering. Due to the large number of Common Yellowthroat observed on-Site, it is presumed that they were either (1) utilizing the Site as a stop-over during migration, or (2) were resident breeders that have yet to migrate south. Other observed species



included Bald Eagle (*Haliaeetus leucocephalus*), Red-tailed Hawk (*Buteo jamaicensis*), and Turkey Vulture (*Cathartes aura*).

Fish species that were observed within the pool portions of Aquetong Creek and its tributary included creek chub (*Semotilus atromaculatus*), panfish (*Lepomis sp.*), and longnose dace (*Rhinichthys cataractae*). A few green frog (*Lithobates clamitans*) and pickerel frog (*Lithobates palustris*) were also observed throughout the wetland and stream portions of the Site.

White-tailed deer (*Odocoileus virginianus*) was observed within the uplands and northern wetland enhancement portions of the Site. American mink (*Neovison vison*) was observed within the wetland enhancement area along the east bank of the tributary to Aquetong Creek.

Additionally, previous monitoring inspections yielded observations of a wide assemblage and diversity of avian, fish, amphibian, mammal, and insect species utilizing the wetland restoration areas, which indicate that the Site is providing quality habitat and is important to both resident and migratory avifauna.

SECTION 5: DISCUSSION AND RECOMMENDATIONS

As of September 2023, the wetland creation area possessed 100% vegetative cover and 198.8% total cover, and the wetland enhancement area possessed 100% total cover and 180.3% total cover, with species composition and abundance primarily driven by hydrophytic native herbaceous and woody species. Both areas supported the installed seed mix, herbaceous plugs, and woody species. The average vegetative and total cover of the wetland restoration area is 100% and 189.6%, respectively.

The observed survivorship of woody plants within the wetland restoration area was 87.3%, which exceeds the 85% survivorship threshold. The high survivorship is primarily driven by the continued development and recruitment red maple, river birch, American sycamore, and black willow.

Cover of non-native, undesirable species within the wetland restoration areas decreased from 28.8% in 2022 to 2.5% in 2023 (**Tables 5 and 6**). Invasive species observed within the wetland restoration areas included common reed and Japanese stiltgrass. While other undesirable species such as Japanese bristlegrass, small carpetgrass, and reed canarygrass, were observed, these species mainly occurred outside of the wetland restoration areas and in small, scattered patches. As discussed above, monitoring of invasive species presence will continue moving forward with additional herbicide applications occurring on an as warranted basis.

To address invasive species, an herbicide application occurred on September 6th and 7th, 2023 and October 24th, 2023, with the effort targeting these previously documented undesirable species. It is anticipated that, as the Site continues to develop, desirable native species will continue to proliferate and spread into areas where invasive species were present prior to herbicide application.

Overall, the Site is on a positive developmental trajectory, as evidenced by the diverse suite of desirable native species, structural diversity, and Site utilization by breeding avifauna that require specific habitat attributes associated with the presence of desirable native species and structural diversity. Equally important is the presence of a suitable hydrological regime that supports the development of hydrophytic plant species, both herbaceous and woody. It is anticipated that this positive developmental trajectory will continue moving forward, ultimately resulting in the restoration areas satisfying the conditions set forth by the PADEP Restoration Waiver 16 and accompanying statutes.



SECTION 6: REFERENCES

Environmental Laboratory. 2012. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Version 2.0). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

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Princeton Hydro, LLC. June 2019. *Aquetong Creek Restoration Project Environmental Assessment Addendum*. Last updated September 2019.

United States Army Corps of Engineers (USACE). 2020. The National Wetland Plant List, Version 3.5. https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html#

APPENDIX I

PLANT SPECIES LIST

PLANT SPECIES LIST

The following is a list of plant species that occur at the Aquetong Spring Park Restoration Project located in Solebury Township, Bucks County, Pennsylvania. Nomenclature follows the National Wetland Plant List: 2020 wetland ratings (USACE 2020) for the Eastern Mountains and Piedmont Region. NA = Not Applicable, NI = No Indicator, NL = Not Listed.

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u>
Aceraceae	Maple Family	
<i>Acer negundo</i>	Boxelder	FAC
<i>Acer rubrum</i>	Red maple	FAC
<i>Acer saccharinum</i>	Silver maple	FACW
Alismataceae	Water-Plantain Family	
<i>Sagittaria latifolia</i>	Broadleaf arrowhead	OBL
Anacardiaceae	Sumac Family	
<i>Toxicodendron radicans</i>	Eastern poison ivy	FAC
Apocynaceae	Dogbane Family	
<i>Apocynum cannabinum</i>	Indianhemp	FACU
Aquifoliaceae	Holly Family	
<i>Ilex opaca</i>	American holly	FACU
<i>Ilex verticillata</i>	Common winterberry	FACW
Asclepiadaceae	Milkweed Family	
<i>Asclepias incarnata</i>	Swamp milkweed	OBL
<i>Asclepias syriaca</i>	Common milkweed	FACU
Asteraceae / Compositae	Aster Family	
<i>Ageratina altissima</i>	White snakeroot	FACU
<i>Ambrosia artemisiifolia</i>	Annual ragweed	FACU
<i>Artemisia vulgaris</i>	Common wormwood	UPL
<i>Bidens cernua</i>	Nodding beggartick	OBL
<i>Bidens frondosa</i>	Devil's beggartick	FACW
<i>Cirsium arvense</i>	Canada thistle	FACU
<i>Erechtites hieraciifolius</i>	American burnweed	NL
<i>Erigeron philadelphicus</i>	Philadelphia fleabane	FACU
<i>Eupatorium perfoliatum</i>	Common boneset	FACW
<i>Eupatorium serotinum</i>	Lateflowering thoroughwort	FAC
<i>Helenium autumnale</i>	Common sneezeweed	FACW
<i>Helianthus strumosus</i>	Paleleaf woodland sunflower	FACU
<i>Lactuca biennis</i>	Tall blue lettuce	FACU
<i>Rudbeckia laciniata</i>	Cutleaf coneflower	FACW

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u>
<i>Solidago altissima</i>	Tall goldenrod	FACU
<i>Solidago canadensis</i>	Canada goldenrod	FACU
<i>Symphyotrichum lateriflorum</i>	Calico aster	FACW
<i>Symphyotrichum novae-angliae</i>	New England aster	FACW
<i>Symphyotrichum puniceum</i>	Purplestem aster	OBL
Balsaminaceae	Touch-Me-Not Family	
<i>Impatiens capensis</i>	Jewelweed	FACW
Betulaceae	Birch Family	
<i>Alnus serrulata</i>	Smooth alder	OBL
<i>Betula nigra</i>	River birch	FACW
Boraginaceae	Borage Family	
<i>Hackelia virginiana</i>	Beggar's-lice	FACU
<i>Myosotis scorpioides</i>	True forget-me-not	OBL
Brassicaceae/Cruciferae	Mustard Family	
<i>Alliaria petiolata</i>	Garlic mustard	FACU
<i>Cardamine bulbosa</i>	Bulbous bittercress	OBL
<i>Cardamine hirsute</i>	Hairy bittercress	FACU
<i>Cardamine impatiens</i>	Narrowleaf bittercress	FAC
<i>Nasturtium officinale</i>	Watercress	OBL
<i>Sinapis arvensis</i>	Charlock mustard	NL
<i>Thlaspi arvense</i>	Field pennycress	UPL
Buddlejaceae	Butterfly-bush Family	
<i>Buddleka davidii</i>	Orange-eye butterfly-bush	FACU
Caprifoliaceae	Honeysuckle Family	
<i>Lonicera japonica</i>	Japanese honeysuckle	FACU
<i>Viburnum dentatum</i>	Southern arrowwood	FAC
<i>Viburnum sieboldii</i>	Siebold's viburnum	NL
Cornaceae	Dogwood Family	
<i>Cornus amomum</i>	Silky dogwood	FACW
Cucurbitaceae	Cucumber Family	
<i>Sicyos angulatus</i>	One-seed bur cucumber	FACU
Cupressaceae	Cypress Family	
<i>Juniperus virginiana</i>	Eastern redcedar	FACU
Cyperaceae	Sedge Family	
<i>Carex comosa</i>	Longhair sedge	OBL

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u>
<i>Carex crinita</i>	Fringed sedge	OBL
<i>Carex gracillima</i>	Graceful sedge	FACU
<i>Carex hystericina</i>	Bottlebrush sedge	OBL
<i>Carex lupulina</i>	Hop sedge	OBL
<i>Carex lurida</i>	Shallow sedge	OBL
<i>Carex scoparia</i>	Broom sedge	FACW
<i>Carex vulpinoidea</i>	Fox sedge	OBL
<i>Cyperus esculentus</i>	Yellow nutsedge	FACW
<i>Schoenoplectus tabernaemontani</i>	Softstem bulrush	OBL
<i>Scirpus atrovirens</i>	Green bulrush	OBL
<i>Scirpus cyperinus</i>	Woolgrass	FACW
Elaeagnaceae	Oleaster Family	
<i>Elaeagnus angustifolia</i>	Russian olive	FACU
<i>Elaeagnus umbellata</i>	Autumn olive	NL
Fabaceae/Leguminosae	Pea Family	
<i>Chamaecrista fasciculata</i>	Partridge pea	FACU
<i>Robinia pseudoacacia</i>	Black locust	FACU
<i>Senna hebecarpa</i>	American senna	FAC
<i>Senna marilandica</i>	Maryland senna	FAC
<i>Trifolium repens</i>	White clover	FACU
Fagaceae	Beech Family	
<i>Quercus bicolor</i>	Swamp white oak	FACW
<i>Quercus palustris</i>	Pin oak	FACW
<i>Quercus phellos</i>	Willow oak	FAC
Iridaceae	Iris Family	
<i>Iris versicolor</i>	Harlequin blueflag	OBL
<i>Iris pseudacorus</i>	Paleyellow iris	OBL
Juglandaceae	Walnut Family	
<i>Juglans nigra</i>	Black walnut	FACU
Juncaceae	Rush Family	
<i>Juncus effusus</i>	Common rush	FACW
<i>Juncus tenuis</i>	Path rush	FAC
Lemnaceae	Duckweed Family	
<i>Lemna minor</i>	Common duckweed	OBL
Liliaceae	Lily Family	
<i>Allium vineale</i>	Wild garlic	FACU

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u>
Lythraceae <i>Lythrum salicaria</i>	Loosestrife Family Purple loosestrife	FACW
Magnoliaceae <i>Liriodendron tulipifera</i>	Magnolia family Tuliptree	FACU
Oleaceae <i>Fraxinus pennsylvanica</i>	Olive Family Green ash	FACW
Onagraceae <i>Chamerion angustifolium</i> <i>Epilobium coloratum</i>	Evening Primrose family Fireweed Purpleleaf willowherb	FAC FACW
Phytolaccaceae <i>Phytolacca americana</i>	Pokeweed Family American pokeweed	FACU
Poaceae / Gramineae <i>Arthraxon hispidus</i> <i>Bromus inermis</i> <i>Calamagrostis canadensis</i> <i>Cinna arundinacea</i> <i>Dichanthelium clandestinum</i> <i>Echinochloa muricata</i> <i>Elymus virginicus</i> <i>Glyceria striata</i> <i>Leersia oryzoides</i> <i>Lolium multiflorum</i> <i>Microstegium vimineum</i> <i>Panicum dichotoflorum</i> <i>Panicum virgatum</i> <i>Poa pratensis</i> <i>Phalaris arundinacea</i> <i>Phragmites australis</i> <i>Schedonorus arundinaceus</i> <i>Setaria faberi</i> <i>Tridens flavus</i>	Grass Family Small carpetgrass Smooth brome Bluejoint grass Woodreed Deertongue Rough barnyard grass Virginia wildrye Fowl mannagrass Rice cutgrass Italian ryegrass Nepalese browntop Fall panicgrass Switchgrass Kentucky bluegrass Reed canarygrass Common reed Tall fescue Japanese bristlegrass Purpletop tridens	FAC UPL FACW FACW FACW OBL FACW OBL OBL NL FAC FACW FAC FACU FACW FACW FACU UPL FACU
Polygonaceae <i>Persicaria hydropiperoides</i> <i>Persicaria pensylvanicum</i> <i>Persicaria punctata</i> <i>Polygonum persicaria</i> <i>Rumex obtusifolius</i>	Buckwheat Family Swamp smartweed Pennsylvania smartweed Dotted smartweed Spotted lady's-thumb Bitter dock	OBL FACW OBL FACW FACU

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u>
Potamogetonaceae <i>Potamogeton crispus</i>	Pondweed Family Curly pondweed	OBL
Platanaceae <i>Platanus occidentalis</i>	Plane-Tree Family American sycamore	FACW
Rosaceae <i>Amelanchier canadensis</i> <i>Aronia arbutifolia</i> <i>Rosa multiflora</i> <i>Rosa palustris</i> <i>Rubus phoenicolasius</i>	Rose Family Canadian serviceberry Red chokecherry Multiflora rose Swamp rose Wine raspberry	FAC FACW FACU OBL FACU
Rubiaceae <i>Cephalanthus occidentalis</i>	Madder Family Common buttonbush	OBL
Salicaceae <i>Populus deltoides</i> <i>Salix discolor</i> <i>Salix nigra</i>	Willow Family Eastern cottonwood Pussy willow Black willow	FAC FACW OBL
Scrophulariaceae <i>Paulownia tomentosa</i> <i>Penstemon digitalis</i> <i>Verbascum thapsus</i> <i>Veronica anagallis-aquatica</i>	Figwort Family Princesstree Foxglove beardtongue Common mullein Water speedwell	UPL FAC FACU OBL
Simaroubaceae <i>Ailanthus altissima</i>	Quassia Family Tree of heaven	FACU
Solanaceae <i>Solanum dulcamara</i>	Potato Family Climbing nightshade	FAC
Typhaceae <i>Typha latifolia</i>	Cat-tail Family Broadleaf cattail	OBL
Urticaceae <i>Boehmeria cylindrica</i> <i>Pilea pumila</i>	Nettle Family Smallspike false nettle Canadian clearweed	FACW FACW
Hydrocharitaceae <i>Vallisneria americana</i>	Tape-grass Family American eelgrass	OBL
Verbenaceae <i>Verbena hastata</i> <i>Verbena urticifolia</i>	Verbena Family Swamp verbena White vervain	FACW FAC

Scientific Name

Vitaceae

Parthenocissus quinquefolia

Common Name

Grape Family

Virginia creeper

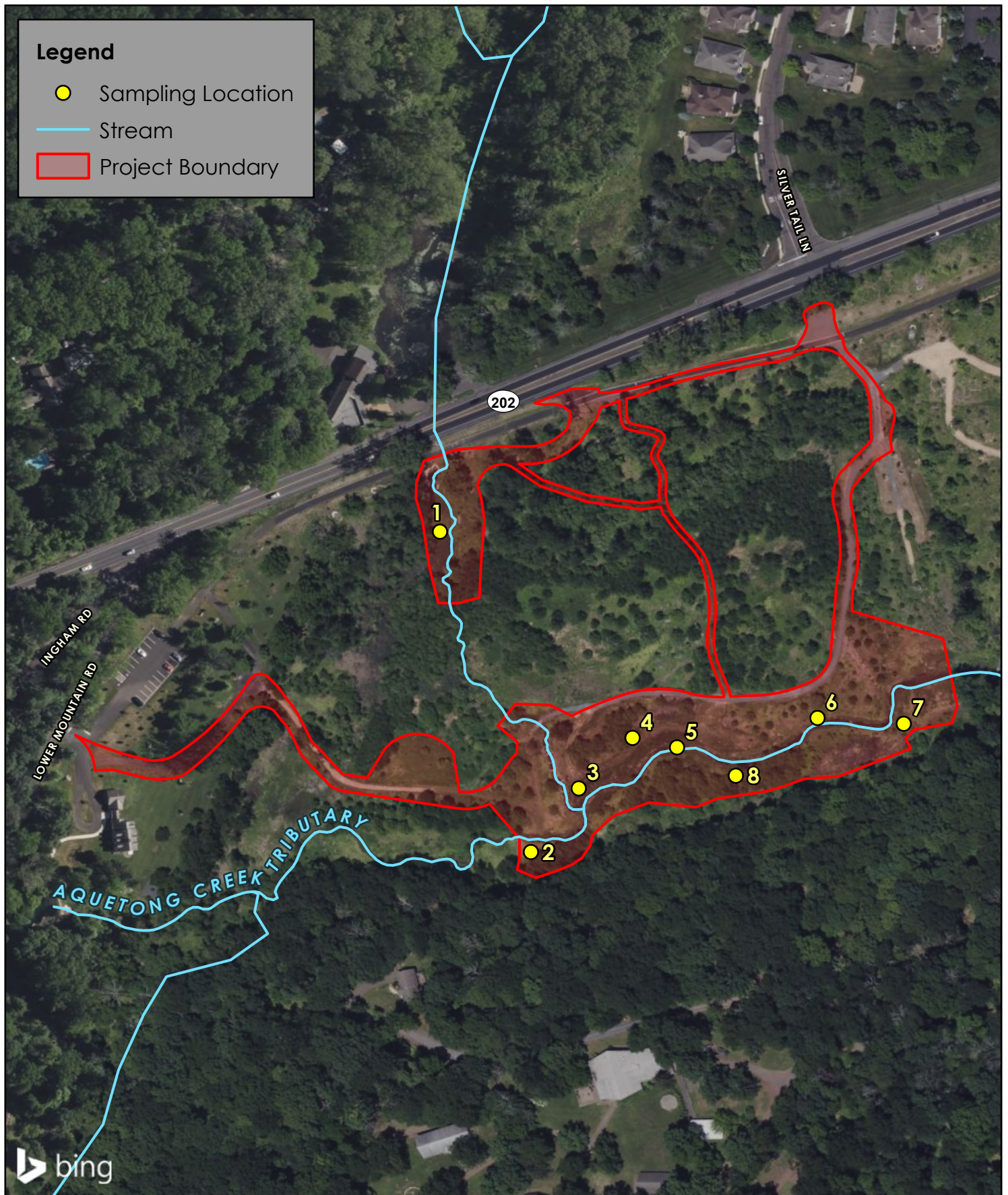
Indicator Status

FACU

APPENDIX II

SAMPLING PLOT LOCATIONS

File: P:\0388\Projects\0388011\GIS\APR\Aquetong Year 2 Monitoring Report.aprx, 11/6/2023, Drawn by Isrinivasan, Copyright Princeton Hydro, LLC.



NOTES:
1. Sampling locations, stream, and project boundary are approximate.
2. Aerial imagery obtained through ArcGIS Online Bing Maps (C)
2023 Microsoft Corporation and its data suppliers.

0 100 200 Feet
Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

SAMPLING LOCATION MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

APPENDIX III

PHOTOGRAPHS

PHOTO LOCATION MAP

Photographic Log

Client: Solebury Township**Site Name:** Aquetong Spring Park Restoration Project**Project Number:** 0388.011**Site Location:** Solebury Township, PA**Photograph ID:** 1**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** South**Comments:** General view of healthy and thriving (>5 ft.) installed woody species, such as river birch (*Betula nigra*) and American sycamore (*Platanus occidentalis*) along the east bank of the tributary on-Site.**Photograph ID:** 2**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** Northeast**Comments:** View of the well-established herbaceous community along the tributary featuring several healthy installed woody species such as black willow (*Salix nigra*) and silver maple (*Acer saccharinum*).

Photographic Log

Client: Solebury Township Site Name: Aquetong Spring Park Restoration Project Project Number: 0388.011 Site Location: Solebury Township, PA	
Photograph ID: 3	
Date: Sept. 29, 2023	
Location: See photo location map.	
Direction: East	
Comments: View of the wetland enhancement area along the north bank of Aquetong Creek featuring well-established installed woody species including river birch, black willow, and swamp white oak (<i>Quercus palustris</i>).	
Photograph ID: 4	
Date: Sept. 29, 2023	
Location: See photo location map.	
Direction: East	
Comments: View of Aquetong Creek flowing through the wetland creation area featuring a robust herbaceous stratum and healthy installed woody species such as swamp white oak (left) and black willow (right).	

Photographic Log

Client: Solebury Township**Site Name:** Aquetong Spring Park Restoration Project**Project Number:** 0388.011**Site Location:** Solebury Township, PA**Photograph ID:** 5**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:**
Southwest**Comments:** View of the well-established herbaceous and woody vegetation within the wetland enhancement and creation areas along Aquetong Creek.**Photograph ID:** 6**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** East**Comments:** Typical view of Aquetong Creek and its banks that are well-established with a robust herbaceous plant community.

Photographic Log

Client: Solebury Township**Site Name:** Aquetong Spring Park Restoration Project**Project Number:** 0388.011**Site Location:** Solebury Township, PA**Photograph ID:** 7**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** West**Comments:** View of the diverse plant community within the wetland creation area along the north bank of Aquetong Creek.**Photograph ID:** 8**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** East**Comments:** View of a thriving river birch amidst a well-established herbaceous community of Canada goldenrod (*Solidago canadensis*) within the wetland enhancement area in the western portion of the Site.

Photographic Log

Client: Solebury Township Site Name: Aquetong Spring Park Restoration Project Project Number: 0388.011 Site Location: Solebury Township, PA	
Photograph ID: 9	
Date: Sept. 29, 2023	
Location: See photo location map.	
Direction: Southeast	
Comments: View of several well-established black willow live stakes and river birch within the wetland creation area in the eastern portion of the Site.	
Photograph ID: 10	
Date: Sept. 29, 2023	
Location: See photo location map.	
Direction: Northeast	
Comments: View of healthy woody material within the wetland creation area amidst a robust hydrophytic herbaceous layer consisting of Pennsylvania smartweed (<i>Polygonum pensylvanicum</i>).	

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 11

Date: Sept. 29, 2023

Location:
See photo location map.

Direction: East

Comments:
General view of the diverse and well-established herbaceous layer within the wetland enhancement area along Aquetong Creek featuring a black willow live stake (right).



Photograph ID: 12

Date: Sept. 29, 2023

Location:
See photo location map.

Direction: South

Comments: View of the live stakes that have established well along the banks of Aquetong Creek including pussy willow (*Salix discolor*) and black willow.



Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 13

Date: Sept. 29, 2023

Location:
See photo location map.

Direction: Northeast

Comments: Typical view of the well-established herbaceous layer within the wetland enhancement area along the south bank of Aquetong Creek.



Photograph ID: 14

Date: Sept. 29, 2023

Location:
See photo location map.

Direction: Northwest

Comments:
General view of several healthy black willow live stakes along the south bank of Aquetong Creek.



Photographic Log

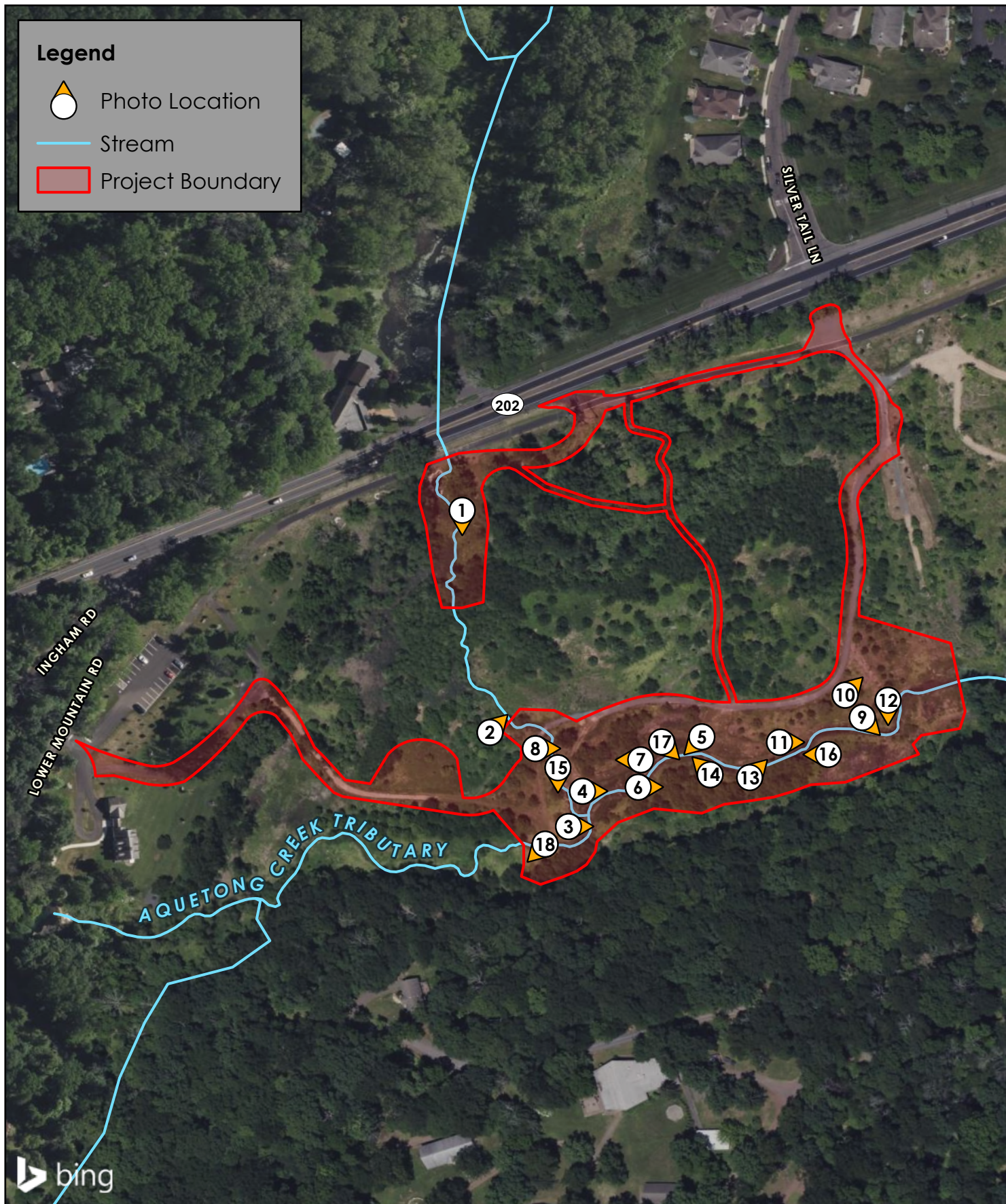
Client: Solebury Township Site Name: Aquetong Spring Park Restoration Project	Project Number: 0388.011 Site Location: Solebury Township, PA
--	--

Photograph ID: 15**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** South**Comments:**
View of the diverse assemblage of hydrophytic herbaceous and woody plants within the wetland creation area along the banks of the tributary to Aquetong Creek.**Photograph ID:** 16**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** West**Comments:**
General view of the diverse and well-established herbaceous layer within the wetland enhancement area along Aquetong Creek featuring Pennsylvania smartweed, black willow, and pussy willow.

Photographic Log

Client: Solebury Township**Site Name:** Aquetong Spring Park Restoration Project**Project Number:** 0388.011**Site Location:** Solebury Township, PA**Photograph ID:** 17**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:** Southeast**Comments:**
Closeup view of the diverse and well-established herbaceous layer within the wetland creation area along Aquetong Creek, featuring hop sedge (*Carex lupulina*).**Photograph ID:** 18**Date:** Sept. 29, 2023**Location:**
See photo location map.**Direction:**
Southwest**Comments:**
General view of Aquetong Creek within the western portion of the Site, featuring a swamp white oak and numerous black willows.

File: P:\0388\Projects\0388011\GIS\APRX\Aquetong Year 2 Monitoring Report.aprx, 11/6/2023, Drawn by tsrinivasan, Copyright Princeton Hydro, LLC.



NOTES:
1. Photo locations, stream, and project boundary are approximate.
2. Aerial imagery obtained through ArcGIS Online Bing Maps (C)
2023 Microsoft Corporation and its data suppliers.

0 100 200 Feet
Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

PHOTO LOCATION MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

APPENDIX IV

PADEP CHAPTER 105 RESTORATION WAIVER 16 APPROVAL LETTER



pennsylvania
DEPARTMENT OF ENVIRONMENTAL
PROTECTION

October 23, 2019

Mr. Dennis Carney
Solebury Township
3092 Sugan Road
P.O. Box 139
Solebury, PA 18963

Re: Aquetong Creek Restoration Project
DEP File Nos. EA09-013 and WL0919301
APS No. 996246, AUTH ID No. 1278424
Solebury Township
Bucks County

Dear Mr. Carney:

The Department of Environmental Protection (DEP) has reviewed and approved the Environmental Assessment and Restoration Plan, including the 401 Water Quality Certification to restore and maintain approximately 1,200 linear feet of stream channel and to enhance the floodplain grading and riparian corridor along Aquetong Creek (Perennial, HQ-CWF). The southern limit of the site is located at the former terminus of the Aquetong Lake impoundment (Lambertville, NJ, USGS Quadrangle, Latitude: 40.354181N"; Longitude: -74.988711W").

This letter may be considered sufficient authorization for the proposed stream restoration plan with the following special conditions:

- A. Stream and wetland restoration areas and wetland creation areas shall be monitored, and reports submitted to DEP, in accordance with the Mitigation Plan narrative included in the Environmental Assessment provided to DEP.
- B. All Conservation Measures recommended in the Pennsylvania Department of Conservation and Natural Resource's review letter dated May 1, 2019, shall be incorporated into the project.
- C. Temporary stream crossing(s) shall be constructed of suitable nonerodible material in order to prevent any road materials from washing out if structure is overtopped during periods of high water.

- D. Streambank disturbance shall be kept to a minimum and stabilized with indigenous vegetation within 20 days of final earthmoving to prevent erosion and provide cover, shading, and food source for aquatic life.
- E. All disturbed areas are to be restored to the original or proposed contours and shall be replanted with indigenous plant species.
- F. Demolition or excavated materials shall not be deposited in any wetland, watercourse, floodway, floodplain, or other body of water without applying for and receiving the written permit of DEP.
- G. Water pumped from the construction area shall be diverted into a sediment trap or basin, or into an appropriate vegetated filter area to prevent sediment from being discharged into any waters of the Commonwealth.
- H. Upon discovery of significant changes that could compromise the integrity of the project, the permittee shall immediately notify DEP and the Bucks County Conservation District.

This authorization does not give any property rights, either in real estate or material, nor any exclusive privileges, nor shall it be construed to grant or confer any right, title, easement, or interest in, to, or over any land belonging to the Commonwealth of Pennsylvania; nor any infringement of Federal, State, or local laws or regulations.

Regarding Federal authorization, we have determined that your proposed work, if accomplished in accordance with the enclosed terms and conditions, is authorized by the Pennsylvania State Programmatic General Permit-5 (PASPGP-5). This PASPGP-5 verification provides U.S. Army Corps of Engineers authorization pursuant to Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act. This authorization may be subject to modification, suspension, or revocation if any of the information contained in the application, including the plans, is later found to be in error.

The enclosed list of conditions must be followed for purposes of the PASPGP-5 (Enclosure 1). A PASPGP-5 Permit Compliance, Self-Certification Form must be completed and returned to the appropriate Corps of Engineers office upon completion of construction (Enclosure 2).

Proper erosion and sediment control measure are required during and after construction and the adequacy of the measures can be determined by contacting the Bucks County Conservation District at 215.345.7577.

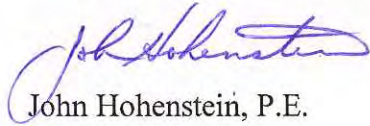
Mr. Dennis Carney

- 3 -

October 23, 2019

If you have any questions, you may contact Mr. Jason Oseredzuk at the address located in the first page footer or by telephone at 484.250.5158.

Sincerely,



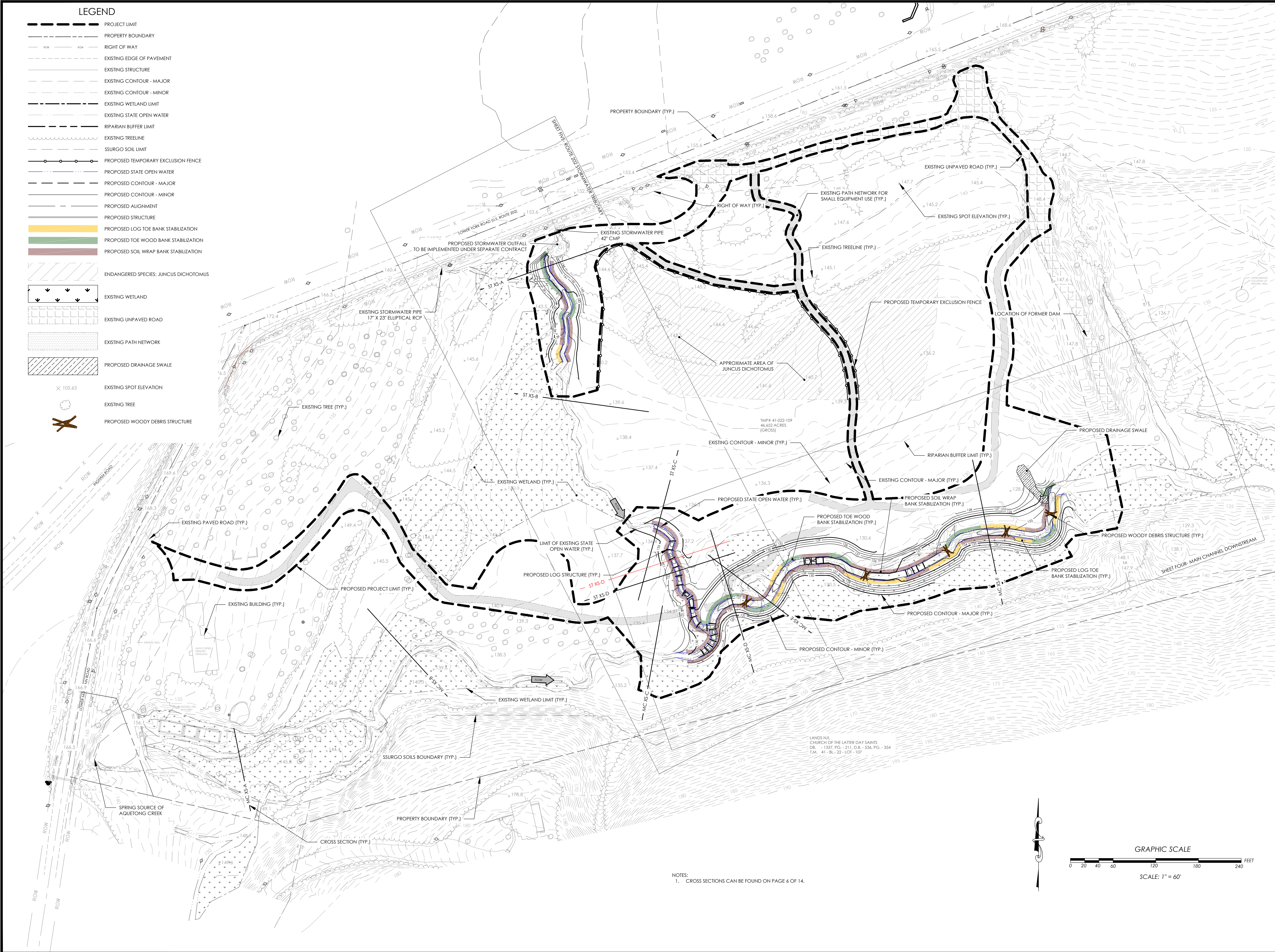
John Hohenstein, P.E.
Regional Manager
Waterways and Wetlands

Enclosure

cc: Bucks County Conservation District
PA Fish and Boat Commission
Army Corps of Engineers
Mr. George - Princeton Hydro, LLC
Mr. Oseredzuk
Re 30 (GJS19WAW)296-10

APPENDIX V

SITE PLANS



CALL BEFORE YOU DIG!
PENNSYLVANIA LAW REQUIRES
3 WORKING DAYS NOTICE FOR
CONSTRUCTION PHASE AND 10 WORKING
DAYS IN DESIGN STAGE - STOP CALL
PENNSYLVANIA ONE CALL SYSTEM, INC.
REFERENCE PENNSYLVANIA ACT 38
 1-800-242-1776

PROJECT NOTES

- THE VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAV88), FEET. THE FOLLOWING CONVERSION FOR NAV88 TO NGVD29 IS APPLICABLE FOR THIS LOCATION:
NGVD29 = NAV88 - 0.63 FT
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- FEMA FIRM NOT MAPPED SINCE DAM REMOVAL: NO FHA AREA AVAILABLE.
- IN A RESPONSE DATED MAY 1, 2019 TO PNDI NO. 482836, PADONR PROVIDED A MAP OUTLINING A POPULATION OF PA ENDANGERED JUNCUS DICHOTOMUS, BY INSTALLING EXCLUSORY FENCING AROUND THIS AREA, NO IMPACT ANTICIPATED.
- 150-FT RIPARIAN BUFFER DETERMINED IN ACCORDANCE WITH 25 PA CODE CHAPTER 102.14
- AS-BUILT DATA COLLECTED BY PRINCETON HYDRO ON OCTOBER 22, 2020 AND OCTOBER 15, 2021.

10/10/19	REVISED PER BUCKS COUNTY CONSERVATION DISTRICT COMMENTS
7/25/19	REVISED FOR CONSTRUCTION CLARITY
DATE	DESCRIPTION
REVISIONS	

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

PRINCETON HYDRO

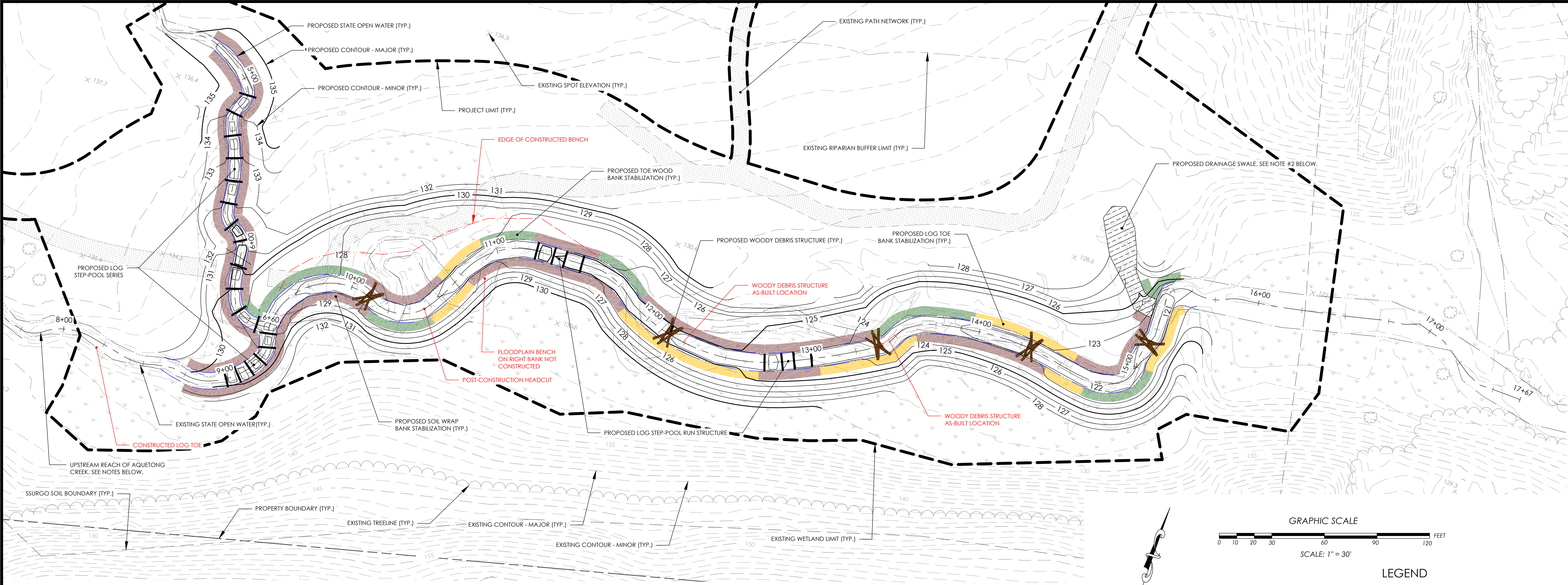
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

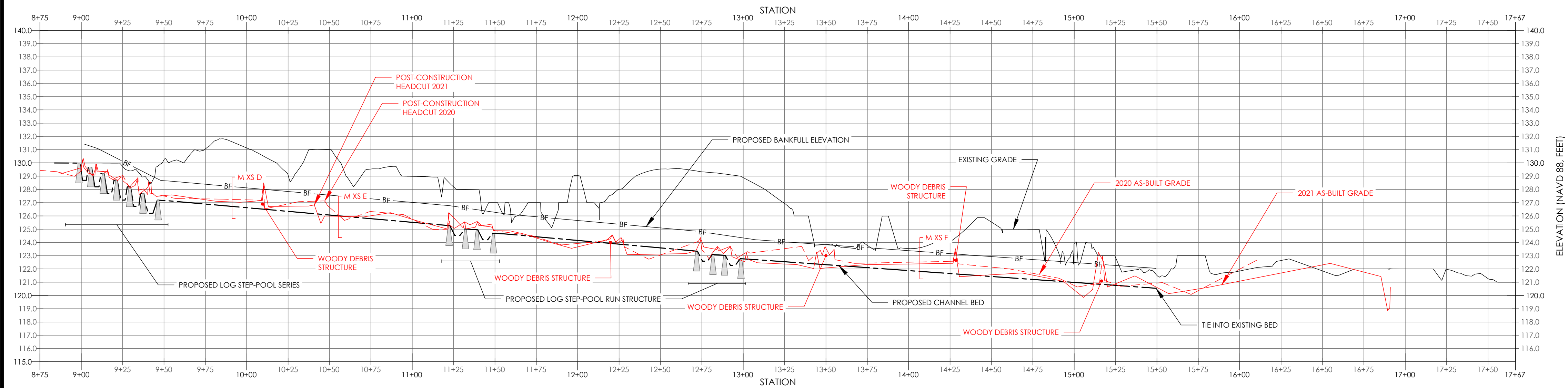
DRAWING NAME:
PROPOSED CONDITIONS OVERVIEW

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	1"=60'
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC
SHEET NO.	

3 OF 15

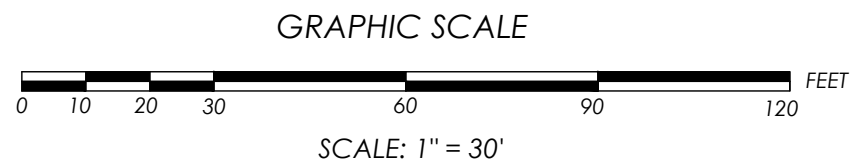
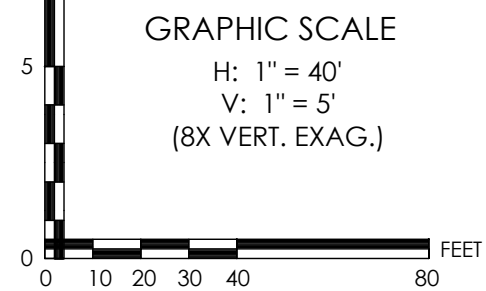


A PROPOSED PLAN VIEW - MAIN CHANNEL - DOWNSTREAM
1" = 30'



B PROPOSED PROFILE - MAIN CHANNEL - DOWNSTREAM
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (8X VERT. EX.)

- NOTES:
- ACTIVE EROSION IS OCCURRING THROUGHOUT THE REACH OF AQUETONG CREEK UPSTREAM OF STATION 08+75, HOWEVER NO TREATMENT OR ACTIVE RESTORATION IS CURRENTLY PROPOSED. IF TREATMENT IS NEEDED IN THE FUTURE, IT SHALL BE COMPLETED UNDER SEPARATE COVER.
 - THE DRAINAGE SWALE SHALL BE STABILIZED USING STEP POOLS CONSTRUCTED FROM EXCESS LOGS AND ROCKS. THESE STEP POOLS SHALL BE FIELD FIT BASED ON THE FIELD CONDITIONS AT THE TIME OF CONSTRUCTION AND AS DIRECTED BY ONSITE ENGINEER. THE STEP POOLS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A ON SHEET 7 OF 15.
 - THE TWO CULVERTS UNDER ROUTE 202 DRAINING INTO THE 202 STORMWATER TRIBUTARY SHALL BE STABILIZED UNDER A SEPARATE CONTRACT.



- LEGEND
- PROJECT LIMIT
 - PROPERTY BOUNDARY
 - RIGHT OF WAY
 - EXISTING EDGE OF PAVEMENT
 - EXISTING STRUCTURE
 - EXISTING CONTOUR - MAJOR
 - EXISTING CONTOUR - MINOR
 - EXISTING WETLAND LIMIT
 - EXISTING STATE OPEN WATER
 - RIPARIAN BUFFER LIMIT
 - EXISTING TREELINE
 - SSURGO SOIL LIMIT
 - PROPOSED TEMPORARY EXCLUSION FENCE
 - PROPOSED STATE OPEN WATER
 - PROPOSED CONTOUR - MAJOR
 - PROPOSED CONTOUR - MINOR
 - PROPOSED ALIGNMENT
 - PROPOSED STRUCTURE
 - PROPOSED LOG TOE BANK STABILIZATION
 - PROPOSED TOE WOOD BANK STABILIZATION
 - PROPOSED SOIL WRAP BANK STABILIZATION
 - PROPOSED CHANNEL BED
 - PROPOSED BANKFULL ELEVATION
 - ENDANGERED SPECIES: JUNCUS DICHOTOMUS
 - EXISTING WETLAND
 - EXISTING UNPAVED ROAD
 - EXISTING PATH NETWORK
 - PROPOSED DRAINAGE SWALE
 - EXISTING SPOT ELEVATION
 - EXISTING TREE
 - PROPOSED WOODY DEBRIS STRUCTURE
 - 2020 AS-BUILT GRADE
 - 2021 AS-BUILT GRADE

CALL BEFORE YOU DIG!
PENNSYLVANIA LAW REQUIRES
3 WORKING DAYS NOTICE FOR
CONSTRUCTION PHASE AND 10 WORKING
DAYS IN DESIGN STAGE - STOP CALL
PENNSYLVANIA ONE CALL SYSTEM, INC.
REFERENCE PENNSYLVANIA ACT 38
1-800-242-1776

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REVISIONS	

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E
11/19/2021
DATE

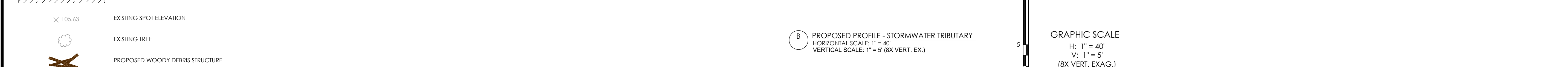
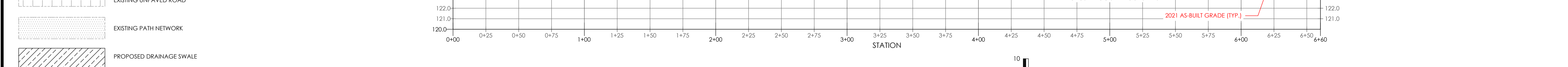
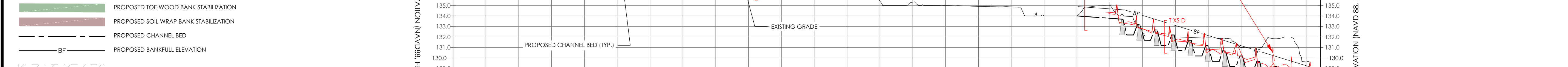
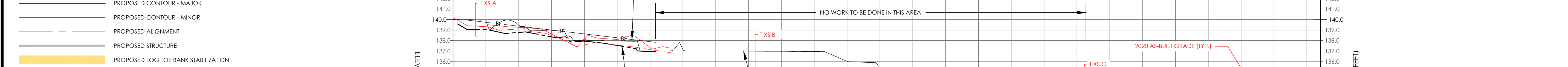
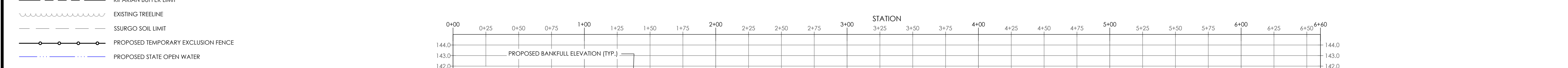
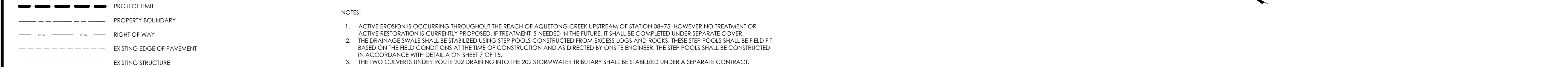
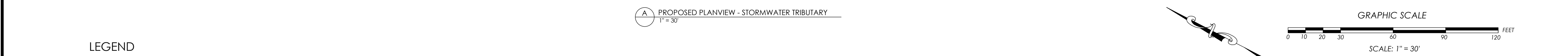
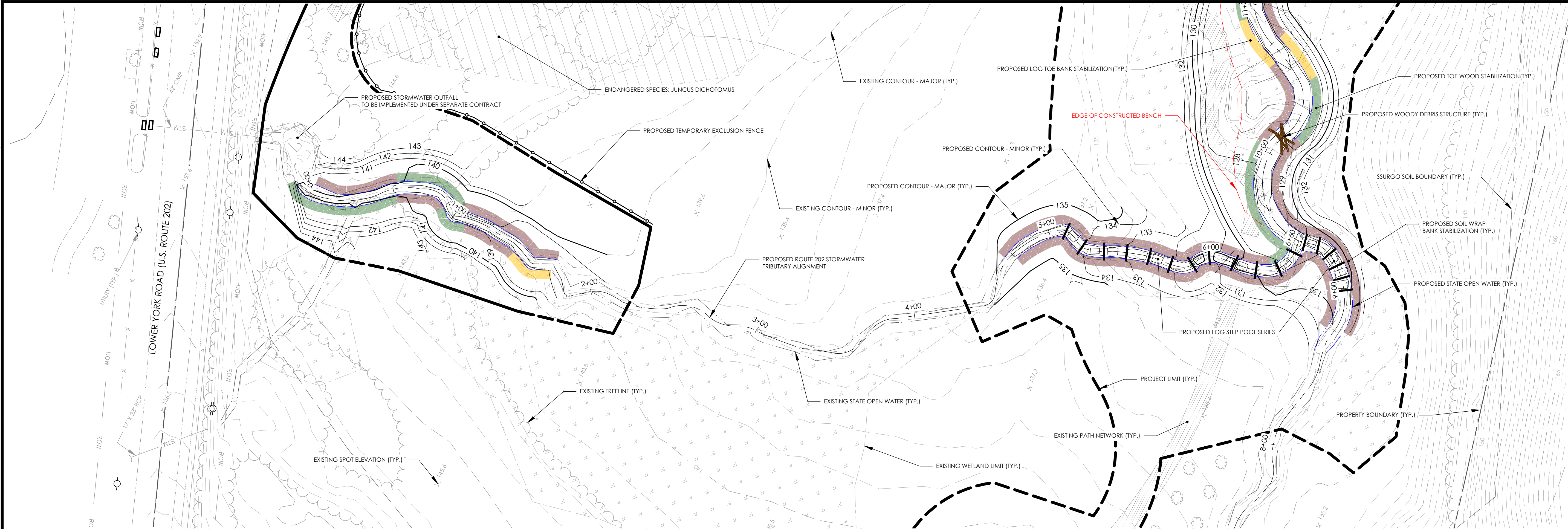
PRINCETON HYDRO
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

DRAWING NAME:
PROPOSED
CONDITIONS-MAIN
CHANNEL DOWNSTREAM

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	AS SHOWN
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

SHEET NO.



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7/25/19	REVISED FOR CONSTRUCTION CLARITY
DATE	DESCRIPTION
REVISIONS	

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

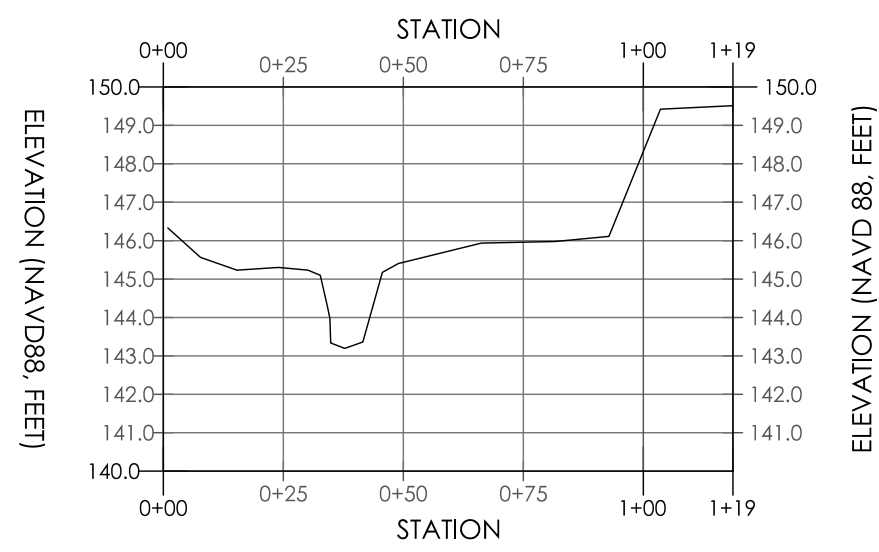
PRINCETON HYDRO
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

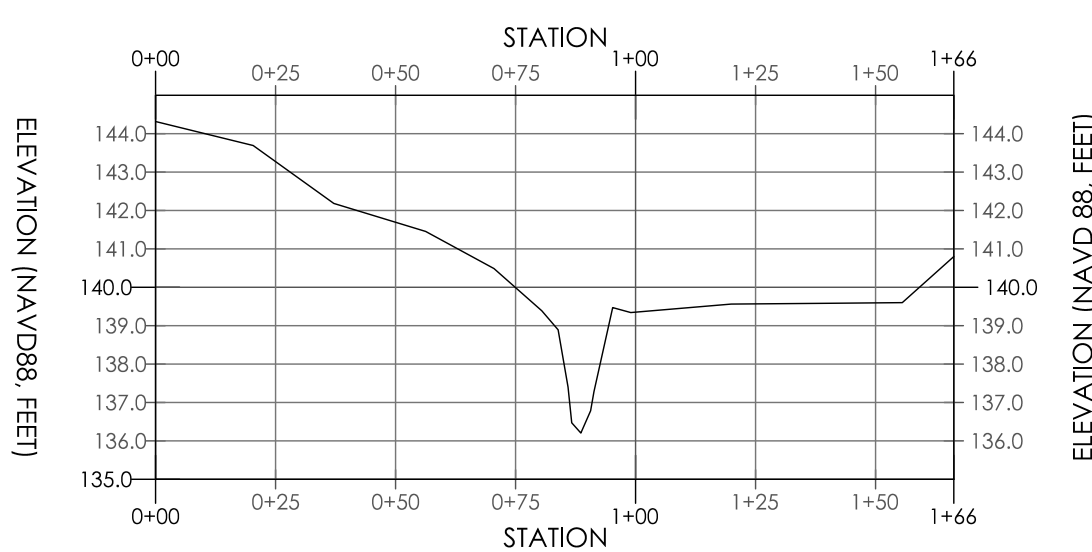
DRAWING NAME:
**PROPOSED CONDITIONS-
ROUTE 202 STORMWATER
TRIBUTARY**

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	AS SHOWN
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

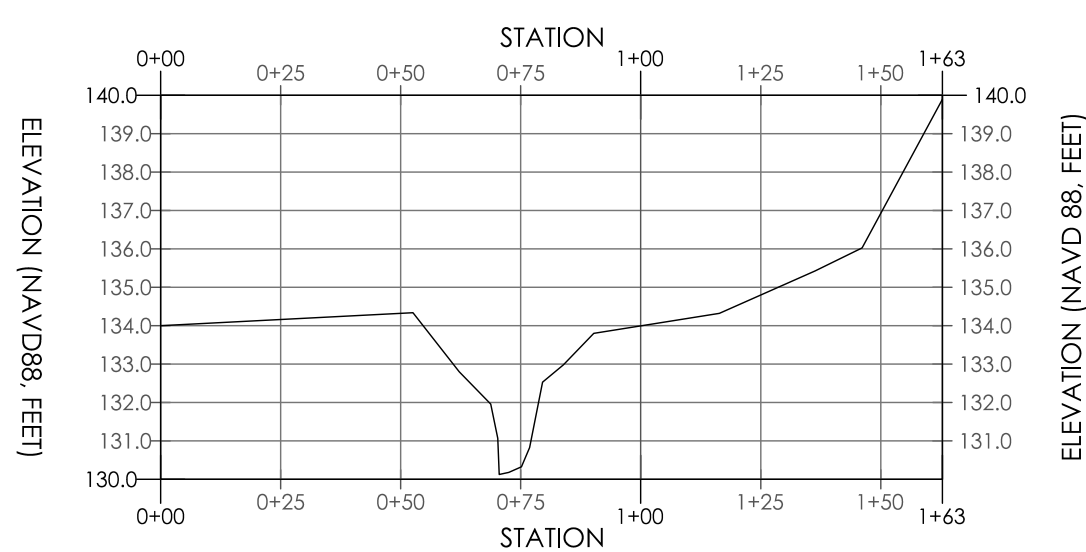
SHEET NO.
5 OF **15**



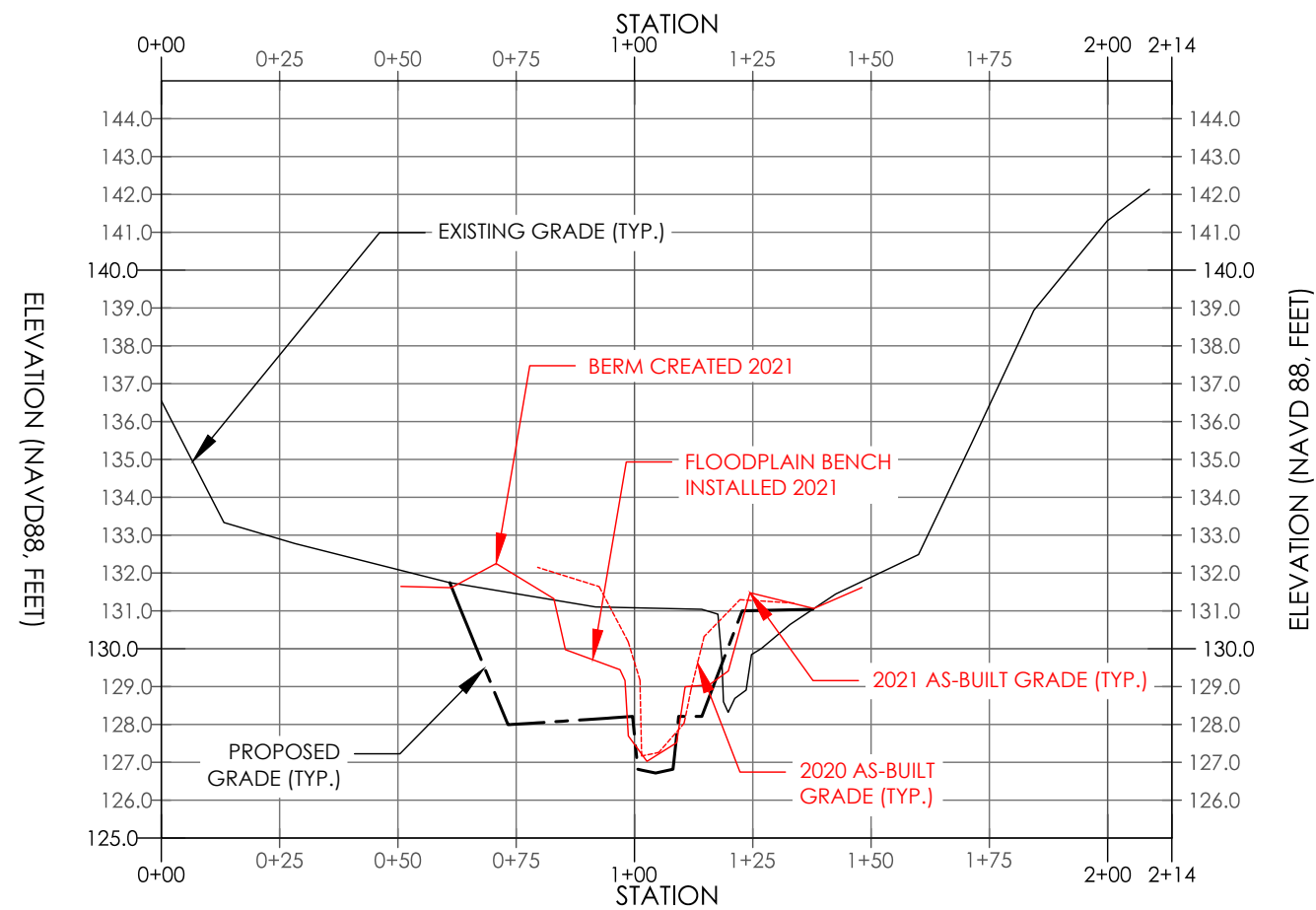
A MAIN CHANNEL CROSS SECTION A (MC XS-A)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



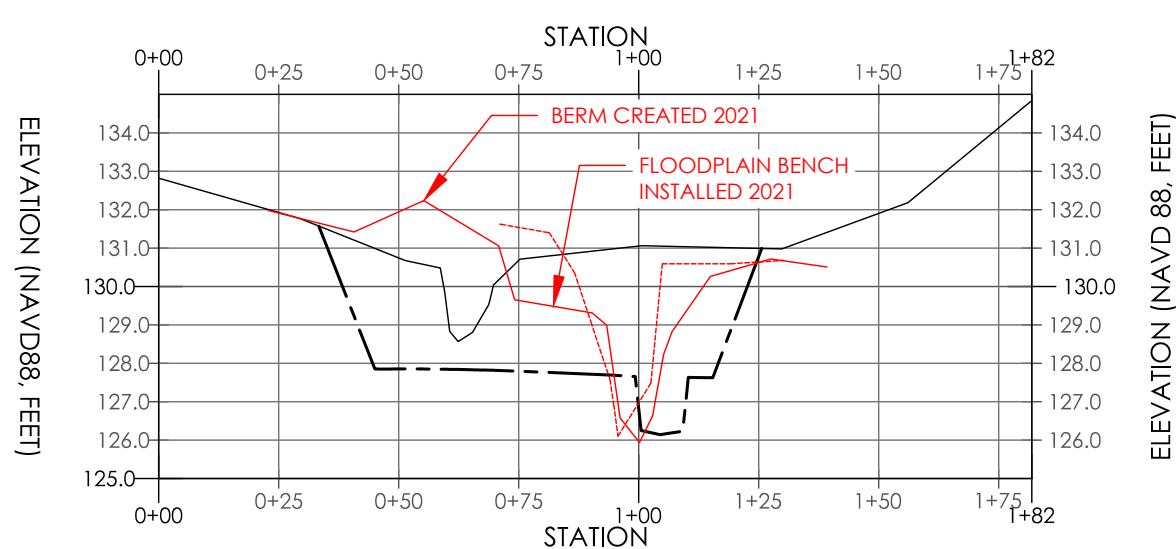
B MAIN CHANNEL CROSS SECTION B (MC XS-B)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



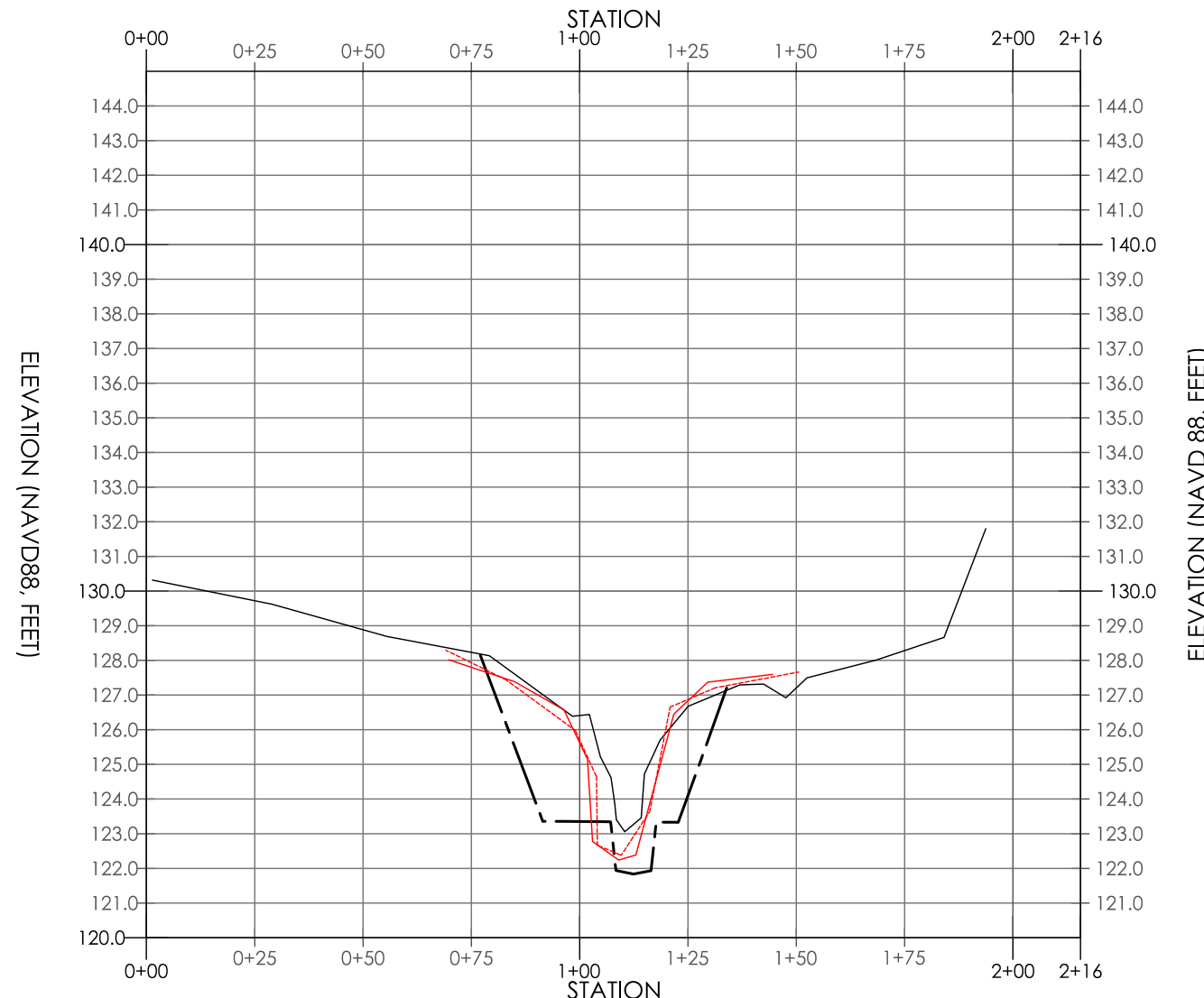
C MAIN CHANNEL CROSS SECTION C (MC XS-C)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



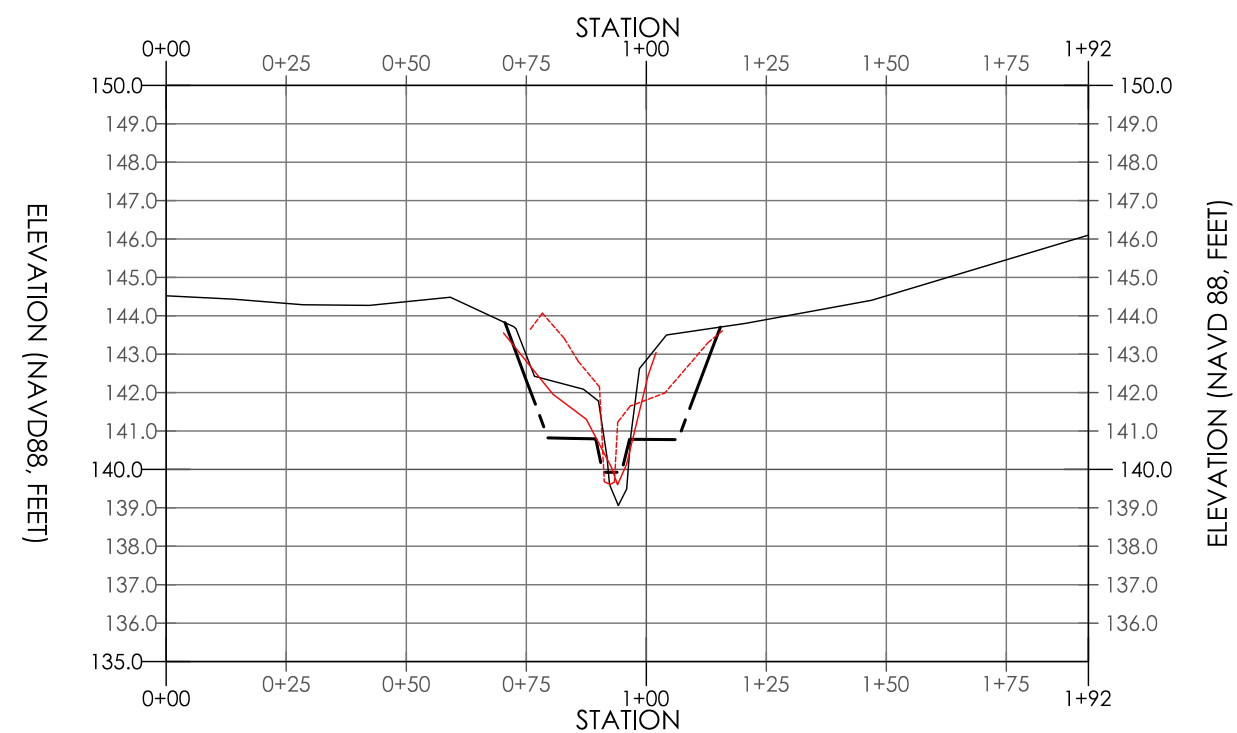
D MAIN CHANNEL CROSS SECTION D (MC XS-D)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



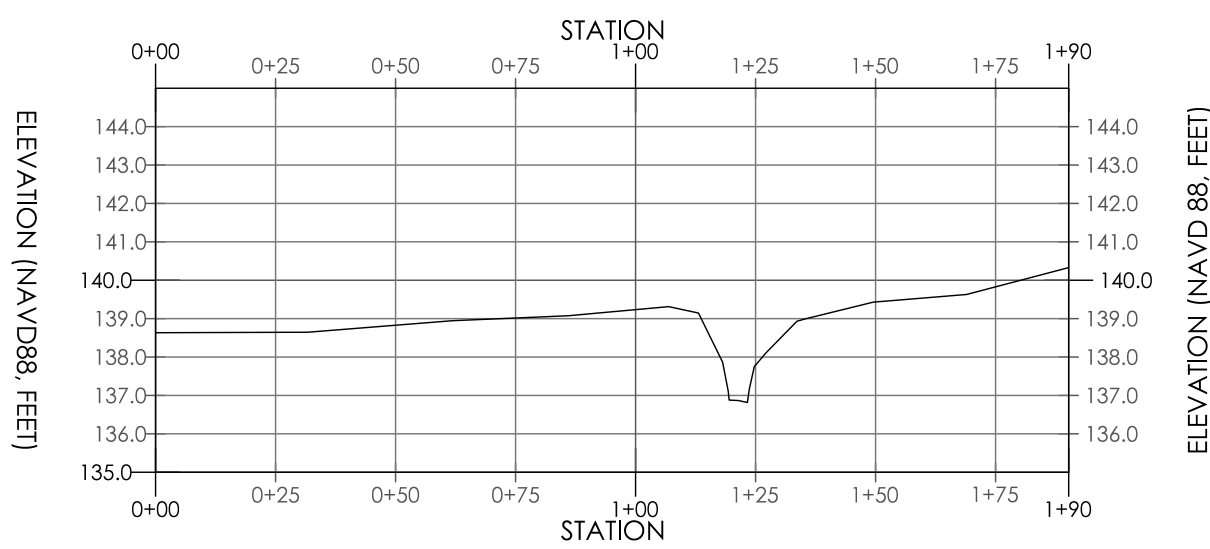
E MAIN CHANNEL CROSS SECTION E (MC XS-E)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



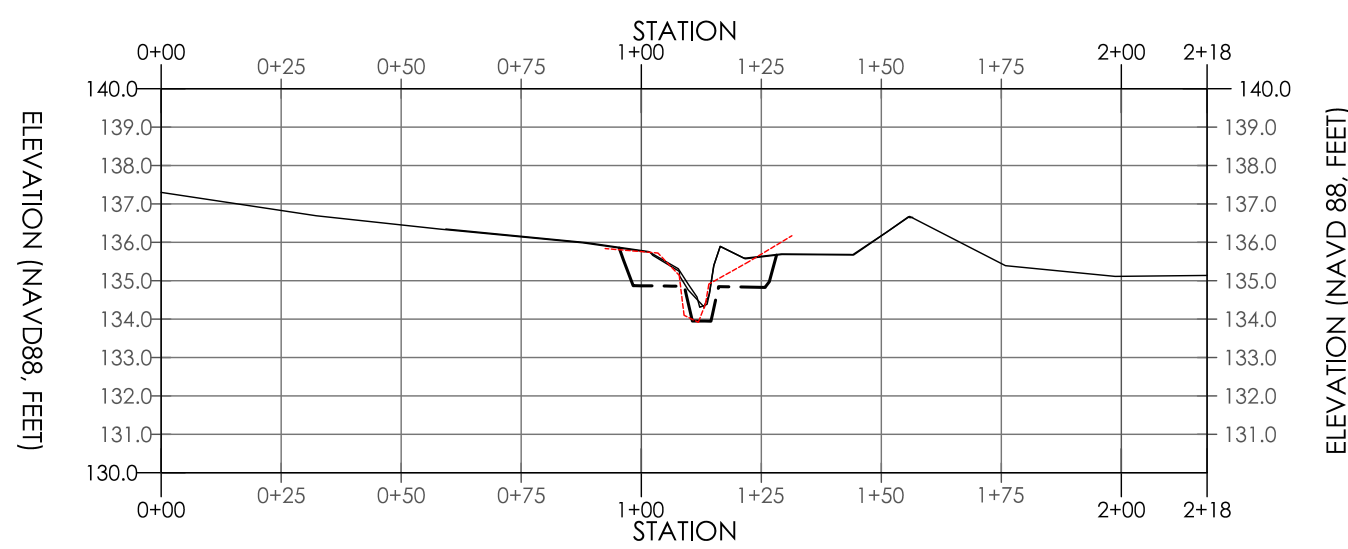
F MAIN CHANNEL CROSS SECTION F (MC XS-F)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



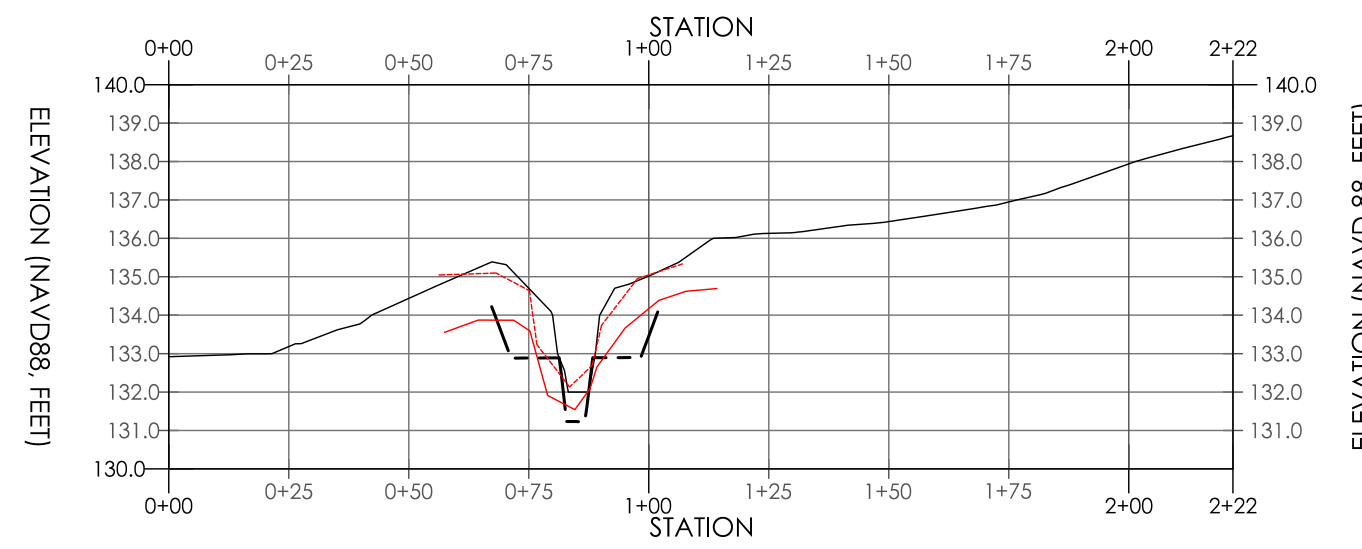
G STORWATER TRIBUTARY CROSS SECTION A (ST XC-A)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



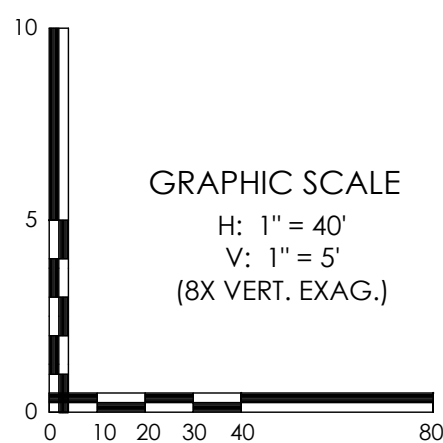
H STORWATER TRIBUTARY CROSS SECTION B (ST XC-B)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



I STORWATER TRIBUTARY CROSS SECTION C (ST XC-C)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



J STORWATER TRIBUTARY CROSS SECTION D (ST XC-D)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



- NOTES:
- ALL CROSS SECTIONS ARE DEPICTED FROM LEFT BANK TO RIGHT BANK, LOOKING DOWNSTREAM.
 - CROSS SECTION LOCATIONS CAN BE FOUND ON PAGE 3 OF 15.

LEGEND	
	EXISTING GRADE
	PROPOSED GRADE
	2020 AS-BUILT GRADE
	2021 AS-BUILT GRADE

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3 WORKING DAYS NOTICE FOR
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- FEMA FIRM NOT MAPPED SINCE DAM REMOVAL: NO FHA AREA AVAILABLE.
- IN A RESPONSE DATED MAY 1, 2019 TO PNDI NO. 482836, PADCNR PROVIDED A MAP OUTLINING A POPULATION OF PA ENDANGERED JUCUS DICHOTOMUS. BY INSTALLING EXCLUSIONARY FENCING AROUND THIS AREA, NO IMPACT ANTICIPATED.
- 150-FT RIPARIAN BUFFER DETERMINED IN ACCORDANCE WITH 25 PA CODE CHAPTER 102.14
- AS-BUILT DATA COLLECTED BY PRINCETON HYDRO ON OCTOBER 22, 2020 AND OCTOBER 15, 2021.

DATE	DESCRIPTION
10/10/19	REVISED PER BUCKS COUNTY CONSERVATION DISTRICT COMMENTS
7/25/19	REVISED FOR CONSTRUCTION CLARITY
REVISIONS	

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

PRINCETON HYDRO
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

DRAWING NAME:

CROSS SECTIONS

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	AS SHOWN
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

SHEET NO.

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