

BRANDYWINE SHAD 2020
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WILMINGTON, DELAWARE 19801
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www.brandywineshad2020.org

July 7, 2020

Julie R. Molina
Delaware Department of Natural Resources and Environmental Control
Wetlands and Subaqueous Lands Section
89 Kings Highway
Dover, DE 19901

RE: Brandywine Shad 2020 - Subaqueous Lands Permit Application/Federal Consistency Coordination for Removal of Dams 3, 4, and 6 for Anadromous Fish Passage along the Brandywine River

Dear Ms. Molina:

Brandywine Shad 2020 has prepared this Subaqueous Lands Permit Application for the removal of Dams No. 3, 4, and 6 to restore passage of anadromous fish and improve ecological function along the Brandywine River in the City of Wilmington, Delaware. Brandywine Shad 2020 (est. 2017) is a cross-section of educational organizations, nonprofits, governmental agencies, and private citizens with a goal is to restore the region's most historic fish, the American Shad, to the Brandywine River by the year 2020 by returning the river to its free-flowing, pre-colonial state. Founding members include the Brandywine Conservancy, Brandywine Red Clay Alliance, Hagley Museum and Library and University of Delaware Water Resources Center. This project is supported by the National Fish and Wildlife Foundation (NFWF) and the Delaware River Basin Conservation Act of 2016. The schedule calls for permitting and removal of Dams 3, 4, and 6 by the end of 2020. At the request of the State Historic Preservation Office (SHPO), Brandywine Shad 2020 is conducting a cultural survey with the University of Delaware Center for Historic Architecture and Design (CHAD) to be submitted to you later in summer 2020. If you have any questions, please do not hesitate to contact me at 302-584-2728.

Sincerely,

Hunter Lott

H. Hunter Lott III, Director
Brandywine Shad 2020
Wilmington, Del.

Attachment 1: DNREC Subaqueous Lands/401 Water Quality Certification/Coastal Zone Application
Attachment 2: Delaware Dams along the Brandywine River
Attachment 3: Map of Delaware Dams along the Brandywine River
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cc: Ms. Kelly Williams, City of Wilmington Public Works Department
New Castle County
Federal/State Agencies

Attachment 1

DNREC Subaqueous Lands/401 Water Quality Certification/Coastal Zone Application

Attachment 2: Delaware Dams along the Brandywine Rivere (Dam 1 removed Fall 2019 and Dams 3, 4, and 6 to be removed highlighted)

Dam No.	Dam Name	River Mile	Latitude/ Longitude	Function	Height/ Width (ft.)	East Bank Parcel # Owner	West Bank Parcel # Owner	Status	Shad Production Potential	Historic?
1	West Street	2.1	39.75142/ -75.54760	Protect water supply from tidal influence. Encloses sewer pipes	3 ft. 176 ft.	2601340075 City of Wilmington	2601340075 City of Wilmington	Removed 2019	3,300	Wilmington Historic District
2	Brandywine Park/ Broom Street	2.9	39.75868/ -75.55502	City water intake; aesthetic (waterfall and mill race supply)	7 ft. 154 ft.	2601410006 City of Wilmington	2601340075 City of Wilmington		3,600	Wilmington Historic District
3	Augustine Mill	3.35	39.76491/ -75.55695	None known; was for industrial water supply	3 ft. 135 ft.	0614300001 State of Delaware	2600640050 2/3 Mill Road LLC	Breached	4,600	Bancroft Mills Historic District
4	Alpacas Run Park and Bancroft Mills	3.6	39.76861/ -75.55922	None known; was for water supply	4 ft. 150 ft.	0612700002 State of Delaware	2600620041 Rockford Falls Partners LLC	Damaged	6,700	Bancroft Mills Historic District
5	Brandywine Falls	4.2	39.77078/ -75.56919	Mill race supply; aesthetic; was for industrial water supply	8-10 ft. 200 ft.	0612700002 State of Delaware	2600230001 Brandy. Falls Condo Assoc.		7,700	TBD
6	DuPont	4.5	39.76959/ -75.57346	None known; possible backup water source	4-6 ft. 182 ft.	0612600002 E I DuPont Nemours & Co.	2600540002 City of Wilmington	Breached	9,000	TBD
7	Brick's Mill/Walker's Mill	4.8	39.77086/ -75.57903	Aesthetic; once fed two mill races	6 ft. 156 ft.	0612600001 Walkers Mill Associate LLC	703020017 Eutherian Mills-Hagley		10,700	National Historic Landmark
8	Henry Clay Mill/ Lower Hagley	5.2	39.77636/ -75.57531	National Historic Landmark, Aesthetic (waterfall), mill race	6-8 ft. 215 ft.	061170001 Eutherian Mills-Hagley	702700032 Eutherian Mills-Hagley		12,100	National Historic Landmark
9	Upper Hagley/ Birkenhead	5.7	39.78270/ -75.57107	National Historic Landmark, Aesthetic (waterfall), mill race	2 ft. 205 ft.	0610800002 Black Gates LLC	0702700032 Eutherian Mills-Hagley		13,000	National Historic Landmark
10	Eutherian Mills	6.2	39.78556/ -75.57740	National Historic Landmark, Aesthetic (waterfall), mill race	3 ft. 126 ft.	0609800002 Black Gates LLC	0702700032 Eutherian Mills-Hagley		16,400	National Historic Landmark
11	Rockland Mills	7.2	39.79757/ -75.57497	Part of Historic District. Once fed mill race. Aesthetic	7-8 ft. 135 ft.	0607500002 State of Delaware	0701900007 State of Delaware	Breached	26,600	National Historic Landmark

Attachment 3

Delaware Dams along the Brandywine River



Attachment 4

Photographs of Dams 3, 4, and 6 to be removed

Dam No. 3 in the Brandywine River is located at latitude 39.76491 and longitude -75.55695. The land on the west bank of the dam is parcel number 2600640050 and the owner is 2/3 Mill Road LLC. The east bank is parcel number 0614300001 and the owner is the State of Delaware. The dam is located at 3.35 river miles above the mouth of the Brandywine and has a height of approximately 3 to 6 ft. Dam 3 is in the Bancroft Mills Historic District and was historically used for industrial water supply, but currently has no use. Dam 3 is currently breached and will be removed from the left bank looking downstream to the middle of the channel approximately 65 feet. The estimated shad production potential is 4,600 fish.



Dam 3 Existing



Dam 3 Removed and Channel Restored



Augustine Dam 3, breached



Augustine Dam 3, breached

Dam No. 4 in the Brandywine River is located at Alpacas Run Park and Bancroft Mills at latitude 39.76861 and -75.55922 longitude; the Delaware Department of Natural Resources and Environmental Control owns the dam. The land of the west bank of the dam is parcel number 2600620041 and the owner is Rockford Falls Partners LLC. The east bank is parcel number 0612700002 and the owner is the State of Delaware. The dam is located at 3.6 river miles above the mouth of the Brandywine and has a height of approximately 4 to 8 ft. Dam 4 was historically used for hydropower at Bancroft Mills and is in the Bancroft Mills Historic District. Dam 4 is damaged and has a cavity in the middle third of the structure and is a public safety hazard. Flood risk will be reduced by removing the dam in the center of the structure approximately 65 feet wide. The estimated shad production potential is 6,700.



Dam 4 Existing



Dam 4 Removed and Channel Restored



Bancroft Dam 4, damaged in center of dam



Bancroft Dam 4, damaged in center of dam

Dam No. 6 on the Brandywine River is located at the DuPont Experimental Station at latitude 39.76959 and - 75.57346 longitude, the DuPont Company owns most of the dam. The land of the south bank of the dam is parcel number 2600540002 and the owner is the City of Wilmington. The north bank is parcel number 0612600002 (N. Bank) and the owner is the E I DuPont Nemours & Co. The dam is located at 4.5 river miles above the mouth of the Brandywine and has a height of approximately 4 to 6 ft. Dam 6 currently is the hydraulic control structure for USGS stream gage Brandywine Creek at Wilmington. The estimated shad production potential is 9,000 fish.



Dam 6 Existing



Dam 6 Removed and Channel Restored



DuPont Dam 6, breached



DuPont Dam 6, breached



Hickory shad downstream of Brandywine River Dam 2, May 2020



American shad downstream of Brandywine River Dam 2, May 2020

Attachment 5

Preliminary Engineering Drawings of Dams 3, 4, and 6

Attachment 6

Sediment Quality Analysis

The Delaware Department of Natural Resources and Environmental Control's (DNREC) Watershed Approach to Toxics Assessment and Restoration (WATAR) program has partnered with Brandywine Shad 2020 (BS2020) to characterize sediment quality behind nine (9) dams in the Brandywine River and to evaluate if release of the sediments during dam removals/modifications, either catastrophic or planned, will cause adverse impacts to aquatic inhabitants or humans. BS2020 agreed to fund sample collection, while DNREC, through its WATAR program, agreed to fund sample analysis and conduct data evaluation.

To that end, on March 5, 2020, DNREC and AquaSurvey, Inc. (ASI) began sediment thickness probing, sediment coring, core logging and processing of composited sediment samples from multiple transects at each dam. Field activities commenced and sediment samples were successfully collected from multiple transects at dams 2, 4, 7, 8, and 11. However, on March 12, 2020, State mandated COVID-19 restrictions forced a postponement of further sampling activities. COVID-19 restrictions also impacted ongoing discussions regarding access to dam 5. Finally, on June 9 and 10, 2020, DNREC and ASI remobilized and successfully collected sediment samples from multiple transects at dams 6, 9 and 10. Sediment sampling at dam 5 will be completed at a later date.

All sediment samples collected between March and June 2020 have been transported to the DNREC contract laboratory (Eurofins TestAmerica in Edison, New Jersey) for analysis of chlorinated pesticides, polycyclic aromatic hydrocarbons (PAHs) including alkylated homologs, polychlorinated biphenyls (PCBs), dioxins and furans, TAL metals including mercury, per- and polyfluoroalkyl substances (PFASs), total organic carbon (TOC), and grain size.

Upon receipt, results of the chemical analyses of sediment will be used to evaluate potential risk to aquatic life and humans associated with their release to the river as a result of dam modification/removal. This will be accomplished by conducting equilibrium partitioning calculations and comparing the resulting predicted pore-water concentrations to compound specific freshwater acute and chronic toxicity values published in the State of Delaware Surface Water Quality Standards (DNREC 2011). In addition, laboratory analytical results will be used to evaluate whether the sediment contains contaminant concentrations exceeding risk-based criteria for the protection of human health and the environment in a land-based setting. For this evaluation, analytical results will be compared to the DNREC-Remediation Section's Screening Level Table (DNREC 2013), followed by activity-specific risk assessments. Last, probing data will be used to refine original estimates of sediment volumes behind each dam. Finally, a report will be prepared by DNREC's WATAR program that presents all of the data collected and associated evaluations. It is anticipated that the summary report will be available by the end of Summer 2020.

The WATAR Team's role in the sediment study is to:

- Develop a preliminary sediment sampling scheme at each dam based on aerial photography, an estimated volume, and areal coverage of the potential sediment wedge.
- Be on-site during field sampling to determine sampling locations and methodology based on field conditions.
- Receive samples from the collecting contractor, log and establish custody.
- Determine physical composition of sediment samples.
- Manage chemical testing of the samples by Test America Laboratories, Inc.

John Cargill (Hydrologist V) for the State of Delaware is in charge of the WATAR Team and can discuss the study.

John G. Cargill, IV, P.G., Hydrologist V

Department of Natural Resources and Environmental Control

Division of Watershed Stewardship/Watershed Assessment & Management Section 285 Beiser Blvd. Suite 102

Dover, DE 19904

(302) 739-9939 main - (302) 739-9477 direct

Email: john.cargill@delaware.gov or

Aqua Survey, Inc (ASI) is a 40-year old sampling, testing and consulting firm located in Flemington, New Jersey with a specialization in sediment projects. ASI has been conducting sampling and testing to characterize sediments since the issuance of the first “Green Book” back in 1977. ASI has worked on hundreds of sediment testing projects over the past 30 years, including projects in the Philadelphia, New England, New York, Galveston, Kansas City, the Great Lakes, Charleston, and Jacksonville Corps Districts. These projects include dredging, geotechnical, pipeline, and environmental assessment projects. ASI is subcontracted through Kleinschmidt and their role in the sediment study is to collect the sediment samples at all dams. They have been hired based on their expertise in sediment sampling and their creativity in approaching challenging sampling situations. Aqua Survey will use a slide hammer device with a 3-inch steel barrel and a flexible polyethylene core liner to collect up to 109 cores along 26 transects at 9 dams along the Brandywine. At each transect there will be 3 to 6 core samples collected based on preliminary estimations of the extent of the sediment wedge. The core sampler will be deployed by either walking when there is stable footing and the depth is shallow enough, working off plywood sheets or a similar stable platform in thick sediment in shallow water, or bracing two jon boats together as a work platform. This platform can be anchored and if possible, a line run across the creek to use as a guide and tie point along a transect.

Cores will be collected to an anticipated sediment wedge depth (at the dam) of 2-7 feet below the sediment surface or to point-of-refusal. Point-of-refusal may be caused by a variety of conditions including rock, large stones, gravel, debris and riprap. A petite ponar grab by be available for those areas exhibiting heavier coarse-grained material. Sample sites will be located by DGPS from coordinates provided by Kleinschmidt or visually located and precisely identified via DGPS. Some adjustment in the field to preliminary sample sites locations is expected. Retrieved cores will be relinquished to DNREC personnel. Aqua Survey will fill out core logs for each location and will take photos, as necessary. Samples for each transect will composited and composite samples will be tested at TestAmerica Laboratories Inc. for:

- PCBs by EPA Method 680
- Dioxins/Furans by EPA Method 1613
- Pesticides by EPA Method 8081
- PAHs plus alkylated homologs by Method 8270 SIM
- Metals (including Mercury) by EPA Methods 6020 and 7471, respectively
- Semivolatile Organic Compounds by EPA Method 8270
- Total Organic Carbon

The WATAR Team will make a determination on-site regarding Sediment Grain Size by method D422. By looking at the estimates of sediment volumes behind dams 4 through 6 proposed sampling requirements for complete removal, DNREC-SIRS is anticipating sampling at a rate of once per every 4,400 cubic yards. The estimates above do not include the standard quality assurance and quality control requirements that typically accompany HSCA sampling events. The quantity of these samples depend on sampling schedules, analytical methods used, and the method of sample collection. Assuming that several locations could be sampled in a day, the best estimate of 28 can be increased by 1 sample per dam for a total estimate of 37 samples for the entire project.

Table 1. Sediment volume behind dams 2 through 6

Dam	Dam height (ft)	Length (ft)	Calculated Area (ft ²)	Width (ft)	Volume (yds)
2	3	2,795.6	4,193.3	150	23,296
4	4	1,738.3	3,476.6	150	19,314
5	9.5	833.63	3,959.7	222	32,557
6	5.5	1,017.1	2,797	160	16,574



STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF WASTE AND HAZARDOUS SUBSTANCES
REMEDIATION SECTION

391 LUKEHS DRIVE
NEW CASTLE, DE 19720

TELEPHONE: (302) 395-2600
FAX: (302) 395-2601

November 8, 2019

Mr. Gerald Kauffman, Jr., Director
University of Delaware Water Resources Center
DGS Annex
261 Academy Street
Newark, DE 19716

RE: WATAR (DE-1525) Funding Letter for Dam #2 and #4 sediment analysis within the Brandywine River.

Dear Mr. Kauffman, Jr.:

As you are aware, The Delaware Department of Natural Resources and Environmental Control's (DNREC) Watershed Approach to Toxics Assessment and Restoration (WATAR) program has been in discussions with the Brandywine Shad 2020 group regarding physical and chemical characterization of sediments that are trapped behind dams within the Brandywine River. The purpose of the characterization is to evaluate if release of the sediments during dam removals, either catastrophic or planned, will cause adverse impacts to aquatic inhabitants, or humans, who may come in contact with them.

It is our understanding that characterization of sediments behind Dam #2 and Dam #4 is most desirable in the short term. To that end, DNREC can commit funding in the amount of \$17,000 for characterization of approximately nine (9) composited sediment samples/cores to be collected by another contractor behind Dams #2 and #4. Sediment samples will be analyzed by DNREC's contract laboratory (TestAmerica) for polychlorinated biphenyls (PCBs), dioxins & furans, pesticides, polynuclear aromatic hydrocarbons (PAHs) with alkylated homologs, metals (including mercury), grain size, and total organic carbon. Following data analysis, DNREC's WATAR team will also evaluate the data and make recommendations for disposition of the material, if necessary.

Should you have any questions, please do not hesitate to contact me at 302-395-2600 or via email at John.Cargill@Delaware.gov.

Sincerely,

John G. Cargill, IV, P.G.
Hydrologist V, WATAR Team Co-Lead

Sediment samples were collected in the Brandywine River in the pools behind Dams 3, 4, and 6 below the streambed at locations +20, +200, +400, and +600 ft upstream from each dam. The samples were analyzed for metals and textural class at the Delaware DNREC laboratory in Dover, Del. Table 1 summarizes the results of the sediment quality analysis with values compared to Delaware DNREC default background remediation standards. Sediment metal levels are below/above? the Delaware background remediation standards. Table 2 summarizes the results of the soil textural analysis.

Table 2. Sediment analysis at Brandywine River Dam 3, 4, and 6

Parameter	Date of Analysis	Station +20 ft (mg/kg)	Station +200 ft (mg/kg)	Station +400 ft (mg/kg)	Station +600 ft (mg/kg)	Sediment Background Standard ¹ (mg/kg)
Dam 3						
PCBs by EPA Method 680						
Dioxins/Furans by EPA Method 1613						
Pesticides by EPA Method 8081						
PAHs plus alkylated homologs by Method 8270 SIM						
Metals (including Mercury) by EPA Methods 6020 and 7471						
Semivolatile Organic Compounds by EPA Method 8270						
Total Organic Carbon						
Dam 4						
PCBs by EPA Method 680						
Dioxins/Furans by EPA Method 1613						
Pesticides by EPA Method 8081						
PAHs plus alkylated homologs by Method 8270 SIM						
Metals (including Mercury) by EPA Methods 6020 and 7471						
Semivolatile Organic Compounds by EPA Method 8270						
Total Organic Carbon						
Dam 6						
PCBs by EPA Method 680						
Dioxins/Furans by EPA Method 1613						
Pesticides by EPA Method 8081						
PAHs plus alkylated homologs by Method 8270 SIM						
Metals (including Mercury) by EPA Methods 6020 and 7471						
Semivolatile Organic Compounds by EPA Method 8270						
Total Organic Carbon						

1. Delaware DNREC, 1999. Remediation Standards Guidance Under the Delaware Hazardous Substance Cleanup Act.

Table 3. Sediment textural class at Brandywine River Dams 3, 4, and 6

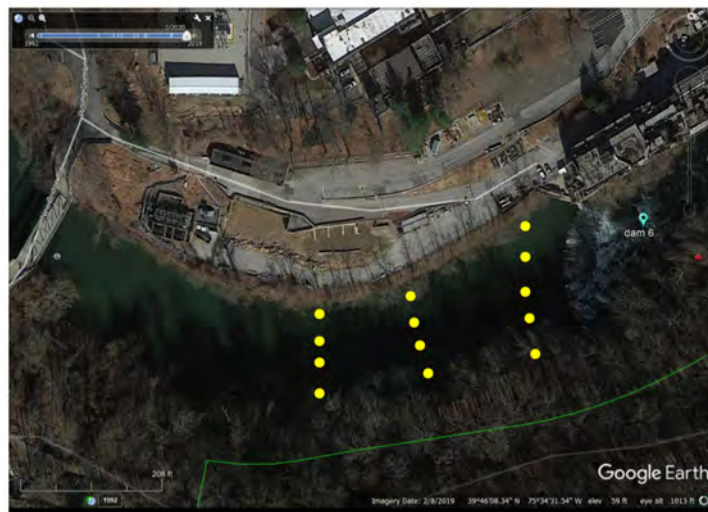
Sample ID	Sand (%)	Silt (%)	Clay (%)	Textural Class
Dam 3				
+20 ft				
+ 200 ft				
+ 400 ft				
+ 600 ft				
Dam 4				
+20 ft				
+ 200 ft				
+ 400 ft				
+ 600 ft				
Dam 6				
+20 ft				
+ 200 ft				
+ 400 ft				
+ 600 ft				



Dam 3 No Sediment Analysis Proposed



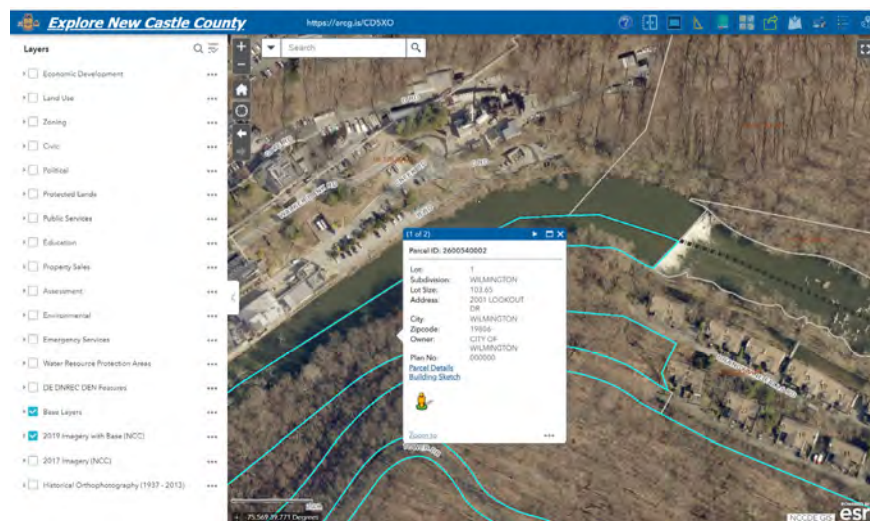
Dam 4 Sediment Analysis Transects



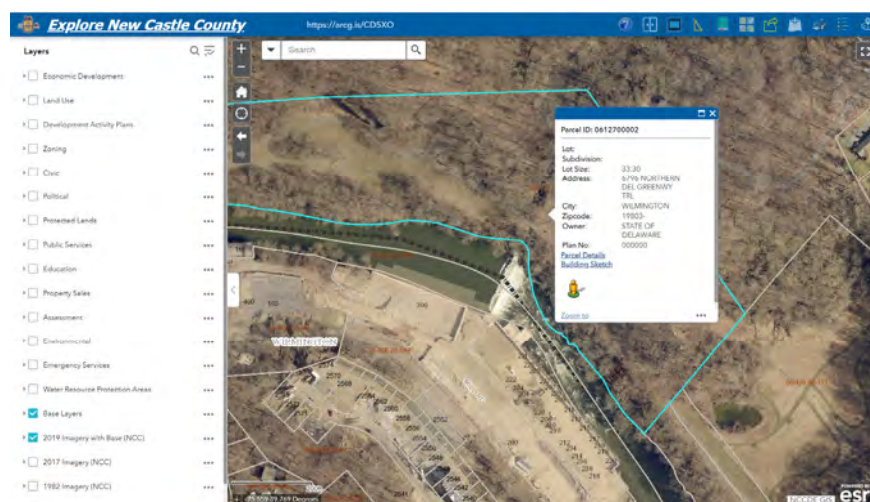
Dam 6 Sediment Analysis Transects



Dam 3 Parcel Boundaries



Dam 4 Parcel Boundaries



Dam 6 Parcel Boundaries

Attachment 7 HECRAS Hydraulic Analysis

The University of Delaware Water Resources Center conducted a hydraulic analysis using the U.S. Army Corps of Engineers HECRAS computer model to estimate changes in flow depth and velocity with and without Brandywine River Dams 3, 4, and 6 in place. The HECRAS model was obtained from FEMA, assembled, verified, and calibrated. We conducted a hydraulic analysis for with (existing) and without (proposed) dam conditions for the 100-yr flood and a range of low flow profiles for the spring spawning period of April through June (Table 1) using data from 1989-2019 for Brandywine Creek at Wilmington USGS stream gage 01479000 situated at Dam No. 6.

Table 1. Flow profiles modeled using HECRAS at Brandywine River Dams 3, 4, and 6

Flow Profile (March-June)	Q (cfs)
95% Exceedance	246
50% Exceedance (Median)	478
5% Exceedance	1418
100 yr	34,189

Tables 2, 3, and 4 summarize flow depth and velocity for the stream cross sections at Brandywine Dams 3, 4, and 6 for the median April through June flow during the critical spring spawning period and the 100-yr flood flow. Removal of Dams No. 3, 4, and 6 is projected to reduce median spring flow depths by -4.8, -4.4, and -7.4 ft, respectively (Table 5). After Dams 3, 4, and 6 are removed, median spring flow depths are projected to be 1.3 ft, 1.5 ft, and 0.9 ft, sufficient for anadromous species such as the American and hickory shad.

Flow velocities will increase median velocities by 3.1, 4.6, and 2.8 fps at each dam. After Dams 3, 4, and 6 are removed, median spring velocities will be 3.7, 5.4, and 2.8 fps sufficient for anadromous species such as the American and hickory shad. Increased velocities after dam removal are expected to carve a new pool and riffle streambed in the sandy gravel sediments that now lie at the bottom of the shallow impoundments.

Table 2. HECRAS hydraulics for existing/proposed dam removed at Brandywine River Dams 3, 4, and 6

Dam/ Flow Profile	Flow (cfs)	Existing Depth (ft)	Proposed Depth (ft)	Change Depth (ft)	Existing Velocity (ft/s)	Proposed Velocity (ft/s)	Change Velocity (ft/s)
Dam 3							
95% Exceedance	246	5.7	0.8	-4.9	0.4	3.0	+2.6
Median	478	6.1	1.3	-4.8	0.6	3.7	+3.1
5% Exceedance	1418	7.2	2.6	-4.6	1.5	5.2	+3.7
100-yr Flow	34,189	20.1	20.2	0.0	9.6	9.6	0.0
Dam 4							
95% Exceedance	246	5.6	1.0	-4.6	0.5	4.4	+3.9
Median	478	5.9	1.5	-4.4	0.8	5.4	+4.6
5% Exceedance	1418	6.9	2.6	-4.3	1.8	8.2	+6.4
100-yr Flow	34,189	17.5	12.8	-4.7	12.0	17.9	+5.9
Dam 6							
95% Exceedance	246	8.0	1.9	-6.1	0.2	2.5	+2.3
Median	478	8.3	0.9	-7.4	0.3	3.1	+2.8
5% Exceedance	1418	9.3	0.6	-8.7	0.8	4.4	+3.6
100-yr Flow	34,189	20.3	15.1	-5.2	7.8	11.0	+3.2

Table 3. HECRAS hydraulics for existing conditions at Brandywine River Dams 3, 4, and 6

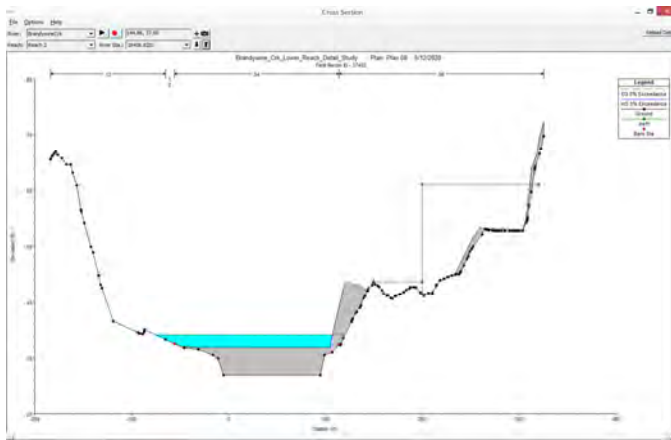
River	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Flow Depth	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
BrandywineCrk	18419.6	5% Exceedance	1418	23.1	27.9	4.8	2.8	110
BrandywineCrk	18419.6	50% Exceedance	478	23.1	26.0	2.9	1.6	106
BrandywineCrk	18419.6	95% Exceedance	246	23.1	25.3	2.2	1.1	104
BrandywineCrk	18419.6	100-yr Flow	34,189	23.1	47.1	24.0	8.5	372
BrandywineCrk	18458.82		Dam 3					
BrandywineCrk	18472.53	5% Exceedance	1418	26.9	34.1	7.2	1.5	195
BrandywineCrk	18472.53	50% Exceedance	478	26.9	33.0	6.1	0.6	179
BrandywineCrk	18472.53	95% Exceedance	246	26.9	32.6	5.7	0.4	173
BrandywineCrk	18472.53	100-yr Flow	34,189	26.9	47.0	20.1	9.6	381
BrandywineCrk	19960.12	5% Exceedance	1418	29.1	34.4	5.3	2.5	110
BrandywineCrk	19960.12	50% Exceedance	478	29.1	33.1	4.0	1.2	108
BrandywineCrk	19960.12	95% Exceedance	246	29.1	32.7	3.6	0.7	107
BrandywineCrk	19960.12	100-yr Flow	34,189	29.1	51.0	22.0	10.3	218
BrandywineCrk	19996.21		Dam 4					
BrandywineCrk	20006.35	5% Exceedance	1418	40.0	46.9	6.9	1.8	193
BrandywineCrk	20006.35	50% Exceedance	478	40.0	45.9	5.9	0.8	190
BrandywineCrk	20006.35	95% Exceedance	246	40.0	45.6	5.6	0.5	189
BrandywineCrk	20006.35	100-yr Flow	34,189	40.0	57.5	17.5	12.0	218
BrandywineCrk	22953.41	5% Exceedance	1418	58.8	61.1	2.3	6.0	151
BrandywineCrk	22953.41	50% Exceedance	478	58.8	59.7	0.9	5.1	102
BrandywineCrk	22953.41	95% Exceedance	246	58.8	59.4	0.6	4.3	101
BrandywineCrk	22953.41	100-yr Flow	34,189	58.8	73.6	14.8	11.5	287
BrandywineCrk	22976.07		Dam 5					
BrandywineCrk	22995.66	5% Exceedance	1418	63.9	70.1	6.2	1.2	268
BrandywineCrk	22995.66	50% Exceedance	478	63.9	69.3	5.4	0.5	259
BrandywineCrk	22995.66	95% Exceedance	246	63.9	69.0	5.1	0.3	256
BrandywineCrk	22995.66	100-yr Flow	34,189	63.9	80.06	16.2	9.3	377
BrandywineCrk	24415.89	5% Exceedance	1418	65.9	73.4	7.5	1.6	159
BrandywineCrk	24415.89	50% Exceedance	478	65.9	72.0	6.1	0.7	153
BrandywineCrk	24415.89	95% Exceedance	246	65.9	71.5	5.6	0.4	147
BrandywineCrk	24415.89	100-yr Flow	34,189	65.9	87.99	22.1	9.3	265
BrandywineCrk	24490.22		Dam 6					
BrandywineCrk	24525.16	5% Exceedance	1418	72.0	81.3	9.3	0.8	214
BrandywineCrk	24525.16	50% Exceedance	478	72.0	80.3	8.3	0.3	206
BrandywineCrk	24525.16	95% Exceedance	246	72.0	80.0	8.0	0.2	205
BrandywineCrk	24525.16	100-yr Flow	34,189	72.0	92.3	20.3	7.8	390

Table 4. HECRAS hydraulics for proposed (dam removal) conditions at Brandywine River Dams 3, 4, and 6

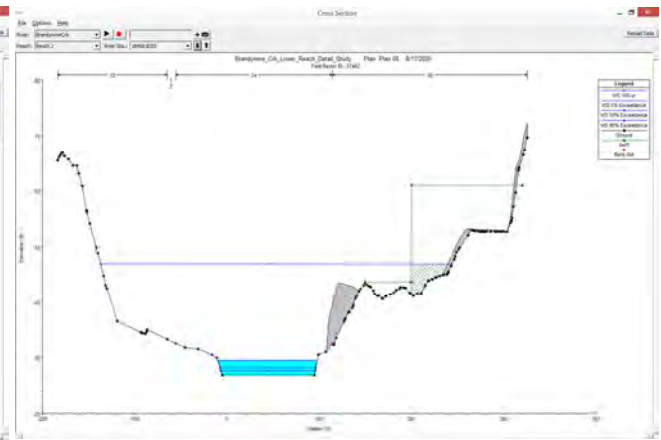
River	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Flow Depth	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
BrandywineCrk	18419.6	5% Exceedance	1418	23.1	27.9	4.8	2.8	110
BrandywineCrk	18419.6	50% Exceedance	478	23.1	26.0	2.9	1.6	106
BrandywineCrk	18419.6	95% Exceedance	246	23.1	25.3	2.2	1.1	104
BrandywineCrk	18419.6	100-yr Flow	34093	23.1	47.1	24.0	8.5	372
BrandywineCrk	18458.82		Dam 3					
BrandywineCrk	18472.53	5% Exceedance	1418	26.9	29.5	2.6	5.2	108
BrandywineCrk	18472.53	50% Exceedance	478	26.9	28.2	1.3	3.7	104
BrandywineCrk	18472.53	95% Exceedance	246	26.9	27.7	0.8	3.0	102
BrandywineCrk	18472.53	100-yr Flow	34093	26.9	47.1	20.2	9.6	387
BrandywineCrk	19960.12	5% Exceedance	1418	29.1	31.8	2.7	5.1	105
BrandywineCrk	19960.12	50% Exceedance	478	29.1	29.9	0.8	5.3	102
BrandywineCrk	19960.12	95% Exceedance	246	29.1	29.6	0.5	4.3	101
BrandywineCrk	19960.12	100-yr Flow	34070	29.1	51.0	21.9	10.3	218
BrandywineCrk	19996.21		Dam 4					
BrandywineCrk	20006.35	5% Exceedance	1418	40.0	42.6	2.6	8.2	83
BrandywineCrk	20006.35	50% Exceedance	478	40.0	41.5	1.5	5.4	69
BrandywineCrk	20006.35	95% Exceedance	246	40.0	41.0	1.0	4.4	62
BrandywineCrk	20006.35	100-yr Flow	34070	40.0	52.8	12.8	17.9	210
BrandywineCrk	22953.41	5% Exceedance	1418	58.8	61.1	2.3	5.9	151
BrandywineCrk	22953.41	50% Exceedance	478	58.8	59.9	1.1	4.4	102
BrandywineCrk	22953.41	95% Exceedance	246	58.8	59.6	0.8	3.2	102
BrandywineCrk	22953.41	100-yr Flow	34070	58.8	73.6	14.8	11.5	287
BrandywineCrk	22976.07		Dam 5					
BrandywineCrk	22995.66	5% Exceedance	1418	63.9	70.1	6.2	1.1	268
BrandywineCrk	22995.66	50% Exceedance	478	63.9	69.3	5.4	0.5	259
BrandywineCrk	22995.66	95% Exceedance	246	63.9	68.9	5.0	0.3	256
BrandywineCrk	22995.66	100-yr Flow	34070	63.9	80.1	16.2	9.3	377
BrandywineCrk	24415.89	5% Exceedance	1418	65.9	70.8	4.9	2.8	114
BrandywineCrk	24415.89	50% Exceedance	478	65.9	69.4	3.5	1.3	107
BrandywineCrk	24415.89	95% Exceedance	246	65.9	69.0	3.1	0.8	106
BrandywineCrk	24415.89	100-yr Flow	33720	65.9	86.9	21.0	10.4	259
BrandywineCrk	24490.22		Dam 6					
BrandywineCrk	24525.16	5% Exceedance	1418	72.0	73.9	1.9	4.4	187
BrandywineCrk	24525.16	50% Exceedance	478	72.0	72.9	0.9	3.1	185
BrandywineCrk	24525.16	95% Exceedance	246	72.0	72.6	0.6	2.5	184
BrandywineCrk	24525.16	100-yr Flow	33720	72.0	87.1	15.1	11.0	337

Table 5. Change in HECRAS hydraulics due to removal of Brandywine River Dams 3, 4, and 6

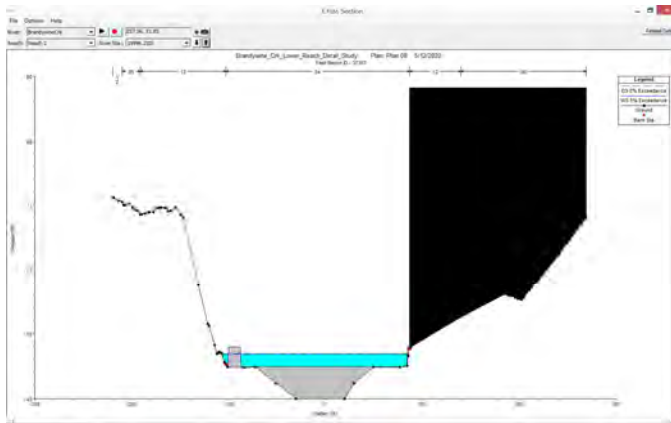
River	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Flow Depth	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
BrandywineCrk	18419.6	5% Exceedance	1418	23.1	0.0	0.0	0.0	0.3
BrandywineCrk	18419.6	50% Exceedance	478	23.1	0.0	0.0	0.0	0.2
BrandywineCrk	18419.6	95% Exceedance	246	23.1	0.0	0.0	0.0	-0.3
BrandywineCrk	18419.6	100-yr Flow	34093	23.1	0.0	0.0	0.0	0.0
BrandywineCrk	18458.82		Dam 3					
BrandywineCrk	18472.53	5% Exceedance	1418	26.9	-4.6	-4.6	3.7	-87.2
BrandywineCrk	18472.53	50% Exceedance	478	26.9	-4.8	-4.8	3.1	-74.7
BrandywineCrk	18472.53	95% Exceedance	246	26.9	-4.9	-4.9	2.6	-70.8
BrandywineCrk	18472.53	100-yr Flow	34093	26.9	0.1	0.1	0.0	6.0
BrandywineCrk	19960.12	5% Exceedance	1418	29.1	-2.6	-2.6	2.6	-5.2
BrandywineCrk	19960.12	50% Exceedance	478	29.1	-3.2	-3.2	4.2	-6.0
BrandywineCrk	19960.12	95% Exceedance	246	29.1	-3.1	-3.1	3.6	-6.2
BrandywineCrk	19960.12	100-yr Flow	34070	29.1	0.0	-0.1	0.0	0.0
BrandywineCrk	19996.21		Dam 4					
BrandywineCrk	20006.35	5% Exceedance	1418	40.0	-4.3	-4.3	6.4	-109.8
BrandywineCrk	20006.35	50% Exceedance	478	40.0	-4.4	-4.4	4.6	-120.8
BrandywineCrk	20006.35	95% Exceedance	246	40.0	-4.6	-4.6	3.9	-126.7
BrandywineCrk	20006.35	100-yr Flow	34070	40.0	-4.7	-4.7	5.9	-8.0
BrandywineCrk	22953.41	5% Exceedance	1418	58.8	0.0	0.0	0.0	-0.3
BrandywineCrk	22953.41	50% Exceedance	478	58.8	0.2	0.2	-0.7	0.1
BrandywineCrk	22953.41	95% Exceedance	246	58.8	0.2	0.2	-1.1	0.9
BrandywineCrk	22953.41	100-yr Flow	34070	58.8	0.0	0.0	0.0	0.0
BrandywineCrk	22976.07		Dam 5					
BrandywineCrk	22995.66	5% Exceedance	1418	63.9	0.0	0.0	0.0	-0.4
BrandywineCrk	22995.66	50% Exceedance	478	63.9	0.0	0.0	0.0	-0.4
BrandywineCrk	22995.66	95% Exceedance	246	63.9	0.0	0.0	0.0	-0.2
BrandywineCrk	22995.66	100-yr Flow	34070	63.9	0.0	0.0	0.0	0.0
BrandywineCrk	24415.89	5% Exceedance	1418	65.9	-2.6	-2.6	1.2	-45.5
BrandywineCrk	24415.89	50% Exceedance	478	65.9	-2.6	-2.6	0.6	-45.7
BrandywineCrk	24415.89	95% Exceedance	246	65.9	-2.5	-2.5	0.4	-40.7
BrandywineCrk	24415.89	100-yr Flow	33720	65.9	-1.1	-1.1	1.1	-6.0
BrandywineCrk	24490.22		Dam 6					
BrandywineCrk	24525.16	5% Exceedance	1418	72.0	-7.4	-7.4	3.6	-26.8
BrandywineCrk	24525.16	50% Exceedance	478	72.0	-7.4	-7.4	2.8	-20.8
BrandywineCrk	24525.16	95% Exceedance	246	72.0	-7.4	-7.4	2.3	-21.0
BrandywineCrk	24525.16	100-yr Flow	33720	72.0	-5.2	-5.2	3.2	-53.0



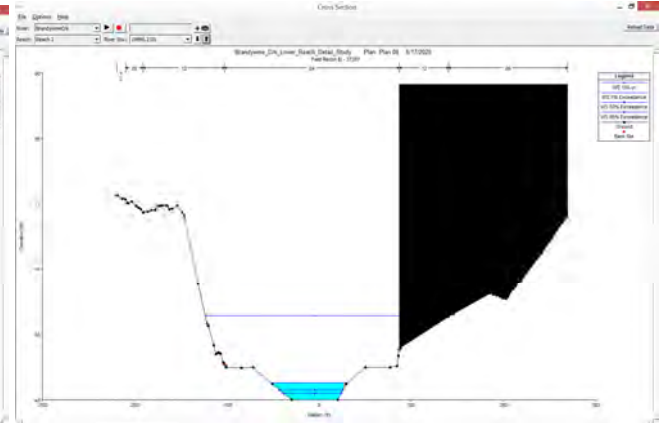
Dam 3



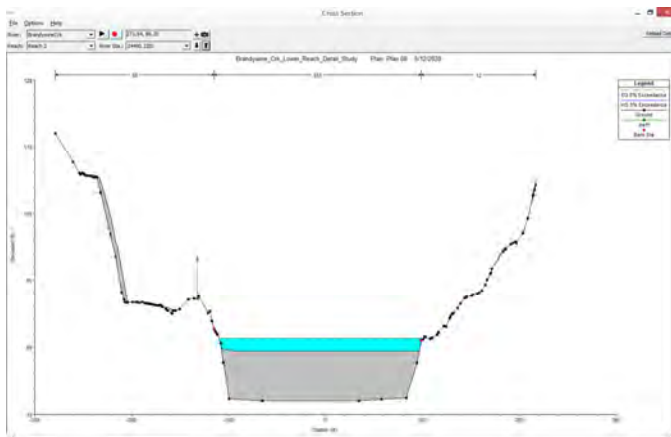
Dam 3 removed



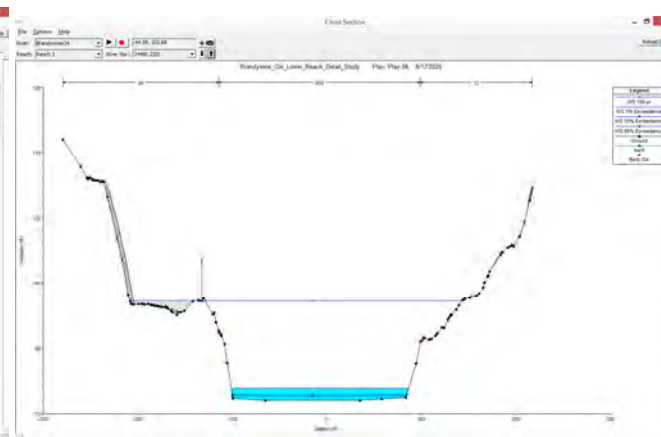
Dam 4



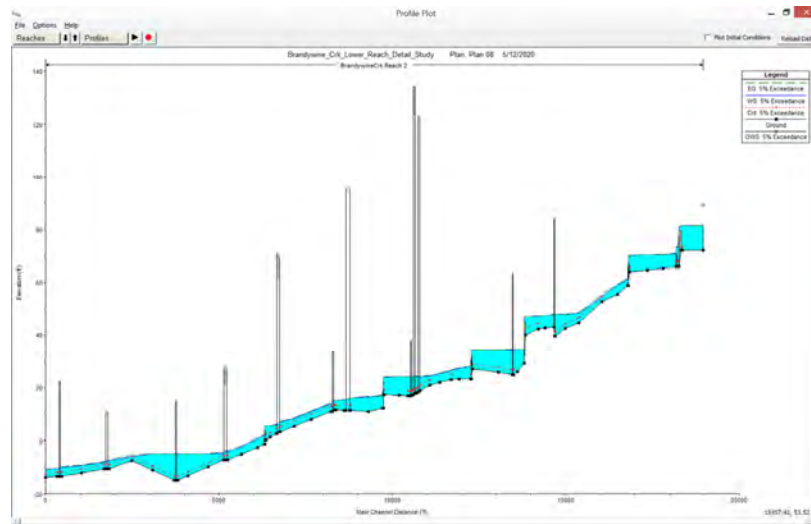
Dam 4 Removed



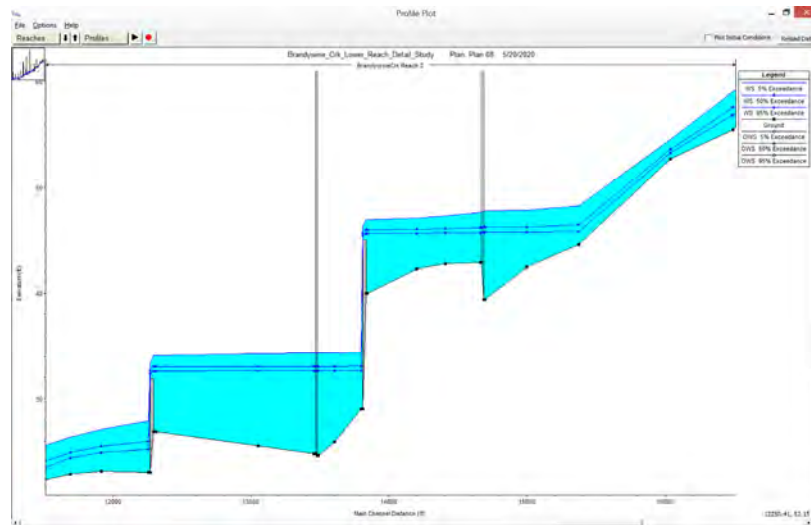
Dam 6



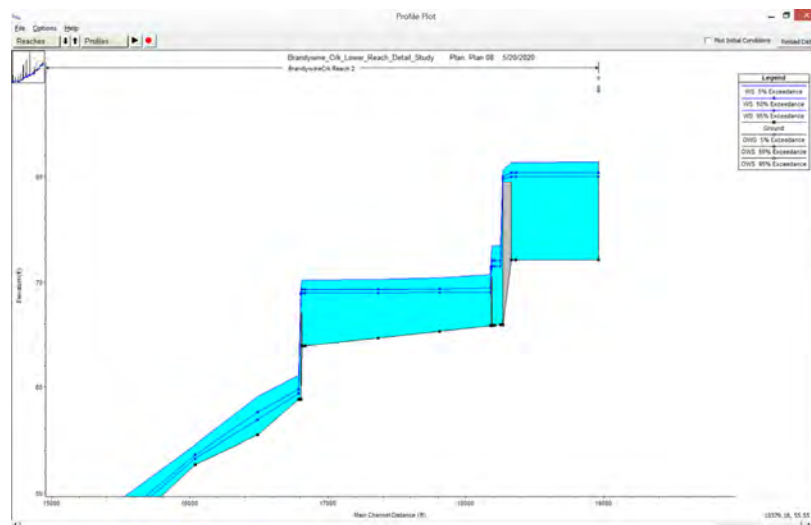
Dam 6 removed



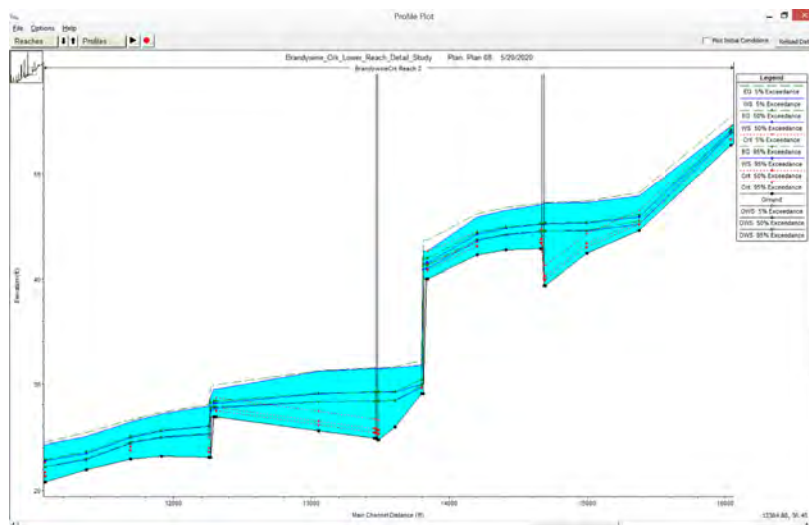
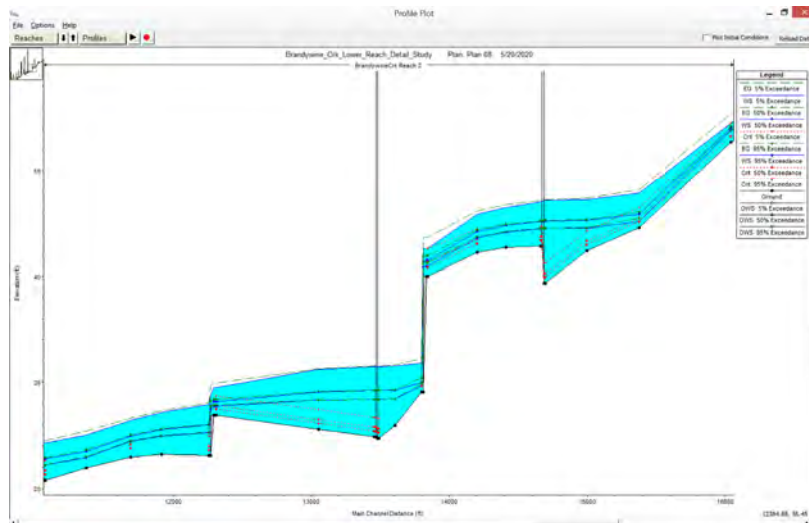
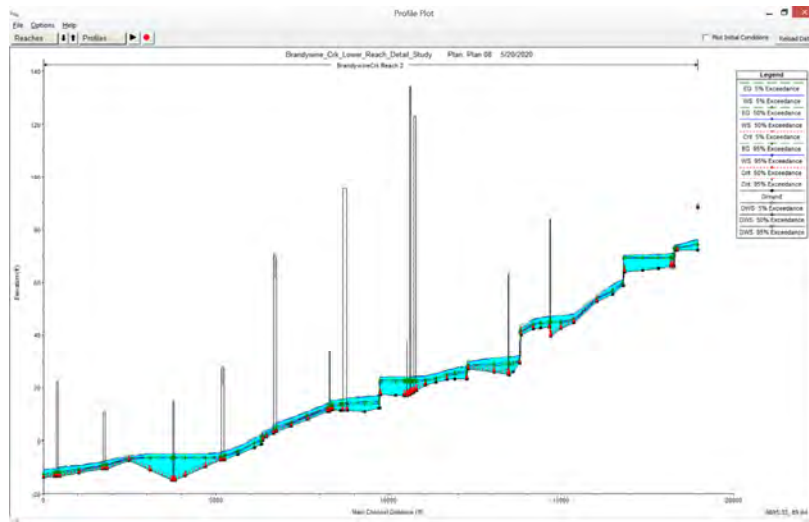
Brandywine River Profile Existing



Brandywine River Dam 3 and 4 Existing



Brandywine River Dams 5 and 6 Existing



Attachment 8

Cultural/Historic Review

Scope: The University of Delaware Center for Historic Architecture and Design (CHAD) will prepare a cultural and historic survey to obtain approval from the Delaware State Historic Preservation Office (SHPO) to partially remove Brandywine River Dams 3, 4, and 6 to provide passage for anadromous fish populations such as the American shad. In compliance with Section 106 of the National Historic Preservation Act and its implementing regulations under 36 CFR Part 800, Brandywine Shad 2020 has determined that because of the nature and scope of this undertaking, the proposed project has the potential to cause effects to historic properties if any such exist in the project area. Thus, Brandywine Shad 2020 is initiating Section 106 consultation with the Delaware State Historic Preservation Office (DE SHPO). Because a U.S. Army Corp of Engineers (USACE) permit will be required to conduct the work, USACE will serve as the lead federal agency for this undertaking. The scope of work includes:

1. Cultural Resource Survey form and digital photographs of the dam and raceway
2. Narrative history/description of dam. Evaluation of potential eligibility for National Register of Historic Places
3. Physical documentation in the form of a measured site plan showing the dam and raceway, and a section drawing showing the construction features of the timber dam
4. Sequence of maps/site plans showing changes in creek/raceway and relationship to mills
5. Preservation Covenant
6. Memorandum of Agreement

Project Description: Brandywine Shad 2020 is taking a unique watershed approach to dam removal, which has the potential to be the nation's biggest dam removal project across a single watershed. Brandywine Shad 2020, formed in 2017, includes a cross-section of educational organizations, nonprofits, governmental agencies, and private citizens whose shared goal is to restore the region's most historic fish, the American Shad, to the Brandywine River by the year 2020 by returning the river to its free-flowing, pre-colonial state. Founding members include the Brandywine Conservancy, Hagley Museum and Library, and the University of Delaware Water Resources Center.

Possible Area of Potential Effect / Initial Identification Efforts: Brandywine Shad 2020 has identified involved resources that are listed in the National Register of Historic Places (NRHP), and properties that might be considered eligible for listing that are located within the geographic area of the potential effect (APE) of the proposed project. As a means to identify historic properties under 36 CFR 800.4, we have completed a preliminary review of available information on previously identified historic properties to determine if any are located within the APE of this undertaking. The review of existing information revealed that:

- Dam 2 is listed as a contributing element to the Brandywine Park Historic District listed on the National Register of Historic Places in 1976 (CRS# N01566.024).
- Dam 4 is listed as a contributing element to the Bancroft and Sons Cotton Mills Historic District listed on the National Register of Historic Places in 1984 (CRS# N03646.048).

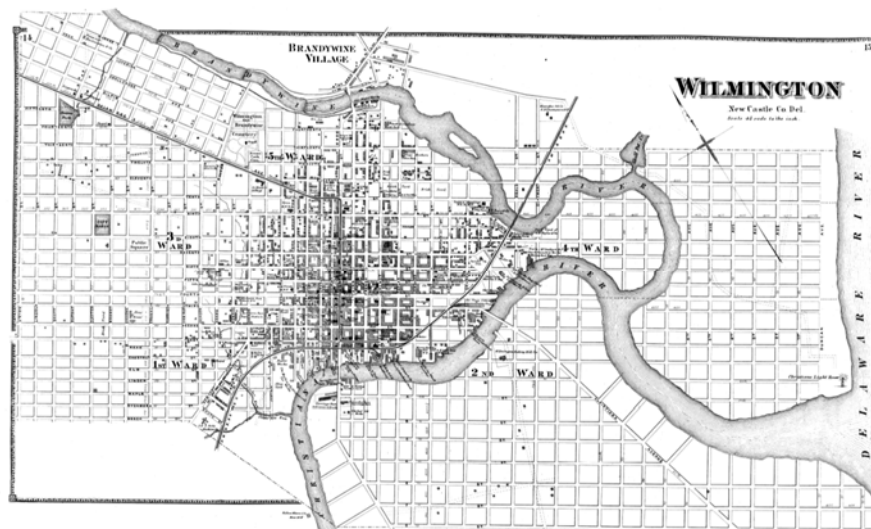
Consulting Parties: We are requesting the DE SHPO's assistance in identifying any individuals or organizations that may wish to be invited to be consulting parties on the proposed project (800.3 (f)). Consulting parties are also invited to provide information concerning any archaeological properties already listed on the National Register of Historic Places or that could be eligible for listing that are not identified in this letter. Please provide any further recommendations you might have for effectively involving the public in the Section 106 review (800.3(e)).

The project schedule calls for completion of permitting in 2020 and removal of dams 3, 4, and 6 by December 2020. DNREC fisheries biologists advise that work in the stream should not occur during the March 15-June 15 spawning period.

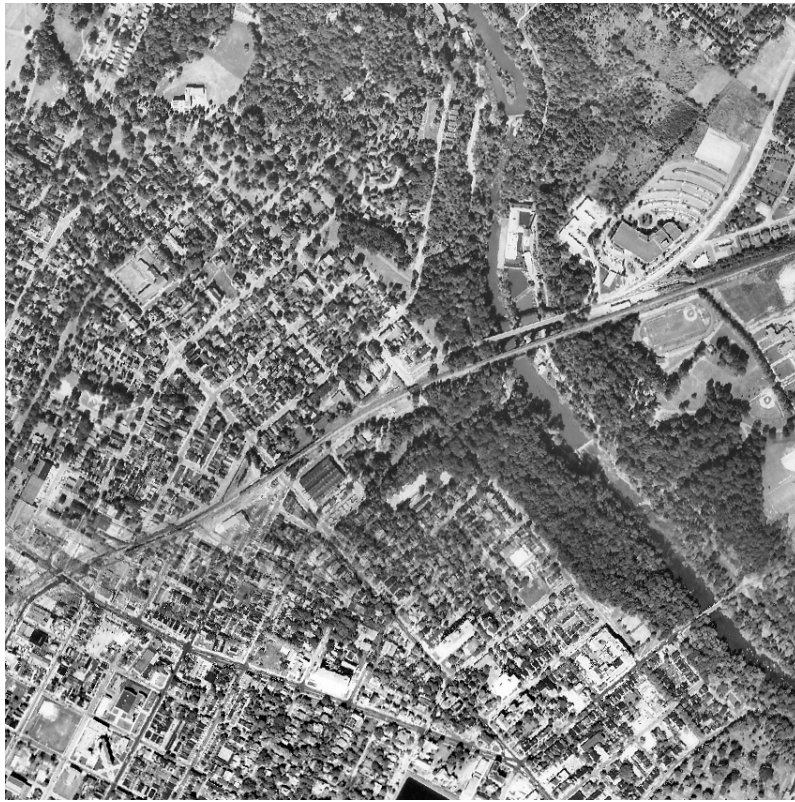
Chronology: For millennia long before the Europeans set foot in the New World the indigenous people, the Lenni Lenape, knew the Brandywine as the river of the long fish (the Atlantic sturgeon). In 1688, the village of Queonemysing [DS1] stood along the river near William Penn's 1682 circular arc boundary near where Smiths Bridge Road covered bridge is today. Founder of the Brandywine Conservancy Frolic Weymouth preserved the river-side land of the Lenape village on the big bend that flows down into Delaware then back up into Pennsylvania then back down into Delaware again.

The steep gradient of the Brandywine and proximity to sea transport made it the ideal place for the Colonists to construct their mills to transport their goods on the shallops[DS2] and sailing ships that would moor at the docks just yards away from the mills. In 1687, Swedish surgeon Dr. Tyman Stidham built the first barley mill along the Brandywine at the head of tide near the old Dam No. 1. By 1727 the lower reach in Wilmington or *Paxahakink* had 6 dams with 12 mills, 6 on each bank[DS3] and the Lenape petitioned the British Governor to remove the dams to allow the shad to spawn again. In 1742, Oliver Canby sold his flour mill to Joseph Tatnall and the Brandywine had dozens of dams.[DS4]. By 1756, the Brandywine Commission began removing dams to restore the fishery in one of the first riparian water rights actions under British common law. In 1787 at the end of the American Revolution, Gilpin of Chadds Ford built the first grist mill. By 1793, Maynard recorded that the Brandywine was packed to the gills with 50 flour mills milling 91,500 barrels, 50 sawmills sawing 1,000 plank feet[DS5] per day, 8 forges, 4 grist mills, 4 paper mills, and one snuff mill.

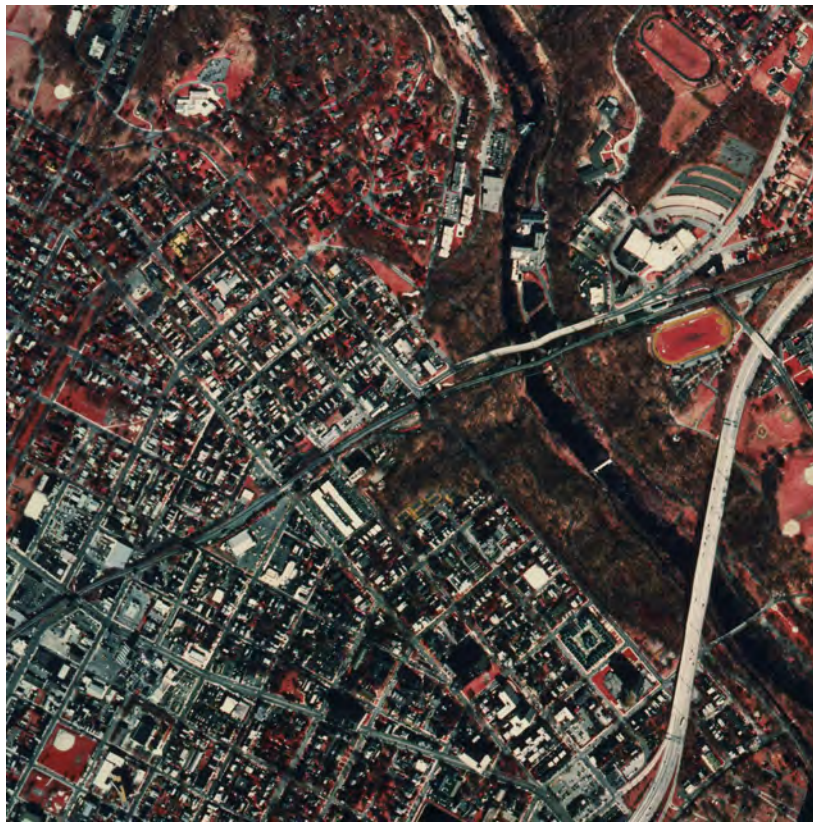
In 1802, the DuPonts searched up and down the Eastern seaboard and settled on the Brandywine as the site of their gunpowder mills, as the river fell from 160 ft above sea level to tidewater (higher than Niagara Falls) in just a few short miles. In 1825, the Marquis de Lafayette returned to the 1777 Battle of the Brandywine site and toured the Hagley Mills with the DuPonts and marveled at the intricacies of American engineering. In 1883, the William Bancroft textile mills above Wilmington were thriving and with foresight the proceeds were used to secure open land in the upper valley for the workers. This land was entrusted to the Woodlawn Trustees later became Delaware's first national park in 2015 when Barack Obama designated First State National Monument by Executive Order under the 1906 Antiquities Act. The Brandywine is also the valley of Pyle and Wyeth and in the late 19th century the Wilmington commissioners asked Frederick Law Olmsted's firm to weigh in on the design of Brandywine Park near Dam 2. The American Industrial Revolution began right here with hydropower from centuries old mill dams along the Brandywine--it was the Silicon Valley of their day.



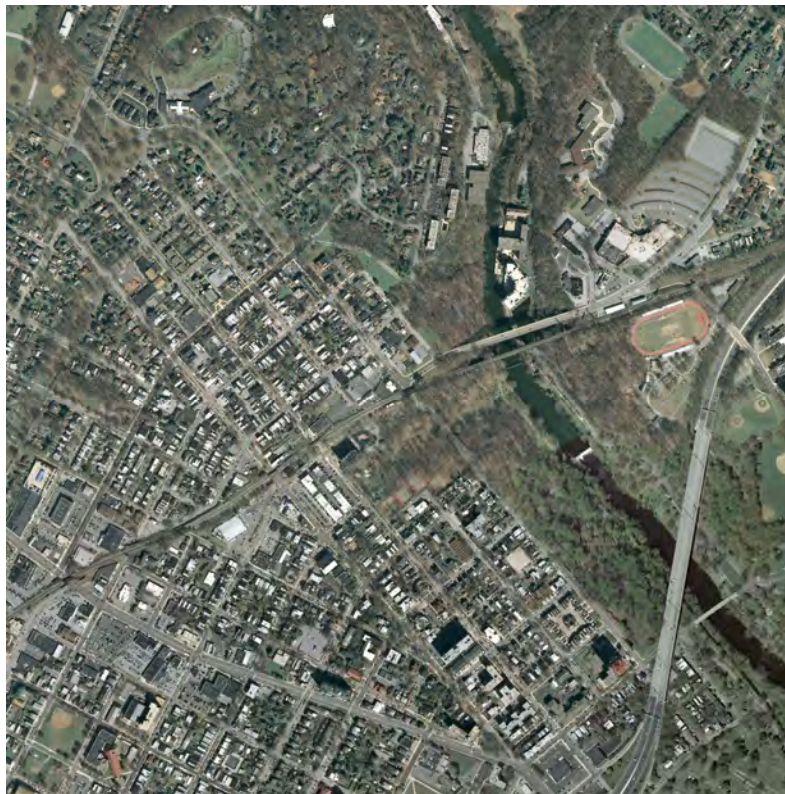
1868 Beers Atlas



Brandywine River 1961



Brandywine River 1993



Brandywine River 2010

TABLE 1
INVENTORY OF NON-FEDERAL DAMS IN DELAWARE

NEW CASTLE COUNTY																		
DAM NO.	PRINCIPAL NAME (Secondary Name)	LOCATION		REPORTED OWNER OF DAM	STREAM	DOWNSTREAM FLOOD- LATION CENTER Name Distance (ft)	TYPE OF DAM	YEAR CONSTR.	FUR- POSE	AREA (HP.) (A)	DAM HEIGHT (FT.) (Hr. Hydr.)		INF. CAP. (A.F.T.) Max. Nor.		INFORMATION SOURCE			
		Lat. N	Long. W								Str.	Hydr.	Locn.	Acra	St.			
DAMS REPORTED TO CORPS OF ENGINEERS - PART I DATA SHEETS																		
11	Bellevue Lake	39°46.8'	75°29.3'	Wil. Suburb. Water Co.	Stoney Creek	Bellevue	0	PC	1930	S	14	7	6	300	200	103	C(6)	G(6)
12	Edgemoor Reservoir	39 43.4	75 31.3	Wil. Suburb. Water Co.	Shellpot Cr.	Wilmington	0	PC	1909	S	5	15	12	65	60	102	C(6)	C(6)
13	Porter Reservoir	39 46.4	75 32.6	City of Wilmington	Park Run	Wilmington	1	PC	1900	S	6	23	16	107	109	102	C(6)	C(6)
14	Cool Spring Reservoir	39 45.1	75 33.6	City of Wilmington	Brandywine Cr.	Wilmington	0	PC	1880	S	7	23	20	123	120	102	C(6)	C(6)
15	Edgar H. Rogers Reservoir	39 42.4	75 38.1	City of Wilmington	Red Clay Cr.	Cransford Rpts.	1	PC	1912	S	191	115	102	6300	6300	101	C(6)	C(6)
45	Brandywine Creek #9 (Rockland)	39 47.5	75 34.5	Bissell & Vinton Assoc.	Brandywine Cr.	Wilmington	5	PC	1800	R	20	11	10	113	113	101	C(6)	B(6)
46	Sunset Lake (Silver Lake)	39 37.5	75 42.5	Howark Anglers Club	White Clay Cr.	Christiana	5	PC	1916	R, I	42	13	10	250	250	108	C(6)	B(6)
47	Becks Pond (Battens)	39 37.5	75 42.2	Del. Fish & Wildlife	White Clay Cr.	Christiana	4	CR	1938	R	21	15	12	90	75	108	B(6)	B(6)
48	Christiana Creek (Shalleys)	39 39.2	75 40.3	Wil. Suburb. Water Co.	Christiana R.	Christiana	2	PC	1907	S	19	18	12	84	80	105	B(6)	B(6)
49	Shallcross Lake	39 38.7	75 39.6	Del. Ang. & Cannery	Brandywine Cr.	Nona	-	PC	1921	R	43	10	6	130	130	101	C(6)	C(6)
50	Nonantum Pond	39 36.1	75 41.0	Mrs. Wm. T. Ellison	Appaquimink	Odessa	6	VA	1774	R	178	12	6	400	400	101	C(6)	C(6)
51	Silver Lake	39 26.4	75 41.6	Fred Carey	Swamp Cr.	Odessa	5	PC	1945	R	38	12	10	145	145	101	C(6)	C(6)
52	Wiggins Hill Pond	39 26.1	75 42.4	Mrs. U. L. Dugan	Appaquimink	Odessa	6	CR	1960	R	21	15	12	85	85	101	C(6)	C(6)
53	Shadobrook	39 45.3	75 38.8	Garret Copeland	Burreughs St.	RR, Cuba	3	PC	1937	R	13	22	20	100	100	101	C(6)	C(6)
DAMS NOT LISTED IN CORPS OF ENGINEERS - PART I DATA SHEETS																		
5	Rodney St. Reservoir	39 45.0	75 35.9	City of Wilmington	Brandywine Cr.	Wilmington	0	PC	1916	S	2	20	17	31	23	102	C(6)	C(6)
7	Wilmington C. C. Reservoir	39 47.8	75 35.6	Wilmington Country Cl.	Wilson Run	Wilmington	1	RE, PC	1960	R, I	4	30	26	43	40	102	C(6)	C(6)
8	Winterthur Upper Reservoir	39 48.5	75 36.5	Winterthur Museum	Wilson Run	Rockland	2	RE, PC	1959	T, R	4	25	15	25	24	67	C(6)	C(6)
9	Winterthur Lower (B. Barn Pond)	39 48.2	75 35.7	Winterthur Museum	Wilson Run	Rockland	2	PC	1965	I	2	8	5	4	4	102	C(6)	C(6)
9	Winterthur - Wildlife	39 48.5	75 35.8	Winterthur Museum	Wilson Run	Rockland	2	PC	1965	I, R	2	15	12	9	9	102	C(6)	C(6)
9	Chestnut Run Reservoir	39 43.0	75 36.1	Du Pont Co.	Chestnut Run W.R.	Elsmore	1	RE, PC	1930	I	1	10	10	8	8	62	C(6)	C(6)
10	Nassau	39 47.0	75 34.0	St. Joseph Paper Co.	Bunbards Run	Wilmington	1	PC	1929	I, R	2	30	26	24	20	102	C(6)	C(6)
11	Twin Lakes	39 46.5	75 36.1	Geo. T. Weymouth	Brandywine Cr.	Greenville	1	PC	1935	R	11	10	6	44	44	102	I	I
12	Sideman Reservoir	39 48.9	75 35.9	Sideman Golf Club	Wells	Rockland	1	PC	1964	I	3	10	8	10	8	102	C(6)	C(6)
13	Brandywine Creek #1	39 45.1	75 35.9	City of Wilmington	Brandywine Cr.	Wilmington	0	PC	1909	0	16	8	7	40	40	102	C(6)	C(6)
14	Brandywine Creek #2	39 45.5	75 35.3	City of Wilmington	Brandywine Cr.	Wilmington	0	PC	1909	0	9	10	8	25	25	102	C(6)	C(6)
15	Brady Cr. #3 (Sawcrott Lower)	39 45.9	75 35.4	Coxsacker Corp	Brandywine Cr.	Wilmington	1	PC	1909	S	2	10	8	19	10	102	C(6)	C(6)
16	Brady Cr. #4 (Sawcrott)	39 46.1	75 35.5	Wilm. Finishing Co.	Brandywine Cr.	Wilmington	2	PC	1909	S	4	8	6	19	10	102	C(6)	C(6)
17	Brady Cr. #5 (Sawcrott Upper)	39 46.2	75 34.2	Wilm. Finishing Co.	Brandywine Cr.	Wilmington	2	PC	1909	S	5	15	8	15	15	102	C(6)	C(6)
18	Brady Cr. #6	39 46.1	75 34.3	Du Pont Co. & City Wil.	Brandywine Cr.	Wilmington	3	PC	1909	0	7	15	7	25	25	102	C(6)	C(6)
19	Brady Cr. #7 (Brucks Hill)	39 46.3	75 34.7	Hagley Museum	Brandywine Cr.	Wilmington	5	PC	1815	R	11	8	6	16	16	102	C(6)	C(6)
20	Brady Cr. #8 (Hagley)	39 46.6	75 34.5	Hagley Museum	Brandywine Cr.	Wilmington	5	PC	1904	R	11	8	6	25	25	102	C(6)	C(6)
20A	Brady Cr. #8A (Upper Hagley)	39 46.9	75 34.3	Hagley Museum	Brandywine Cr.	Wilmington	4	PC	1810	R	5	9	9	23	23	102	C(6)	C(6)
20B	Brady Cr. #8B	39 47.3	75 34.7	Hagley Museum	Brandywine Cr.	Wilmington	5	PC	1810	R	5	9	9	33	33	102	C(6)	C(6)
21	Brady Cr. #9	39 47.3	75 34.7	Hagley Museum	Brandywine Cr.	Wilmington	1	PC	1900	R	9	12	10	42	40	102	C(6)	C(6)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICENATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM

DATA SHEET

FOR NPS USE ONLY

RECEIVED JUL 16 1976

DATE ENTERED DEC 22 1976

SEE INSTRUCTIONS IN HOW TO COMPLETE NATIONAL REGISTER FORMS
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME



HISTORIC

BRANDYWINE PARK

AND/OR COMMON

2 LOCATION

STREET & NUMBER

*roughly bounded by Augustine, 18th, Market Sts., and
Southeast of Eighteenth Street & Northeast of Park Drive & Loring Ave.
Loring Ave., between the Augustine Bridge and the
Market Street Bridge*

CITY, TOWN

Wilmington

VICINITY OF
CODE

10

NOT FOR PUBLICATION
CONGRESSIONAL DISTRICT

One

STATE

Delaware

COUNTY

New Castle

CODE

002

3 CLASSIFICATION

CATEGORY

☒ DISTRICT
☐ BUILDING(S)
☐ STRUCTURE
☐ SITE
☐ OBJECT

OWNERSHIP

☒ PUBLIC
☐ PRIVATE
☐ BOTH

PUBLIC ACQUISITION

☐ IN PROCESS
☐ BEING CONSIDERED

STATUS

☐ OCCUPIED
☐ UNOCCUPIED
☐ WORK IN PROGRESS
ACCESSIBLE
☐ YES: RESTRICTED
☒ YES: UNRESTRICTED
☐ NO

PRESENT USE

☐ AGRICULTURE ☐ MUSEUM
☐ COMMERCIAL ☒ PARK
☐ EDUCATIONAL ☐ PRIVATE RESIDENCE
☐ ENTERTAINMENT ☐ RELIGIOUS
☐ GOVERNMENT ☐ SCIENTIFIC
☐ INDUSTRIAL ☐ TRANSPORTATION
☐ MILITARY ☐ OTHER:

4 OWNER OF PROPERTY

NAME

City of Wilmington

STREET & NUMBER

Public Building

CITY, TOWN

Wilmington

VICINITY OF

STATE

Delaware

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE,
REGISTRY OF DEEDS, ETC.

Public Building

STREET & NUMBER

Rodney Square

CITY, TOWN

Wilmington

STATE

Delaware

6 REPRESENTATION IN EXISTING SURVEYS

TITLE

Delaware Survey of Historic Sites & Buildings, N-1566

DATE

1974

FEDERAL ☒ STATE ☐ COUNTY ☐ LOCALDEPOSITORY FOR
SURVEY RECORDS

Division of Historical & Cultural Affairs, Hall of Records

CITY, TOWN

Dover

STATE

Delaware

Draft Preservation Covenant for Brandywine River Dams 3, 4, and 6

In consideration of the preservation of certain real property, hereafter referred to as contained within a portion of the lands of _____, located in the City of Wilmington, County of New Castle, State of Delaware, which is more fully described as:

Brandywine River Dam 3 and associated masonry abutments and millrace that flows from the dam and prepared by the Center for Historic Architecture and Design, University of Delaware...

_____ hereby covenant on behalf of themselves, their heirs, successors and assigns at all time to the Delaware State Historic Preservation Officer (hereafter DE SHPO) to maintain and preserve the parcel of land which contains Brandywine River Dam 3 and associated millrace as follows:

1. _____ shall preserve and maintain this Brandywine River Dam No. 3 and associated millrace in accordance with the attached Management Plan in order to preserve and protect the historic remnants of an 18th century timber crib dam.
2. No construction, alteration or disturbance of the ground surface or any other thing, not identified in this Preservation Covenant and the attached Management Plan, shall be undertaken or permitted to be undertaken on this Brandywine River Dam 3 and associated millrace which would affect the integrity of the historic dam and millrace without the express prior written permission of the DE SHPO, signed by fully authorized representatives thereof.
3. The DE SHPO shall be permitted at all reasonable times to inspect this Brandywine River Dam 3 and associated millrace in order to ascertain if the above conditions are being observed.
4. This covenant is binding on _____, their heirs, successors, and assigns in perpetuity. Restrictions, stipulations, and covenants contained herein shall be inserted by _____ verbatim or by express reference in any deed or other legal instrument by which it divests itself of either the fee simple title or any other lesser estate of property which includes the land which contains this Brandywine River Dam 3 and associated millrace or any part thereof.
5. The failure of the DE SHPO to exercise any right or remedy granted under this instrument shall not have the effect of waiving or limiting the exercise of any other right or remedy or the use of such right or remedy at any other time.
6. The DE SHPO may, for good cause, modify or cancel any or all of the foregoing conditions or restrictions upon application of the _____ their heirs, successors or assigns. The DE SHPO may also make application to the Delaware Racing Association, its heirs, successors or assigns to modify or cancel this covenant.

This covenant shall be a binding servitude upon _____ and shall be deemed to run with the land. Execution of this covenant shall constitute conclusive evidence that _____ agree to be bound by the foregoing conditions and restrictions and to perform obligations herein set forth.

Sealed and Delivered
In the Presence of:

STATE OF DELAWARE)
COUNTY OF NEW CASTLE)

BE IT REMEMBERED, that on this date day of month, 2020, personally came before me, the Subscriber, a Notary Public of the State and County aforesaid, Property Owner, party to this Instrument of Writing, known to me personally to be such, and acknowledged this Instrument of Writing to be their act and deed.

GIVEN under my Hand and Seal of Office, the day, month and year aforesaid.

Notary Public

Notary Public (Print Name)

My Commission Expires: _____

Management Plan for Brandywine River Dam 3

The area included in this preservation covenant encompasses the Brandywine River Dam 3 and associated millrace. It is surrounded by other lands of _____. The Brandywine River Dam 3 and millrace includes 190,000 square feet of land, more or less, and currently includes the historic remnants of an 18th r:

- a. The limits of the Brandywine River Dam 3 and millrace will be delineated in the field by a surveyor licensed by the State of Delaware following the survey location information contained within Attachment A of the Preservation Covenant. Conspicuous, permanent markers will be placed at all corners which bound it. These boundary markers will be installed prior to initiating any clearing of vegetation and/or site development preparation. These boundary markers will be maintained at all times.
- b. Any ground disturbance associated with the full or partial removal of Dam No. 3 or development of the golf course will avoid any transgression into the preservation area. Prior to the initiation of any construction, Brandywine River Dam 3 and millrace will be temporarily fenced off, using conspicuous orange blaze fencing or its equivalent, from all construction activity.
- c. Landscape development and maintenance of the area will be conducted with care so as not to disturb the historic remnants of the dam that will be left intact after removal.
- d. Landscape development may include the installation of a perimeter fence around the dam. Plans and specifications for a permanent perimeter fence will be submitted to the DE SHPO for review and approval.
- e. At no time will mechanical equipment larger than a _____ be permitted to transgress the White Clay Creek Dam No. 1.
- h. All landscape vegetation located within the area containing the dam and raceway including grass, will be reasonably maintained.
- i. It shall be the responsibility of Delaware Racing Association, their heirs, successors or assigns to inform landscape installers and/or other maintenance workers as to the restrictions contained within the Preservation Covenant and this Management Plan.

**MEMORANDUM OF AGREEMENT
BETWEEN THE
THE NATIONAL FISH AND WILDLIFE FOUNDATION AND DELAWARE STATE HISTORIC
PRESERVATION OFFICE
FOR THE
BRANDYWINE RIVER DAM 3 REMOVAL PROJECT, WILMINGTON, DELAWARE**

WHEREAS, the _____ of Brandywine River Dam 3 in New Castle County, Delaware, and intends that the Dam be removed in order to achieve fish passage; and

WHEREAS, Brandywine Shad 2020 is proposing to assist _____ in the removal of Brandywine River Dam 3 to restore a free-flowing riverine system for migratory and resident fish passage in compliance; and

WHEREAS, the NFWF has determined that the removal of the Brandywine River Dam 3 in New Castle County, Delaware will have an adverse effect on historical resources. The dam is eligible for listing in the National Register of Historic Places under criteria A, C and D for its role in the development of milling in the Piedmont region and as a rare surviving example of timber crib dam and mill race construction; and,

WHEREAS, NFWF has consulted with the Delaware State Historic Preservation Office (DE SHPO), pursuant to applicable regulations found in 36 CFR Part 800, and 33 CFR Part 325, Appendix C[LC6], implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470f); and,

WHEREAS, NFWF has invited the Advisory Council on Historical Preservation (ACHP) to participate in the consultation process, and the ACHP has determined that their participation to resolve adverse effects is not necessary; and,

WHEREAS, NFWF has contacted the Lenape Indian Tribe of Delaware [LC7] and to date the Tribe has not indicated its intent to participate in the consultation; and

WHEREAS, NFWF and the Brandywine Shad 2020 have coordinated with and solicited input from the local and regional community interested in the historical resources to participate in this Section 106 consultation process[LC8]; and

NOW THEREFORE, the NFWF, Brandywine Shad 2020, and DE SHPO agree that the Project undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the undertaking on historic properties:

Stipulations

The NFWF shall insure that the following measures are carried out in consultation with the DE SHPO:

I. Interpretive Signage[LC9]

II. Preservation of Partial Dam Structures[LC10]

III. Survey and Data Recovery Standards

The Owner shall ensure that all cultural resource surveys and data recovery plans conducted pursuant to the Agreement are done in accordance with the *Secretary of the Interior's Standards and Guidelines for Identification and Evaluation*, and for *Archaeological Documentation*, and in accordance with the DE SHPO's *Guidelines for Architectural and Archaeological Surveys in Delaware* (1993).

Survey proposals and data recovery plans shall include a research design that stipulates: objectives, methods, and expected results; production of draft and final reports; and preparation of materials for curation in accordance with Stipulation I.E.[LC11], including budgeting for initial conservation assessment and treatment. Additional requirements for data recovery plans are found in Stipulation I.B[LC12]. of this Agreement.

All data recovery plans shall also take into account the Advisory Council on Historic Preservation's guidance *Recommended Approach for Consultation on Recovery of Significant Information from Archaeological Sites*, and reports will meet professional standards set forth by the Department of Interior's "Format Standards for Final Reports of Data Recovery Program" (42 FR 5377-79).[LC13][LC14]

All data recovery plans, public outreach, or future consultation shall also follow and/or consider any supplemental guidance and provisions provided by, but not limited to, the National Park Service, Advisory Council on Historic Preservation or recognized academic journals or professional organizations as identified by the DE SHPO.

The Owner [LC15] shall ensure that all draft and final cultural resource reports are provided to the DE SHPO within two (2) years of the completion of fieldwork.

III[LC16]. Unidentified Historic Properties

IV. Dispute Resolution

V. Limitations and Assurances

VI.Duration

This agreement shall continue in full force and effect until three (3) years after the date of the last signature of a signatory party or the completion of the dam removal, whichever comes first. Prior to such time, NFWF may consult with the other signatories to reconsider the terms of this MOA and amend it in accordance with Stipulation VII below.

VII. Amendments

This MOA may be amended when such an amendment is agreed to in writing by all signatories. The amendment will be effective on the date a copy signed by all of the signatories is filed with the ACHP.

IX. Termination

A. If any signatory to this MOA determines that its terms will not or cannot be carried out, that party shall immediately consult with the other parties to attempt to develop an amendment per Stipulation VII, above. If within thirty (30) days (or another time period agreed to by all signatories) an amendment cannot be reached, any signatory may terminate the MOA upon written notification to the other signatories.

By:_____ Date:_____
NFWF

By: _____ Date: _____
XX, State Historic Preservation Officer

By:_____ Date:_____
XX PROPERTY OWNER

Attachment 9
Project Narrative and Cost Estimates

Restoration of Anadromous Fish to the Brandywine River (Removal of Dams 3, 4, and 6)

I. Project Priority: Brandywine Shad 2020 proposes to remove deteriorating Dams 3, 4, and 6 along the Brandywine River in a broad-based partnership to restore anadromous and resident fish passage to 2 miles and 35 acres of spawning habitat from tidewater to the Piedmont Plateau in Delaware and Pennsylvania. Brandywine Shad 2020 is a consortia of river organizations dedicated to the removal of old mill dams and restoration of fish passage for American Shad, hickory shad, striped bass, and river herring to the Brandywine River by 2020. Under this NFWF grant, Brandywine Shad 2020 is seeking to collaboratively address the following strategic program areas:

- 1. Strategic Program Area 1: Sustain and Enhance Fish and Wildlife Habitat Restoration and Conservation Activities.** Brandywine Shad 2020 will help restore and *sustain* American Shad, hickory shad, striped bass, and river herring *fish populations by removing three dams to restore 2 miles and 35 acres of spawning habitat from tidewater to the Piedmont in Delaware and Pennsylvania.*
- 2. Strategic Program Area 2: Improve and Maintain Water Quality to Support Fish and Wildlife, as well as Habitats for Fish and Wildlife and Drinking Water for People.** Brandywine Shad 2020 will improve water quality in the Brandywine River by removing Dams 3, 4, and 6, restoring pool and riffle habitat that increases dissolved oxygen levels and reduce sediment in the drinking water source for Delaware's largest city, Wilmington.
- 3. Strategic Program Area 3: Sustain and Enhance Water Resource Management for Volume and Flood Damage Mitigation Improvements to Benefit Fish and Wildlife Habitat.** By removing Dams 3, 4 and 6 Brandywine Shad 2020 will reduce water levels that lead to flooding and remove the threat to public safety due to failure of these deteriorating dams during tropical storms and floods on downstream populations in Wilmington.
- 4. Strategic Program Area 4: Improve Opportunities for Public Access and Recreation in the Basin Consistent with the Ecological Needs of Fish and Wildlife Habitat.** Restoration of anadromous fish such as shad and striped bass to the Brandywine River will provide high quality fishing and outdoor recreational opportunities for the urban residents in the City of Wilmington and New Castle County.

Project Activity	Recommended Metric	Additional Guidance
Economic benefits	# jobs created	100 jobs created in underserved communities
Outreach/ Education/ Technical Assistance	# individuals reached by outreach, training, or technical assistance activities	1,000 city residents who benefit from outreach activities, training, or technical assistance activities.
Fish passage improvements	# fish passage barriers rectified	Dams 3, 4, and 6 removed species benefitting are American shad, hickory shad, striped bass, herring.
Fish passage improvements	Miles of stream opened	2 miles of stream (RM 2.9 – 4.8) ultimately reopened to improve aquatic habitat connectivity.
Restoring hydrology	Miles with restored hydrology	2 miles with restored hydrology.

B. Project Context: American Shad (*Alosa sapidissima*) were once an abundant migratory fish found throughout East Coast rivers and streams of North America, including the Brandywine River in Delaware and Pennsylvania. Shad were an important part of Native American and early colonial diets, and later, were the basis

of an important commercial fishery in larger rivers like the Susquehanna and Delaware. Spring runs of shad comprised a unique and dramatic natural phenomenon, now a lost part of our cultural heritage.

Formed in 2017, Brandywine Shad 2020 is a cross-section of educational organizations, non-profits, governmental agencies, and private citizens whose shared goal is to restore the region's most historic fish, the American Shad, to the Brandywine River by providing fish passage to 10 dams in Delaware by the year 2020 by returning the river to its free-flowing, pre-colonial state.

Brandywine Shad 2020 proposes to collaborate with the Delaware DNREC Division of Parks & Recreation (owners of Dams 3 and 4) and DuPont Co./City of Wilmington (owners of Dam 6) to obtain final permits, prepare final engineering plans/specifications, and retain contractors to remove three deteriorating dams as part of a broader initiative to restore fish passage for American Shad and anadromous and resident fish to the Brandywine River in Delaware.

C. Objectives and Methods: The overall objectives of Brandywine Shad 2020 are to:

- Reopen 320 mi² of the Brandywine watershed to anadromous shad migration for the first time in 3 centuries.
- Restore fish habitat to the Brandywine River.
- Increase the number of diadromous and resident fish species.
- Create a self-sustaining population of fish resilient to recreational fishing pressure.
- Make the Brandywine River watershed free flowing again.

The specific objective of this grant application is to secure funding for the removal of Dams 3, 4, and 6 and is a natural extension of the Grant awarded to Brandywine Shad 2020 in 2019 to conduct fish passage feasibility and engineering assessments for Dams 2 through 11. While that project is still in progress, early results of the study concluded that Dam 3, 4, and 6 should be removed. Removal of those dams now will enhance aquatic connectivity in 2 miles of river and restore much of this area to natural pool/riffle/run habitat thereby enhancing overall water quality. Additionally, this action sets the stage for future implementation of fish passage at the other dams and provides additional recreational and educational opportunities for the surrounding communities.

Achieving these goals will include participating with numerous partner organizations including: Delaware Department of Natural Resources and Environmental Control (DNREC), the Brandywine Conservancy, the City of Wilmington, New Castle County, and numerous other government, private, and nonprofit organizations. DNREC will be a key partner in this process because of their expertise in working on dam passage options on rivers in the state such as the Brandywine River. DNREC will also be involved in the activities related to permitting, sampling for toxic contaminants in the sediment behind the dams, and the fish population studies. The Brandywine Conservancy will serve as a critical partner for outreach in this project.

Achieving the short term goal, assessing the feasibility of restoring fish runs to the Brandywine River watershed, will include participating with numerous partner organizations. Partner organizations include: Delaware Department of Natural Resources and Environmental Control (DNREC), the Brandywine Conservancy, the City of Wilmington, New Castle County, and numerous other government, private, and nonprofit organizations. DNREC will be a key partner in this process because of their expertise in working on dam passage options on rivers in the state such as the Brandywine River. DNREC will also be involved in the activities related to permitting, sampling for toxic contaminants in the sediment behind the dams, and the fish population studies. The Brandywine Conservancy will serve as a critical partner in this project.

This project will serve as an expansion of the Brandywine Shad Restoration effort and partnership, since the Brandywine is the largest tributary in the Christina Basin. This is a 'natural' expansion of the project to the full watershed, and by bringing the effort before the full Brandywine-Christina Basin Clean Water Partnership, can solidify both shad restoration efforts at a new level of awareness in a broader community and bring new federal, state, and local partners and potentially new sources of funding into the mix. This approach will combine economic and staff resources and expenses in the areas of public outreach and agency staff support. For

example, we'll work to: develop public information materials about the broader restoration effort that will apply to both waterways; enlarge the Brandywine Shad Partnership and work with DNREC and the Pennsylvania Fish and Boat Commission (PFBC) to establish an active shad-stocking program that will work for both efforts.

Shad were once extremely abundant in the Delaware Estuary's watersheds. Shad numbers began to decline rapidly around 1910 and dammed spawning tributaries is one of several reasons (over fishing and water quality deterioration are the others) for the decline in the shad numbers. According to the *State of the Delaware Estuary 2008*, the Delaware River currently supports a viable commercial and sport shad fishery but harvests are small compared to historic benchmarks. The National Park Service's Wild and Scenic Rivers program states that the designated rivers, "shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." Currently the Brandywine River watershed has 11 dams that block fish passage and prevent fish migration throughout the entire 320 square mile watershed. This project will identify the extent to which fish passage is blocked and will identify options to restore shad and diadromous fish migration so that the Brandywine River is restoring historic numbers of fish and meeting the intent of the Delaware Basin Fish and Wildlife Management Cooperative with the following opportunities:

We plan to address the threat of contaminated sediment trapped behind the dams in question and work with DNREC to test the sediment and determine whether dam removal will release harmful sediment causing harm to the riverine system. And if so may conclude that dam removal may not be an option at that specific site and other fish passage alternatives like notching, fish ladders, or rock ramps will be the more feasible alternatives to restore the fish passage.

This project is extremely valuable to local and regional communities. Shad serve as a valuable indicator of environmental conditions in the Delaware Estuary and Basin. The long-term intent of this project is to increase the migration of shad and the success of this project will prove beneficial to the overall health of the estuary. This project will provide an opportunity to restore a historic fish population and increase recreational opportunities while sustaining a healthy shad population and improving the overall health of the estuary.

D. Partner Justification: Brandywine Shad 2020 founding partners and supporting organizations include:

Founding Partners: Brandywine Conservancy, Hagley Museum and Library, University of Delaware Water Resources Center

Supporting Organizations: American Rivers, Brandywine Red Clay Alliance, The Nature Conservancy, Partnership for the Delaware Estuary, Stroud Water Research Center, The Conservation Fund, Delaware Nature Society

E. Work Plan: Brandywine Shad 2020 is planning to remove three deteriorating Dams 3, 4, and 6 on the Brandywine River over a two-mile reach of the river from just upstream from the Augustine Cutoff Bridge in the City of Wilmington to just downstream of the Hagley Museum in the adjoining portion of New Castle County. Each dam removal project at each of the three dams will require:

Table 2. Proposed grant tasks

PROPOSED GRANT ACTIVITIES	
Task 1	Project Management, coordinate and oversee management of removals at Dams 3, 4, and 6.
Task 2	Secure final local, County, State and Federal permits.
Task 3	Prepare final engineering construction drawing plans and specifications. Prepare construction bid documents.
Task 4	Secure contractor and begin demolition of all or partial breach of Brandywine Dams 3, 4, and 6
Task 5	Conduct pre-and post-dam removal monitoring.
Task 6	Public outreach and Education.
Task 7	Prepare and submit dam removal documentation report.

TASK 1: Project Management: Coordinate and oversee management of removals at Dams 3, 4, and 6:

- Manage engineering consultant
- Manage contractor
- Manage budget
- Coordinate Federal, state, and local approvals

TASK 2: Secure final local, County, State and Federal permits: Receive final regulatory approval from:

- City of Wilmington Floodplain Permit (Dams 3, 4, 6)
- New Castle County Floodplain Permit (Dam 6)
- Delaware DNREC Subaqueous Lands Permit
- U.S. Army Corps of Engineers Sec 404 Clean Water Act Permit
- Dept. of Interior Sec 106 Cultural Resources Approval w/State Historic Preservation Office (SHPO)

TASK 3: Final engineering construction drawing plans and specifications: Retain consultant to prepare construction documents for each of 3 dams:

- Construction Drawings (6 sheets, plan, profile, stream cross sections, soil erosion and sediment control, construction details)
- Specifications
- Bid Documents

TASK 4: Secure contractor and begin demolition and removal of Brandywine Dams 3, 4, and 6:

- Bid contract
- Select contractor
- Remove 3 dams
- Engineering/construction inspection

TASK 5: Pre-post monitoring/Fishery Surveys: We will Work with Delaware DNREC Division of Fish and Wildlife to conduct fisheries surveys for pre and post removal of the dams. The purpose of the monitoring is to document the change in fish species composition, relative abundance, and distribution after the dams are removed. One of the major objectives is for fish species downstream of the dams to redistribute to habitats in upstream reaches of the river. Pre and post removal surveys, utilizing electrofishing (boat or backpack) and seining will provide data to make the necessary comparisons. This data would augment fish abundance and distribution databases maintained by the Division of Fish and Wildlife.

TASK 6: Public Outreach and Education: Conduct workshops to inform the community of the Brandywine River dam removals and how these removals fit into the context of providing overall fish passage in Delaware's reach of the of the River. The Brandywine Conservancy will assist on the following education and outreach activities as needed with public information materials, public meetings, outreach and support-building in Pennsylvania and to help incorporate the public and the education community (at all levels) to participate in the implementation of the restoration effort.

TASK 7: Final Report: Prepare a final report documenting the removal of Dams 3, 4, and 6 including photographic documentation of the removals and a detailed description of methods used to remove the dams, the disposition of the dam materials and the reconstruction of the river channel to a natural state. The final report will also include the result of one season of post removal fish monitoring and an accounting of grant fund distributions.

E. Outcomes and Indicators: This project is an expansion of Brandywine Shad 2020's fish passage feasibility study funded by NFWF. While that project is still in progress, early results of the study concluded that Dam 3, 4,

and 6 should be removed. Initial evaluations based on field investigations are illustrated in the attached existing conditions photo documentation of conditions after removal (Figures 2, 3, and 4.)

Dam removal can take on many forms depending on the objective of the project. It can range from complete removal to partial breaching (only demolishing enough of the dam to meet fish passage needs). Dam removal costs vary with the size of the dam, extent of sediment upstream, and impacts to utilities or other resources such as wetlands that are affected by a reduced water level above the dam.

Detailed cost estimates for each alternative at each Dam (2-6) are found in Table 1. A summary of the cost estimates are provided below, as well as a list of the assumptions used in costing.

Dam	Budget
Dam 3: Dam Removal (re-shaping of middle 1/3 of dam)	\$80,000
Dam 4 Dam Removal (removal of center 80% and fishway, leaving abutments)	\$280,000
Dam 6 Dam Removal (minor re-shaping of center 1/3 of channel)	\$130,000
Total	\$490,000

Budget and Schedule: Brandywine Shad 2020 is requesting the following support to determine the feasibility of removing or retrofitting the fish passage barriers on the Brandywine River ultimately restoring shad and diadromous fish migration to the 320 square mile watershed.

Table 3. Proposed budget for removal of Dams 3, 4, and 6 along the Brandywine River

Task	Description	Dam 3 (\$)	Dam 4 (\$)	Dam 6 (\$)	Total (\$)	Milestone
1	Project Management	12,000	20,000	17,000	49,000	
2	Secure final local, County, State and Federal permits.	5,000	10,000	10,000	25,000	Jul 2020
3	Prepare final engineering construction drawing plans and specifications. Prepare construction bid documents.	20,000	30,000	20,000	70,000	Sep 2020
4	Secure contractor and begin demolition of all or partial breach of Brandywine Dams 3, 4, 6, and 11.	30,000	207,000	70,000	307,000	Oct 2020
5	Conduct pre-and post-dam removal monitoring.	5000	5000	5000	15,000	Oct 2020
6	Public outreach and education.	5000	5000	5000	15,000	Oct 2020
7	Prepare and submit dam removal documentation report.	3000	3000	3000	9,000	Jan 2021
Total		80,000	280,000	130,000	490,000	

Cost Assumptions

- Dam heights, widths, and hydraulic head (from HEC-RAS model).
- No sediment management plan is required.
- Rare, Threatened, and Endangered species are not found at the site and there are minimal restrictions on site work, other than the March 15 - June 15 restricted in-water work period.
- No wetland mitigation is required to offset any wetlands that may be changed due to changing water levels.
- Existing utilities can be easily avoided.
- Landowners are willing participants and do not request compensatory payment for use of their land.
- Target fish passage species: American shad and river herring.
- Abutments are stable and fish passage is acceptable with 10% of dam width left on each side of dam.
- Dams 3 & 6 reshape middle 1/3 of channel with dam material left in river, fill scour holes for bank protection.
- Dam 4: removal of most dam material from the river via site access from within 1,000 feet downstream of the dam.

Table 4. Cost assumptions for removal of Dams 3, 4, and 6 along the Brandywine River

Dam No.	Fish Passage Option	Dam Head (ft)	95% EP Flow HECRAS Model (ft)	Dam Width (ft)	2020 cost (\$)
3	Dam Removal	3	7.4	135	80,000
4	Dam Removal	4	13.0	150	280,000
6	Dam Removal	6	9.6	182	130,000
Total					430,000

Dam 3: 135 ft wide, remove dam, shape middle 1/3 of channel, demolished stone fill existing scour holes.

- Access is difficult to achieve from the State Parks side (looking downstream, the left side). Mill Road appears to be the better side for access (right side).
- Clear the existing trees at the access point to allow for equipment needed to set the materials for the cofferdam. Cofferdam half of the dam. Demolish one half of the dam at a time.
- Some areas on the upstream side of the dam appear to be scoured, causing deep water depths.
- Restore disturbed land areas.
- Permit compliance measures assumed – i.e. shallow turbidity curtain downstream, oil boom, etc.

Dam 4: 150 ft wide, remove dam, adjacent concrete fishway, scatter demolished materials mimic natural riverbed.

- Access would be from the State Park owned land (looking downstream, left side).
- May need to partially fill the existing raceway for access. This fill could be removed after the work is complete.
- We would need to clear the existing trees at the access point to allow for equipment needed to set the materials for the cofferdam. Clearing would be kept to a minimum.
- Cofferdam half of the dam. Demolish one half of the dam at a time.
- Assumed demolishing the existing concrete fish way down to approximate riverbed level.
- Restore disturbed land areas.
- Permit compliance measures assumed – i.e. shallow turbidity curtain downstream, oil boom, etc.

Dam 6: 182 ft wide, remove dam, Re-shape middle 1/3 of channel, demolished stone to fill existing scour holes.

- Access would be from the right side (looking downstream). Easiest access of the three dams considered.
- We would need to clear the existing trees at the access point to allow for equipment needed to set the materials for the cofferdam. Clearing would be kept to a minimum.
- Cofferdam half of the dam. Demolish one half of the dam at a time.
- Restore disturbed land areas.
- Permit compliance measures assumed – i.e. shallow turbidity curtain downstream, oil boom, etc.
-

F. Monitoring and Measuring Performance: Outcomes and Indicators: The most important outcome of this project is the number of dams restored for fish passage along the Brandywine River and evidence of fish migration during the spawning period. The feasibility report will list the most feasible fish passage alternative of each dam from the mouth of the river upstream into Pennsylvania. The long term outcome of this project will be achieved when all barriers to fish migration have been removed and fish abundance surveys indicate that diadromous fish are once again migrating up the Brandywine River from their tidal origins.

G. Dissemination and Transferability of Results: Methods and techniques for restoring fish passage at 10 dams along Brandywine River can be transferred to other Piedmont streams in the greater Delaware River watershed.

Table 6. Species and the number observed while electrofishing below Dam 1 on Brandywine Creek. CPUE represents the number of fish caught per minute of electrofishing.

Fish Species	4/24/2017	5/31/2017	Total Observed	CPUE
	Number Observed	Number Observed		
American Eel	1	1	2	0.03
American Shad	4	0	4	0.06
Channel Catfish	9	3	12	0.19
Common Carp	3	4	7	0.11
Gizzard Shad	34	1	35	0.54
Hickory Shad	6	0	6	0.09
Tiger Muskie	1	1	2	0.03
White Perch	0	6	6	0.09
White Sucker	5	9	14	0.22
Yellow Perch	2	6	8	0.12

Table 7. Species and the number observed while electrofishing between Dam 1 and Dam 2 on the Brandywine Creek. CPUE represents the number of fish caught per minute of electrofishing.

Fish Species	4/27/2017	5/11/2017	CPUE
	Number Observed	Number Observed	
Alewife	0	0	0.00
American Eel	4	10	0.41
American Shad	1	8	0.27
Blueback Herring	0	0	0.00
Blue Gill	6	0	0.18
Channel Catfish	0	3	0.09
Common Carp	6	8	0.41
Gizzard Shad	3	15	0.53
Golden Shiner	0	6	0.18
Hickory Shad	0	0	0.00
Pumpkin Seed	0	1	0.03
Tiger Muskie	7	7	0.41
Rock Bass	4	5	0.27
White Sucker	30	60	2.65
Yellow Perch	8	3	0.32

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The Partnership for the Delaware Estuary

Connecting people, science, and nature for a healthy Delaware River and Bay



Newsletter of the Partnership for the Delaware Estuary - Host of the Delaware Estuary Program

ESTUARY NEWS

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SPECIES SPECIFIC

Back to a Free-flowing State for the Brandywine Creek

It happens every spring. Waters get warmer, and American shad heed the call to leave their ocean homes and head toward fresh water. Instinct drives these fish to swim against the current to spawn in the places where they were born. One of those waterways is the Brandywine Creek.

Shad have spawned in the Brandywine for centuries. For the last 300 years, however, man-made dams have hindered these spawning grounds. A non-profit organization called Brandywine Shad 2020 feels the time is long overdue to free the waters for fish passage and recreational opportunities for fishing, kayaking, and more.

"Here in Delaware, we are making a difference in restoring this important and historic habitat back to before the Europeans got here and made decisions to harness water power for their mills. Those decisions that hold Shad hostage, we want to reverse," said Hunter Lott III, the co-founder, and co-director of Brandywine Shad 2020.

The Brandywine Creek – sometimes referred to as a river – is a tributary of the Christina River and part of the Delaware River Watershed. It's nearly 75 miles long and spans between Delaware and Pennsylvania. Settlers built dams for mills that produced flour, paper, cotton, and gunpowder. The significance of 2020 in the organization's name, Lott said, is this year marks

"Shad have spawned in the Brandywine for centuries. For the last 300 years, however, man-made dams have hindered these spawning grounds."

the 300th anniversary since the first dam went up in 1720.

Over time, the mills went away while many of the dams stayed. Brandywine Shad 2020 would like to see 10 dams removed or modified on more than 17 miles of Delaware's portion of the creek and restore the waterway to a pre-colonial, free-flowing state.

ECOLOGICAL BENEFIT

Shad spawning season spans from March to June. After they migrate, female shad lay hundreds of thousands of eggs in the water to be fertilized by male fish. About 10 percent of the eggs hatch a week or so later.

"If we can do what we can to allow them to return to their homes, their natal spawning grounds, that would be a real plus for the state of Delaware."

—Mike Stangl

"Anything that we can do to open up more habitat for [the shad] is going to be beneficial to the ecology of the system," said Mike Stangl, program manager for freshwater and anadromous species at Delaware's Department of Natural Resources and Environmental

Control (DNREC). He has been working with Brandywine Shad 2020 on the biological and ecological aspects of the project. "If we can do what we can to allow them to return to their homes, their natal spawning grounds, that would be a real plus for the state of Delaware."

THE RIGHT THING TO DO

Lott and fellow Wilmington resident Jim Shanahan co-founded Brandywine Shad 2020 in 2017. Founding member organizations include

the Brandywine Conservancy, Hagley Museum and Library, and the University of Delaware. Nine other entities, including the Partnership for the Delaware Estuary, are listed as supporting organizations.

Lott and Shanahan, who each live along

city's water supply, so a fishway or another modification will be necessary, Lott and Shanahan said.

Kauffman said the university, which is providing technical assistance to the Brandywine Shad 2020 project, was part of the White Clay



the Brandywine, independently developed an interest in the dams and American shad before the issue brought them together.

"I think it was just for the pure objective of restoring our ecology to the way it was before humankind's interference," Shanahan said. "I just thought it was sort of the right thing to do. It just spoke to me to have the fish do what they did for centuries and centuries."

FUNDING AND FEASIBILITY

Last summer, the City of Wilmington removed one dam on the creek near Brandywine Park. Brandywine Shad 2020 didn't play a role in this project but the group supported it. Gerald Kauffman, director of the University of Delaware's Water Resources Center, said the goal is to have three dams go in 2020.

Dam No. 2 in Wilmington is integral to the

Creek Wild and Scenic River Committee to remove a dam built in 1777.

Brandywine Shad 2020 is working to raise funds for the project. So far, it has raised \$482,000. In 2018, the National Fish and Wildlife Foundation, through the Delaware Watershed Conservation Fund, awarded the group a \$241,000 grant. The Delaware Bond Bill matched that grant with an additional \$241,000. Kauffman said these awards are paying for Pennsylvania consulting firm, Kleinschmidt, to run the necessary feasibility studies. Lott said the consultant roughly estimates it will cost between \$2.5 and \$3.5 million to remove or modify the dams.

"What's good for the fish is going to be really good for the people," Kauffman said.

For more information about Brandywine Shad 2020, go to <https://bit.ly/34AXMME>. ♦