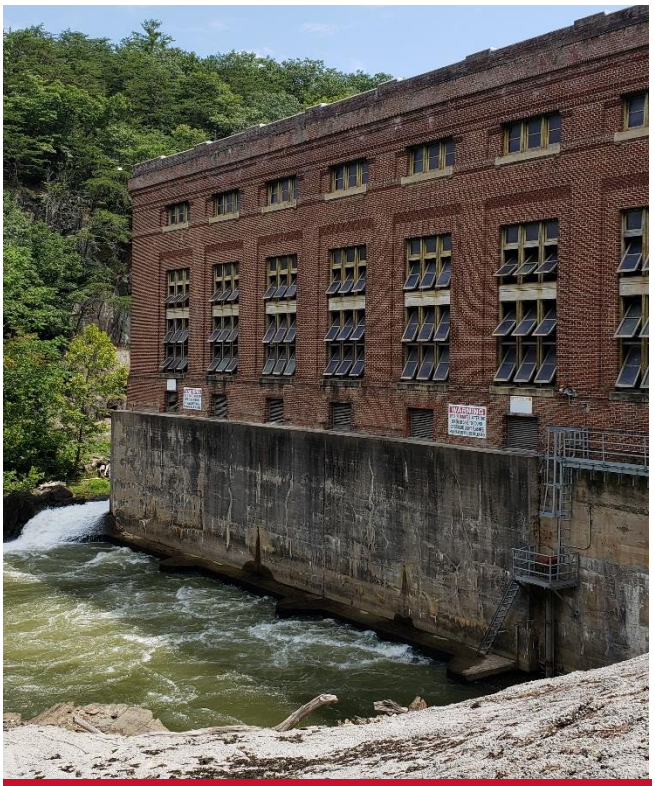

FINAL LICENSE APPLICATION

Volume II of V

Part 1 – Exhibit E

Byllesby-Buck Hydroelectric Project
(FERC No. 2514)

February 28, 2022

Prepared by:

Prepared for:

Appalachian Power Company

APPALACHIAN POWER

An AEP Company

BOUNDLESS ENERGY

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FINAL LICENSE APPLICATION

BYLLESBY-BUCK HYDROELECTRIC PROJECT (FERC NO. 2514)

EXHIBIT E

ENVIRONMENTAL REPORT

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BYLLESBY-BUCK HYDROELECTRIC PROJECT
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Appendices

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
2-D	two-dimensional
AEP	American Electric Power
Appalachian or Licensee	Appalachian Power Company
ADA	Americans with Disabilities Act
APE	area of potential effect
BEHI	Bank Erosion Hazard Index
Buck	Buck Development
Byllesby	Byllesby Development
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CWA	Clean Water Act
CPUE	catch per unit effort
CVSZ	Central Virginia Seismic Zone
DLA	Draft License Application
DO	dissolved oxygen
EDGE	Edge Engineering and Science, LLC
EFH	Essential Fish Habitat
EL.	elevation
ESA	Endangered Species Act
EPRI	Electric Power Research Instituted
FERC or Commission	Federal Energy Regulatory Commission
FLA	Final License Application
ft	feet/foot
GCSZ	Giles County Seismic Zone
GIS	Geographic Information System
H’	Shannon Diversity Index
HBI	Hilsenhoff Biotic Index
HPMP	Historic Properties Management Plan
Hydrolab	Hach Hydrolab® MS5
Hz	hertz
ICM	Integrated Catchment Model

ILP	Integrated Licensing Process
ISR	Initial Study Report
kW	kilowatt
LPDA	Land Planning Design Associates
m	meter
M_w	moment magnitude scale
MW	megawatt
MWh	megawatt-hour
mg/l	milligrams per liter
NTU	Nephelometric turbidity units
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum of 1929
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NOI	Notice of Intent
PAD	Pre-Application Document
PM&E	protection, mitigation, and enhancement
PCBs	polychlorinated biphenyls
POR	period of record
Project	Byllesby-Buck Hydroelectric Project
PSD	Proportional Size Distribution
PSP	Proposed Study Plan
RM	River Mile
rpm	revolutions per minute
RSP	Revised Study Plan
RTE	rare, threatened, and endangered
SHPO	State Historic Preservation Officer
SD1	Scoping Document 1
SD2	Scoping Document 2
SD3	Scoping Document 3
SPD	Study Plan Determination
Stantec	Stantec Consulting Services, Inc.
TMDL	total maximum daily load
USGS	U.S. Geological Survey

USFWS	U.S. Fish and Wildlife Service
USFS	U.F. Forest Service
USACE	U.S. Army Corps of Engineers
USC	United States Code
VAC	Virginia Administrative Code
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDWR	Virginia Department of Wildlife Resources (formerly VDGIF)
VDHR	Virginia Department of Historic Resources
Virginia Tech	Virginia Polytechnic Institute and State University
VSCI	Virginia Stream Condition Index
VWP	Virginia Water Protection
WMP	Wildlife Management Plan
µS/cm	microsiemens per centimeter

Exhibit E - Environmental Report (18 CFR §5.18(b))

E.1 Introduction

Appalachian Power Company (Appalachian or Licensee) is the Licensee, owner, and operator of the two-development Byllesby-Buck Hydroelectric Project (Project) (Federal Energy Regulatory Commission [FERC or Commission] Project No. 2514), located on the upper New River in Carroll County, Virginia.

The Project is located approximately 60 miles south-southwest of the city of Roanoke. The Byllesby Development (Byllesby) is located about 9 miles north of the city of Galax, and the Buck Development (Buck) is located approximately 3 miles downstream of Byllesby and 43.5 miles upstream of Claytor Dam. Figure E.1.1 provides an overview of the Project setting and the FERC Project Boundary, and Figure E.2.1 shows the location of the Project within the New River watershed.

The Byllesby-Buck Project operates in a run-of-river mode under all flow conditions. Because the Buck Development is only 3 miles downstream from the Byllesby Development, operations of the two developments are closely coordinated and operations at Buck are dependent on flows through Byllesby. Under normal operating conditions, Appalachian operates the Project to use available flows for powerhouse generation, maintaining the elevation (EL.) of the Byllesby reservoir between 2,078.2 feet (ft) and 2,079.2 ft[1] and the Buck reservoir between 2,002.4 ft and 2,003.4 ft. Under the existing license, Appalachian is also required to release a minimum flow of 360 cubic ft per second (cfs) or inflow to the Project, whichever is less, downstream of the Project powerhouses.

The Project is currently licensed by the FERC under the authority granted to FERC by Congress through the Federal Power Act, 16 United States Code (USC) §791(a), et seq., to license and oversee the operation of non-federal hydroelectric projects on jurisdictional waters and/or federal land. The Project underwent relicensing in the early 1990s, and the current operating license for the Project expires on February 29, 2024. Accordingly, Appalachian is pursuing a new license for the Project pursuant to the Commission's Integrated Licensing Process (ILP), as described at 18 Code of Federal Regulations (CFR) Part 5. In accordance with FERC's regulations at 18 CFR §16.9(b), the licensee must file its final application for a new license with FERC no later than February 28, 2022.

[1] All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD)

E.1.1 Pre-Filing Consultation

Appalachian filed a Pre-Application Document (PAD) and associated Notice of Intent (NOI) with the Commission on January 7, 2019, to initiate the ILP. The Commission issued Scoping Document 1 (SD1) for the Project on March 8, 2019. As provided in 18 CFR §5.8(a) and §5.18(b), the Commission issued a notice of commencement of the relicensing proceeding concomitant with SD1. On April 10 and 11, 2019, the Commission held public scoping meetings and a site visit pursuant to 18 CFR §5.8(d). During these meetings, FERC staff presented information regarding the ILP and details regarding the study scoping process and how to request a relicensing study, including the Commission's study criteria. In addition, FERC staff solicited comments regarding the scope of issues and analyses for the Environmental Assessment. Resource agencies, Indian Tribes, NGOs, and other interested parties were afforded a 60-day period to request studies and provide comments on the PAD and SD1.

In accordance with ILP regulations, comments on the PAD and SD1 and study requests were due to FERC by May 7, 2019. Stakeholders filed letters with the Commission providing general comments, comments regarding the PAD and SD1, and/or study requests. Twenty-two formal study requests and/or comments were received during the comment period from the following stakeholders;

- Cherokee Nation
- Delaware Nation
- National Park Service
- New River Conservancy
- U.S. Fish and Wildlife Service (USFWS)
- Virginia Department of Conservation and Recreation (VDCR), Division of Planning and Recreation Resources and Division of Natural Heritage
- Virginia Department of Environmental Quality (VDEQ)
- Virginia Department of Wildlife Resources (VDWR) (formerly the Virginia Department of Game and Inland Fisheries [VDGIF])
- Virginia Department of Health
- Virginia Polytechnic Institute and State University (Virginia Tech)

FERC issued Scoping Document 2 (SD2) on June 21, 2019, and, in accordance with 18 CFR §5.11, Appalachian developed a Proposed Study Plan (PSP) for the Project that was filed with the Commission and made available to stakeholders on June 21, 2019. The PSP described Appalachian's proposed approaches for conducting studies and addressed agency and stakeholder study requests. Pursuant to 18 CFR §5.11(e), Appalachian held a PSP Meeting on July 18, 2019, for the purpose of

clarifying the PSP, explaining initial information gathering needs, and addressing outstanding issues associated with the PSP. Appalachian received timely formal comments on the PSP from Commission staff, the USFWS, and VDGIF. Virginia Tech's College of Natural Resources and Environment filed multiple study requests on March 15, 2019.

In accordance with 18 CFR §5.11, Appalachian developed a Revised Study Plan (RSP) for the Project, which incorporated comments and study requests considered in developing the PSP, the Commission's June 21, 2019 SD2 and comments on the PSP, and it was filed with the Commission and made available to stakeholders on October 18, 2019. On November 18, 2019 FERC issued the Study Plan Determination (SPD). On December 18, 2019, Appalachian filed a request for rehearing of the SPD. The SPD was subsequently modified by FERC by an Order on Rehearing dated February 20, 2020. The modified SPD required eight studies to be performed in support of issuing a new license for the Project, as listed below:

1. Bypass Reach Flow and Aquatic Habitat Study
2. Water Quality Study
3. Aquatic Resources Study
4. Wetlands, Riparian, and Littoral Habitat Characterization Study
5. Terrestrial Resources Study
6. Shoreline Stability Assessment Study
7. Recreation Study
8. Cultural Resources Study

On July 27, 2020, Appalachian filed an updated ILP study schedule and a request for extension of time to file the Initial Study Report (ISR) to account for Project delays resulting from the COVID-19 pandemic. The request was approved by FERC on August 10, 2020, and the filing deadline for the ISR for the Project was extended from November 17, 2020 to January 18, 2021.

On December 23, 2020, FERC issued Scoping Document 3 (SD3) for the Project, to account for updates about how Commission staff intend to conduct their National Environmental Policy Act (NEPA) review in accordance with the Council on Environmental Quality's (CEQ) new NEPA regulations at 40 CFR Part 1500-1518.

Appalachian filed the ISR on January 18, 2021, conducted a virtual ISR Meeting on January 28, 2021, and filed the ISR Meeting summary with the Commission on February 12, 2021. Written comments in response to Appalachian's filing of the ISR meeting summary were filed by USFWS, VDWR, and FERC staff. Appalachian filed a response to comments on the ISR on April 13, 2021. Because no

substantive study modifications were requested in response to the ISR, FERC did not in turn provide a Determination on Requests for Study Modifications.

Throughout the study phase of the ILP (i.e., July 2020 through the USR), either by separate filing or in conjunction with the filings described above, Appalachian has provided FERC and relicensing participants with quarterly ILP study progress reports describing study activities completed by Appalachian, updates to the study schedule, and variances from the schedule or methods of the RSP.

In addition to the formal consultation activities describe above and as represented in Appendix I of Volume II of this Final License Application (FLA), Appalachian conducted consultation with specific stakeholders in support of the Cultural Resources Study, informal consultation with stakeholders in association with study activities, and also convened and participated in additional meetings with relicensing participants throughout the pre-filing consultation period, including:

- June 29, 2020: ILP Study Schedule Update to Agencies (Virtual Meeting) (VDWR, VDEQ, USFWS)
- August 28, 2020: Discussion of Byllesby-Buck Bypass Flow and Bypass Reach Study flow test scenarios (Virtual Meeting) (VDWR, USFWS, and VDEQ)
- October 23, 2020: Recreation Study Update (Virtual Meeting) (VDWR, VDCR-New River Trail State Park, USFWS, Carroll County, New River Conservancy)
- October 28, 2020: Byllesby-Buck Recreation Site Stakeholder Visit (VDWR, Carroll County, Land Planning Design Associates [LPDA], VDCR-New River Trail State Park)
- March 24, 2021: Recreation Stakeholder Meeting and Site Visit to Loafer's Rest recreational facility (VDWR)
- June 29, 2021: Potential Recreation Improvements Discussion with DWR (Virtual Meeting)

On October 1, 2021, Appalachian filed the Draft License Application (DLA) with the Commission and distributed notice of these filings to the Projects' mailing list. Comments on the DLA were filed by FERC staff (December 20, 2021), VDWR (December 22, 2021), and USFWS (December 30, 2021).

Studies were completed in 2021 and the USR was filed with the FERC on November 17, 2021. The USR meeting was held on December 1, 2021 and the meeting summary was filed on December 16, 2021. The following parties provided written comments in response to Appalachian's filing of the USR meeting summary: FERC staff (January 18, 2022), USFWS (January 18, 2022), and VDWR (January 18, 2022). On February 14, 2022, Appalachian filed with FERC a response to comments on the USR and a request for extension of time to file revised study reports (Bypass Reach Flow and Aquatic

Habitat Study Report and Aquatic Resources Study Report), given the additional time and effort needed to address comments received on the USR.

Additional consultation conducted by Appalachian in support of preparation of this FLA included the following:

- January 26, 2022 distribution of the draft Recreation Management Plan to recreation stakeholders (VDWR, USFWS, VDCR, VDEQ, Carroll County, Town of Wytheville, and New River Conservancy) for a 30-day review period.
- Informal email and telephone communications (January-February 2022) with VDWR regarding fishery (walleye body depth) data and documentation of past stranding incidents in the Buck bypass reach, as well as the potential for occurrence of Eastern hellbender in each bypass reach.
- Virtual (WebEx) meetings with representatives from VDWR, USFWS, and VDEQ on February 1, 2022 and February 16, 2022 to discuss comments received in response to the USR and DLA.

Appalachian has reviewed and considered all comments received as evidenced through further development of the Licensee's measures proposed in this FLA and summarized in Table ES-1 of the Executive Summary of this FLA and further described in the sections that follow.

E.1.2 Resource Areas and Environmental Analysis Addressed in this Exhibit

As required by FERC's ILP regulations at 18 CFR § 5.18(b), Exhibit E presents effects of the Project on environmental resources using the information filed in the Licensee's PAD, information developed through the Licensee's FERC-approved study plan, and other information developed or obtained by the Licensee. As a significant amount of information exists or has been developed for many resource areas, Appalachian has included here the most important and relevant information and by reference, this Exhibit accounts for and reflects other relicensing filings, in particular the study reports that were filed with the ISR and USR.

This environmental report contains information about the affected environment; analysis of anticipated continuing or new environmental impacts due to Project operation or proposed changes thereto, based on existing information and the results of relicensing studies (several of still are which ongoing as of the filing of this FLA); proposed environmental measures and measures recommended by relicensing participants; and unavoidable adverse impacts that may occur despite recommended or proposed environmental measures.

Consistent with the PAD and Scoping Documents 1, 2, and 3 issued by FERC, the following resources are addressed in this exhibit:

- Geology, geomorphology, and soils
- Water use and quality
- Fish and aquatic resources (including protected and sensitive species)
- Botanical, wetland, and terrestrial resources (including protected and sensitive species)
- Recreation, land use, and aesthetic resources
- Historic and archaeological resources
- Development resources

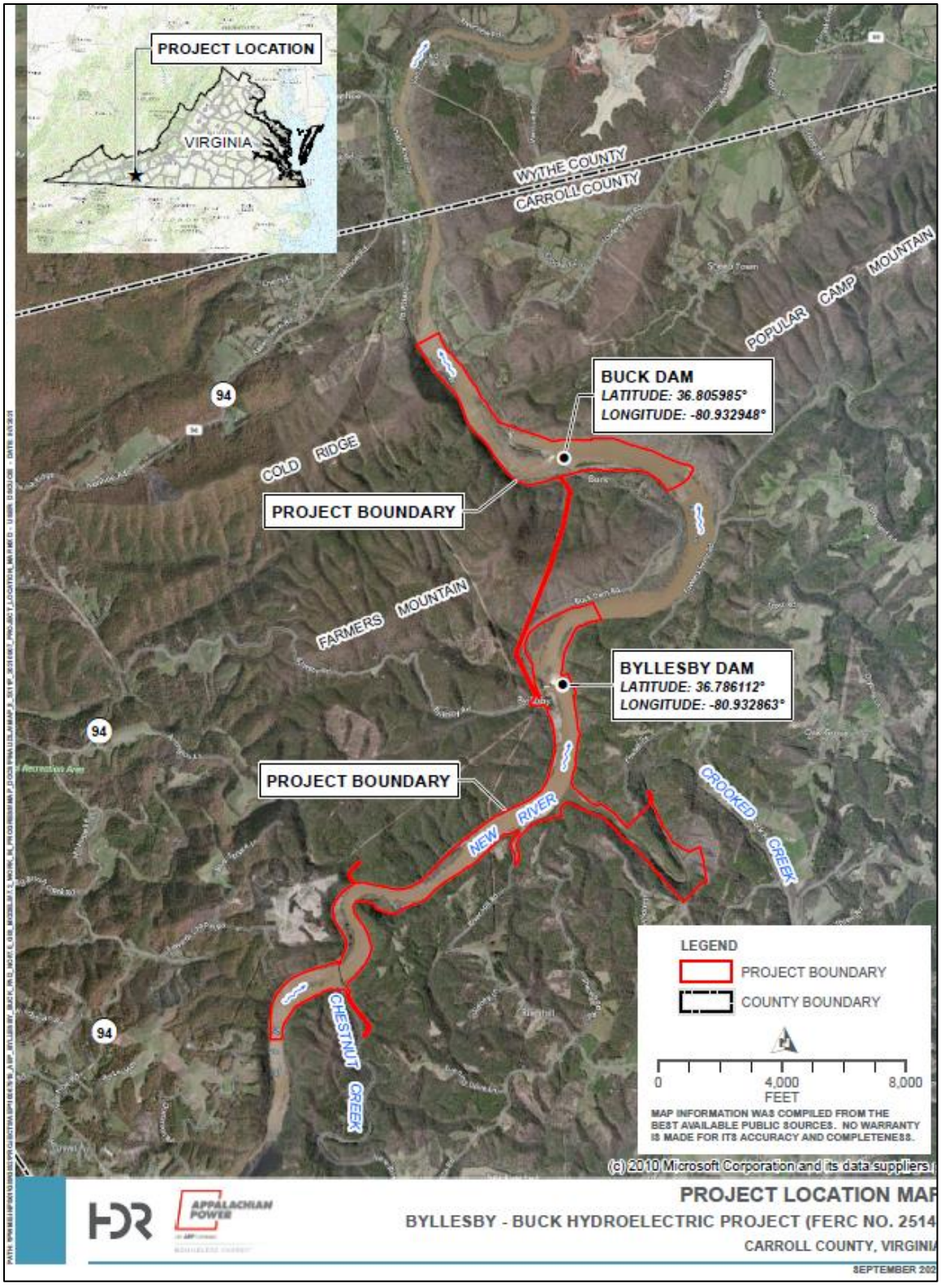


Figure E.1.1. Byllesby Buck Project Location Map

E.2 General Description of the River Basin

E.2.1 New River Watershed

The New River originates in North Carolina at the confluence of the North Fork New River and the South Fork New River. It then flows northward for 320 miles through Virginia before entering West Virginia and flowing to the confluence of the Gauley River forming the Kanawha River, a tributary to the Ohio River. The New River flows through valleys ranging in width from 200 to 1,000 ft and has banks with precipitous bluffs and steep side slopes. This terrain and the steep gradient of the river produce a fast runoff and high flow velocities.

The Byllesby and Buck developments are within the upper New River Basin (Hydrologic Unit Code 050500) which extends from the Bluestone Dam near Hinton, West Virginia, to the headwaters of the New River's north and south forks in northwestern North Carolina near Blowing Rock. The drainage area for the Byllesby Development is 1,310 square miles and 1,320 square miles for the Buck Development.

E.2.2 Geography, Topography, and Climate

The Project is located within the Southern Blue Ridge Physiographic Province on the Blue Ridge Plateau, an upland area with numerous knobs and ridges ranging in elevation from about 2,000 to 3,000 ft. The Blue Ridge Escarpment, a southwest to northeast-trending range of mountains, separates the Blue Ridge Plateau from the Piedmont lowlands to the southeast (Appalachian 1991a). The northwestern border of the Blue Ridge Plateau is formed by the southwest to northeast- trending Iron and Poplar Camp Mountains, beyond which lies a portion of the Great Valley, an extension of the Appalachian Valley, an area known as the Valley and Ridge Physiographic Province. The topography of the New River Basin and the Project area, is rugged, consisting of high mountains, narrow valleys, and steep ravines. The valley in which the Project is situated ranges from 700 to 1,000 ft in width and the adjacent slopes are steep with exposed bedrock.

In Carroll County, the average low temperature is 28 degrees Fahrenheit (°F) (January) and the average high temperature (August) is 87°F. Average annual total rainfall is 58.7 inches with approximately 15 snow days per year based on historical data from the last ten years (Carroll County 2021).

E.2.3 Dams and Diversions in the Watershed

There are a total of seven dams on the New River (Table E.2-1 and Figure E.2.1). The non-FERC jurisdictional Fields Dam and the FERC jurisdictional Fries Dam are the only major dams located

upstream of the Byllesby-Buck Project. There are three major dams located on the New River downstream of the Project, which are the Claytor (also owned and operated by Appalachian), Bluestone, and Hawks Nest dams.

Table E.2-1. Dams and Diversion Structures on the New River

Development/ Dam	Owner	River Mile (RM)	FERC Project No.	Expiration of Current License	Capacity (megawatt [MW])
Fields	Fields Electric	323	N/A	N/A	Unknown
Fries	Aquenergy Systems	303.6	P-2883	2020	5.2
Byllesby	Appalachian Power Company	295	P-2514	2024	21.6
Buck	Appalachian Power Company	292.3	P-2514	2024	8.5
Claytor	Appalachian Power Company	248.8	P-739	2041	75
Bluestone	U.S. Army Corps of Engineers (USACE)	162.4	N/A	N/A	N/A
Hawks Nest	Hawks Nest Hydro	103.57	P-2512	2064	102

Figure E.2.1. Kanawha River Basin and Location of Project

E.2.4 Tributary Rivers and Streams

The major tributaries in the New River Basin include Indian Creek, the Bluestone River, and the Greenbrier River. Tributaries to the New River near the Byllesby-Buck Project include Big Branch, Poor Branch, and a couple of unnamed tributaries. The Project Boundary of the Byllesby Development extends upstream into the lower reach of Crooked Creek, Brush Creek, and Chestnut Creek (see Figure E.2.1).

E.2.5 General Land and Water Use

The New River basin is the least densely populated of Virginia's major river basins. The higher elevations of the New River basin are steep sloped and primarily forested (59 percent), while the lowlands are mostly (35 percent) pasture and cropland (VDEQ 2015). Land use within the Project area consists primarily of deciduous forest with small amounts of evergreen forest, pasture/hay fields, and other land cover. Table E.2-2 lists the estimated land use acreage within the Project Boundary and land use types are also shown on Figure E.2-1. The forest cover is of the oak-chestnut type with a noteworthy percentage of pine and other types such as hickory, hemlock, maple, ash, birch, rhododendron, locust and basswood (Appalachian 1991a).

Table E.2-2. Estimated Land Use Coverage (Acres) within the Project Boundary

Land Use	Estimated Acres
Barren Land	1.11
Deciduous Forest	197.34
Developed, Low Intensity	1.89
Developed, Open Space	7.46
Emergent Herbaceous Wetlands	12.37
Evergreen Forest	33.53
Hay/Pasture	11.41
Herbaceous	13.60
Mixed Forest	22.19
Open Water	369.05
Shrub/Scrub	14.25
Woody Wetlands	23.24
Grand Total	**707.44**

Data Source: National Land Cover Database 2011

Most of the land to the west of the Project is owned by the U.S. Forest Service (USFS) and consists of the George Washington and Jefferson National Forest. The Mount Rogers National Recreation Area, a unit within the Jefferson National Forest and created in 1966, borders the Project to the west, as illustrated by the light green shading in Figure E.2-2. These lands include approximately 100 acres of former Project lands that were transferred by Appalachian to the USFS in 1984, and subsequently removed from the Project Boundary, as authorized by FERC order dated December 18, 1984.

E.2.6 Downstream Reach Gradients

The river has an average gradient of approximately 6.3 ft/mile through the upper New River Basin (Appalachian 1991a), compared to an average gradient of 20 ft/mile one mile downstream of the Project and of approximately 24 ft/mile in the Buck bypass reach. The gradient of the Byllesby bypass reach is known to be steep as well, though detailed digital elevation model data is not available to calculate the gradient over this short (approximately 590 ft) reach.

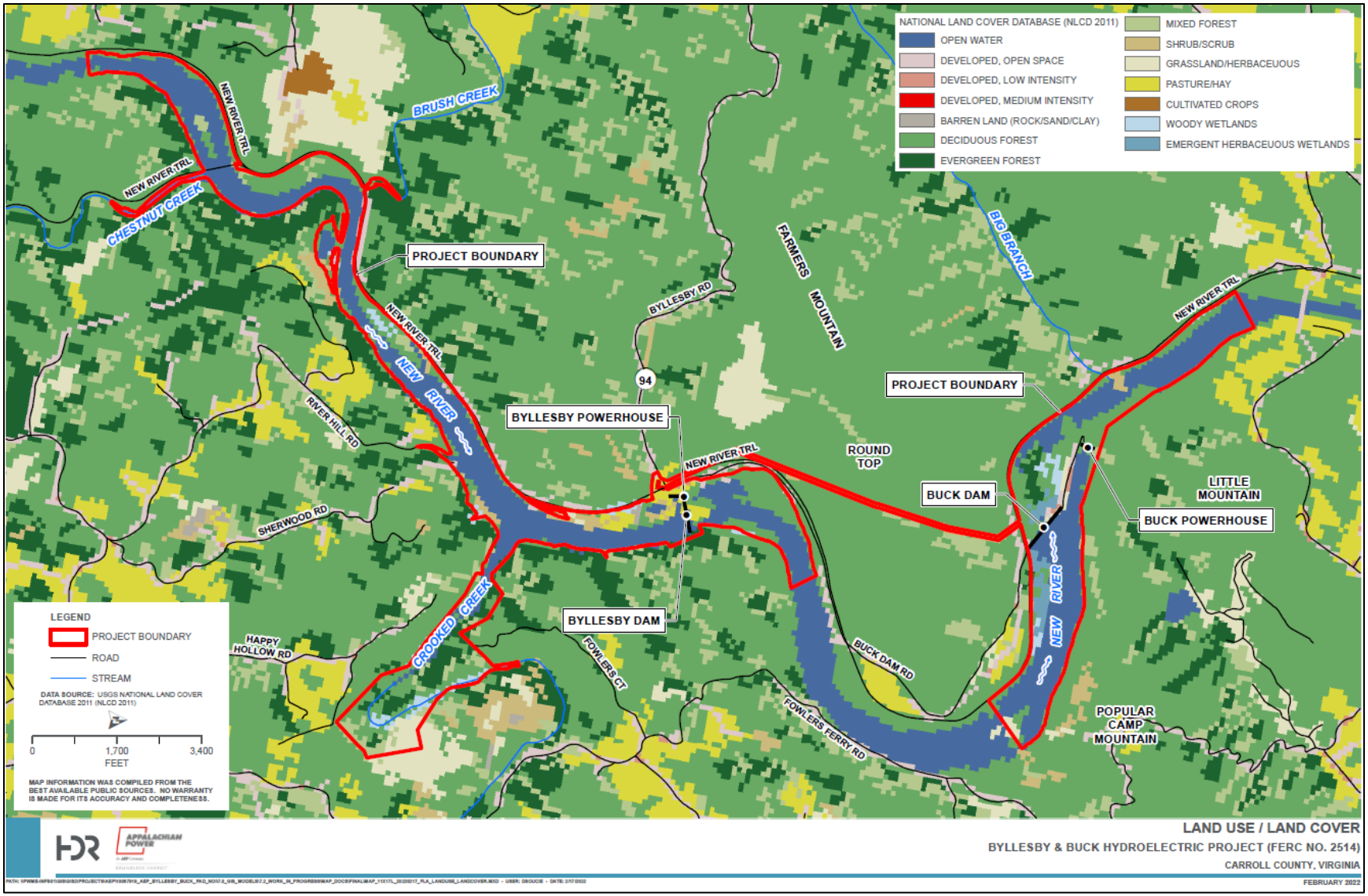


Figure E.2-1. Land Use and Land Cover

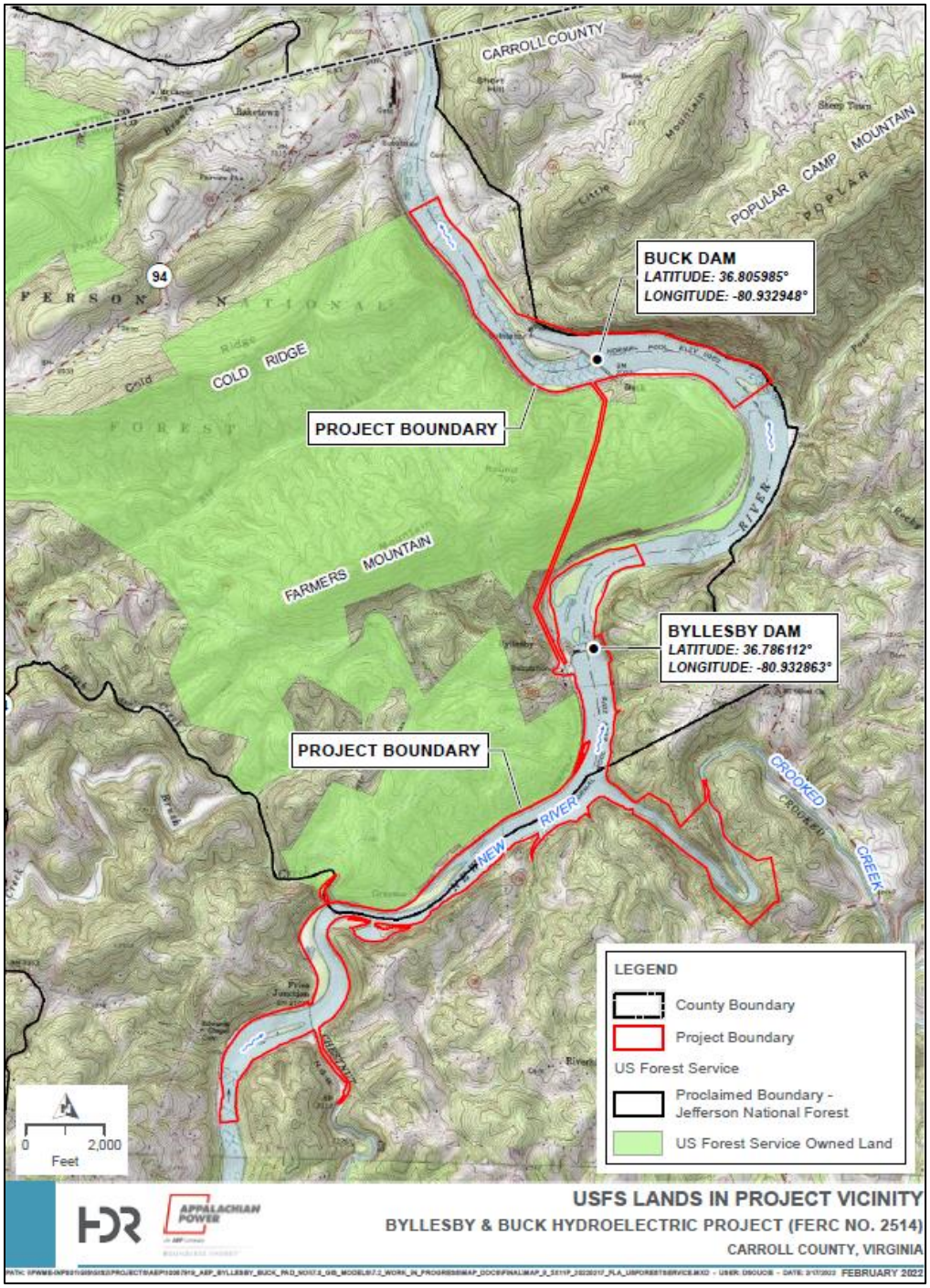


Figure E.2-2. USFS Lands in Project Vicinity[2]

[2] The transmission corridor crosses 7.23 acres of federal lands (Jefferson National Forest). Appalachian understands these lands to be held in easement as the corridor pre-dates the Jefferson National Forest. Based on publicly available parcel data, other areas of the Project Boundary overlap with the proclamation boundary of the Jefferson National Forest, but these lands are not federally held or subject to provisions of the Federal Power Act for licensing projects on federal lands (see 54 FERC ¶61,132 [1991]).

E.3 Cumulative Effects

According to the CEQ regulations for implementing NEPA (40 CFR § 1508.7), a cumulative effect was historically defined as the effect on the environment that results from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

However, in a final rule issued on July 15, 2020, CEQ revised its regulations under 40 CFR Parts 1500-1518 that federal agencies use to implement NEPA. The revised regulations repealed the definition of cumulative effects and provided a new definition for effects to be considered in the environmental analysis as follows; FERC's NEPA document will be consistent with this definition:

> *Effects or impacts means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives.*
>
> *(1) Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic (such as the effects on employment), social, or health effects. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.*
>
> *(2) A "but for" causal relationship is insufficient to make an agency responsible for a particular effect under NEPA. Effects should generally not be considered if they are remote in time, geographically remote, or the product of a lengthy causal chain. Effects do not include those effects that the agency has no ability to prevent due to its limited statutory authority or would occur regardless of the proposed action.*

On the basis of this regulatory change, and because FERC did not identify any resources that could be cumulatively affected by the proposed continued operation and maintenance of the Project in their scoping documents, Appalachian is not separately addressing cumulative effects in this FLA.

E.4 Compliance with Applicable Laws

E.4.1 Section 401 of the Clean Water Act

Under Section 401 of the Clean Water Act (CWA) (33 USC § 1251 et seq.), a federal agency may not issue a license or permit to conduct any activity that may result in any discharge into waters of the United States unless the state or authorized tribe where the discharge would originate either issues a Section 401 Water Quality Certification finding compliance with existing water quality requirements or waives the certification requirement. In the Commonwealth of Virginia, under § 62.1-44.15 of the Code of Virginia, the VDEQ provides Section 401 Water Quality Certification through the Virginia Water Protection (VWP) Program, as authorized by the State Water Control Law and as described in the VWP Permit Regulation.

Appalachian is preparing a joint permit application for a VWP permit and surface water withdrawal for the continued operation of the Project in parallel with the FERC licensing process and intends, to the greatest extent possible, to use licensing documents including but not limited to study reports and the license application exhibits to satisfy this parallel regulatory process. Requirements for a VWP permit are described in 9 Virginia Administrative Code (VAC) 25-210-80 and 9VAC25-210-340. Pursuant to 18 CFR § 5.23(b), Appalachian will file an application for water quality certification with VDEQ no later than 60 days of the Commission's Notice of Acceptance and Ready for Environmental Analysis. The VDEQ must act on the request for water quality certification within the one-year timeframe allowed under the CWA.

E.4.2 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) (19 USC §1536(c)), as amended, requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Under the ESA, the USFWS is responsible for freshwater and terrestrial species, and the National Marine Fisheries Service (NMFS) (National Oceanic and Atmospheric Administration [NOAA] Fisheries) is responsible for marine and anadromous species (not applicable to the Byllesby-Buck Project). In the notice of the Licensee's intent to file a FLA, filing of the PAD, commencement of pre-filing process, and scoping issued on March 26, 2019, the Commission designated Appalachian as the Commission's non-federal representative for carrying out informal consultation pursuant to Section 7 of the ESA. Information from the USFWS and the VDWR and collected during execution of the relicensing studies has been used by the Licensee to identify endangered or threatened species in the Project area. A discussion of the rare, threatened, and endangered (RTE) species relevant to the Project is contained in Sections E.9.1.5 and E.11.

E.4.3 Magnuson-Stevens Fishery Conservation and Management Act

The 1996 amendments to the Magnuson-Stevens Act authorized the NMFS, in accordance with regional fisheries management councils, to delineate essential fish habitat (EFH) for the protection of habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. Essential Fish Habitat includes "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Project area is not located within designated EFH for any species.

E.4.4 Coastal Zone Management Act

Section 307(c)(3) of the Coastal Zone Management Act requires that activities conducted or supported by a federal agency that affect the coastal zone be consistent with the enforceable policies of the federally-approved state coastal management plan to the maximum extent practicable. Policies associated with the Coastal Zone Management Act are not applicable to the Project, which is not located within Virginia's designated Coastal Zone. By letter dated September 1, 2017, VDEQ's Office of Environmental Impact Review confirmed that Carroll County is not located within Virginia's coastal management area and that it appeared to be unlikely that the Project would affect any land or water use or natural resources of Virginia's designated coastal resources management plans; therefore, a federal consistency certification is not required for this relicensing.

E.4.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 (NHPA) (54 USC §300101 et seq.) requires federal agencies to take into account the effects of their undertakings on historic properties and to afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on such actions. Historic properties include significant sites, buildings, structures, districts, and individual objects listed in or eligible for inclusion in the National Register of Historic Places (NRHP). If a property has not yet been nominated to the NRHP for determined eligible for inclusion, it is the responsibility of FERC to ascertain its eligibility.

The Commission's issuance of a new license for the continued operation of the Project is considered an undertaking subject to the requirements of Section 106 and its implementing regulations. FERC initiated consultation under Section 106 with federally recognized Indian tribes by letter dated April 25, 2018. By notice dated March 8, 2019, FERC designated Appalachian as its non-federal representative for purposes of conducting informal consultation pursuant to Section 106.

E.4.6 Wild and Scenic Rivers and Wilderness Act

The reach of the New River in the vicinity of the Project is not located within or adjacent to any presently designated National Wild and Scenic River systems or state protected river segments. The Project does not occur in or occupy lands designated as wilderness area under the Wilderness Act.

E.5 Project Facilities and Operations

E.5.1 Maps of Project Facilities Within Project Boundary

The following figures in this FLA depict the Project facilities within the Project Boundary:

- Exhibit G – Project Boundary Map (Volume III)
- Figure E.1.1 – Project Location Map with Project Boundary
- Figure A.2-1 and A.2-2 of Volume I, Exhibit A – Existing Project Facilities

E.5.2 Project Facilities

The Byllesby Development consists of (1) a 64-ft-high, 528-ft-long concrete dam, sluice gate, and main spillway section topped with four sections of 9-ft-high flashboards, five sections of 9-ft-high inflatable Obermeyer crest gates, and six bays of 10-ft-high Tainter gates; (2) an auxiliary spillway including six sections of 9-ft-high flashboards; (3) a 239-acre reservoir with a gross storage capacity of approximately 2,000 acre-ft; (4) a powerhouse containing four generating units with a total installed capacity of 18 MW; (5) a control house and switchyard; and (6) appurtenant facilities.

The Buck Development consists of (1) a 42-ft-high, 353-ft-long concrete dam and sluice gate; (2) a 1,005-ft-long, 19-ft-high spillway section topped with 20 sections of 9-ft-high flashboards, four sections of 9-ft-high inflatable Obermeyer crest gates, and six bays of 10-ft-high Tainter gates; (3) a 66-acre impoundment with a gross storage capacity of approximately 661 acre-ft; (4) a powerhouse containing three generating units with a total installed capacity of 8.087 MW; (5) a two 2-mile long overhead 13.2-kV transmission lines extending from the Buck powerhouse to the Byllesby control house; and (6) appurtenant facilities.

E.5.3 Project Waters

Both developments have little storage capacity or ability to regulate river flow; inflow is either used for generation or passed through the spillway. The reservoir formed by the Byllesby Dam is approximately 16.8 miles long with a surface area of 239 acres at EL. 2,079.2. The Byllesby Development includes a short, 590-ft-long bypass reach consisting primarily of exposed bedrock and rock outcroppings.

The reservoir formed by the Buck Dam is approximately 5.8 miles long with a surface area of 66 acres at EL. 2,003.4 ft. The Buck Development includes a 4,100-ft-long, steep bypass reach consisting of exposed bedrock.

Outflow from the Project is measured at the U.S. Geological Survey (USGS) gage 03165500 New River at Ivanhoe, VA gage, which is located approximately 3 miles downstream of the Buck Development.

E.5.4 Turbine and Generator Specifications

Existing turbine and generator specifications for both developments are included in Volume I (Exhibit A) of this FLA and are also provided in the tables below for reference.

Table E.5-1. Byllesby Turbine and Generator Data – Existing

Turbines	
Number of Units	4
Type	Vertical Francis, I.P. Morris Co.
Design Head	49 ft
Rated Capacity	6,000 hp / 4,500 kW (each unit)
Minimum Discharge	325 cfs (per unit)
Maximum Discharge	1,467 cfs (per unit)
Operating Speed	116 rpm
Generators	
Type	Vertical configuration, General Electric Co.
Rated Capacity	5,400 kW (per unit)
Power Factor	0.9
Phase	3 PH (per unit)
Voltage	13,200 V (per unit)
Frequency	60 Hz (per unit)
Synchronous Speed	116 rpm (per unit)

kW=kilowatt; rpm=revolutions per minute; PH=phase; V=volts; Hz=Hertz

Table E.5-2. Buck Turbine and Generator Data – Existing

Turbines	
Number of Units	3
Type	**Units 1 and 3:** Vertical Francis, I.P. Morris Co. **Unit 2:** American Hydro
Design Head	34 ft
Rated Capacity	**Units 1 and 3**: 3,500 hp / 2,626 kW **Unit 2:** 4,480 hp / 3,360 kW
Minimum Discharge	275 cfs (per unit)
Maximum Discharge	1,180 cfs (per unit)
Operating Speed	97 rpm
Generators	
Type	Vertical configuration, General Electric Co.
Rated Capacity	2,835 kW (per unit)
Power Factor	0.9
Phase	3 PH (per unit)
Voltage	13,200 V (per unit)
Frequency	60 Hz (per unit)
Synchronous Speed	97 rpm (per unit)

kW=kilowatt; rpm=revolutions per minute; PH=phase; V=volts; Hz=Hertz

E.5.5 Dependable Capacity and Average Annual Energy Production

The Project has been operated by Appalachian over the previous license term in a run-of-river mode, utilizing upper New River inflows to provide up to 30.1 MW of renewable capacity and average annual energy generation of 92,891 megawatt hours (MWh) based on recent generation data.

The Project operates to provide dependable winter and summer season capacities (combined for both developments) of 13 MW and 8 MW, respectively. These estimates are based on the monthly Project flow duration curves for the months of January (winter season) and August (summer season) and manufacturer's data relative to equipment performance.

E.5.6 Project Operations

The Byllesby-Buck Project operates in a run-of-river mode under all flow conditions. Because the Buck Development is approximately 3 miles downstream from the Byllesby Development, operations of the two developments are closely coordinated and operations at Buck are dependent on flows through Byllesby. Under normal operating conditions, Appalachian operates the Project to use available flows for powerhouse generation, maintaining the elevation of the Byllesby reservoir between 2,078.2 ft and

2,079.2 ft and the Buck reservoir between 2,002.4 ft and 2,003.4 ft. Appalachian is also required to release a minimum flow of 360 cfs or inflow to the Project, whichever is less, downstream of the Project powerhouses.

Under normal operating conditions, the minimum flow requirements and normal headwater elevation is maintained by passing flow through the turbine generating units. The unit operations are monitored and controlled either locally from the plant's computer or remotely from AEP's COC in Columbus, Ohio. Tainter gate and Obermeyer gate operation at both Byllesby and Buck are also remotely controlled from AEP's COC. Operators are stationed at the control center twenty-four hours per day, seven days per week. Plant personnel are typically present at the Project during normal working hours Monday through Thursday to perform routine maintenance. The plant is staffed four days a week (typically Monday through Thursday), 10 hours a day during normal operating conditions.

As further described in Exhibit B (Volume I of this FLA), when inflow to either development exceeds the discharge capacity of the powerhouse (5,868 cfs for Byllesby and 3,540 cfs for Buck), the Tainter gates and/or Obermeyer gates are opened to pass the excess flow. The Byllesby auxiliary spillway has historically been operated after all Tainter and Obermeyer gates have been opened and release of all wooden flashboard sections, typically at flows in excess of 46,690 cfs. Gate openings are planned and based on monitoring of the USGS gage 03164000 New River near Galax, VA and Byllesby and Buck forebay elevations. If inflows exceed the capacity of the Tainter and Obermeyer gates, the wooden flashboards are manually released. The wooden flashboards must then be re-installed during a period when the reservoir is drawn down to the spillway crest elevation.

Ramping rates are required under Article 406 of the license for the protection of fish resources downstream of the Buck spillway. The gradual reduction of flow allows fish to progressively leave the area, versus possible stranding at sudden flow discontinuation. Following periods of spill from the Buck spillway when a spillway gate has been opened 2 ft or more, Appalachian is required to discharge flows through a 2-ft gate opening for at least three hours. Appalachian is then required to reduce the opening to 1 ft for at least an additional 3 hours, after which Appalachian may close the gate.

E.6 Proposed Action and Alternatives

E.6.1 No-Action Alternative

Under the no-action alternative, the Project would continue to operate as required by the current license (i.e., there would be no change to the existing environment). No new environmental protection, mitigation, and enhancement (PM&E) measures would be implemented. This alternative establishes baseline environmental conditions for comparison with other alternatives.

The following resource protection measures are required by the existing license and implemented by Appalachian:

- Geological and Soil Resources
    - There are no specific license article requirements related to geology and soils for the Project; however, bank erosion is monitored annually by Appalachian in consultation with VDWR through implementation of the Wildlife Management Plan (WMP) required by Article 408. Operation of the Project in a run-of-river mode with maintenance of the reservoirs within a narrow operating band provides relatively stable water levels in the reservoirs that serve to reduce the potential for shoreline erosion due to Project operation.

- Aquatic Resources
    - Operate the project in a run-of-river mode, maintaining the Byllesby reservoir between EL. 2,078.2 ft and 2,079.2 ft and the Buck reservoir between EL. 2,002.4 ft and 2,003.4 ft (Article 401).
    - Provide a minimum flow of 360 cfs, or inflow to the Project, whichever is less, to the New River downstream of the powerhouse (Article 403).
    - Implement the existing ramping rate for the Buck bypass reach; whereby, following periods of spill when a spillway gate has been opened 2 ft or more, water will continue to be released into the bypass reach through a 2-ft-gate opening for at least 3 hours, then the gate opening will be reduced to 1 ft for 3 hours before closing the gate (Article 406).

- Terrestrial Resources
    - Continue to follow the Commission-approved WMP that includes provisions to annually inspect undeveloped land within the Project Boundary for evidence of increased human disturbance, consult with VDWR about activities that affect these lands, and notify VDWR of any unanticipated impacts within these lands (Article 408).

- Threatened and Endangered Species
    - There are no existing license article requirements related to threatened and endangered species for the Byllesby-Buck Project. However, due to the potential for protected species to occur in Project waters as later described in this document, Appalachian has performed, in consultation with natural resource agencies, species-specific surveys and mussel salvage efforts in support of recent reservoir drawdowns and other activities in support of Project maintenance activities.

- Recreation and Land Use and Aesthetic Resources
    - Continue to follow a Commission-approved Recreation Plan and continue to provide Project recreation access, monitor recreation use and demand, consult with interested stakeholders on potential recreation enhancement measures, and update the Recreation Plan as needed (Article 411).
- Cultural Resources
    - Continue to follow a Commission-approved Cultural Resources Management Plan (Article 409).

E.6.2 Applicant's Proposal

During the new license term, Appalachian proposes to modernize the Byllesby and Buck developments to include replacement of Byllesby Units 1, 2, and 4 and Buck Units 1 and 3. All but one (Buck Unit 2) of the seven turbine-generator units installed at the Project are the original major components of the Project as constructed in 1912. Many of the major electrical and mechanical and supporting systems and components of the Project are nearing the end of their useful service life, when compared to industry-recognized standards. Appalachian is presently planning a three-phase unit replacement program for the Project. The first phase involves the replacement of Byllesby Unit 4 starting in 2024. The second phase involves the replacement of Byllesby Units 1 and 2 in 2025 and 2026; existing Byllesby Unit 3 would remain in place and would be operated as last unit on and first unit off. The third phase involves the replacement of Buck Units 1 and 3 in 2027 and 2028, respectively. Existing Buck Unit 2 would remain in place and would be operated as last unit on and first unit off.

The existing vertical Francis units would be replaced by fixed blade Kaplan units. Unit upgrade activities would be confined to within the powerhouse, and there would be minimal changes to operating parameters for the Project. Following completion of the upgrades, the authorized installed capacities for the Byllesby and Buck developments will be 20.85 MW and 10.39 MW, respectively, with maximum hydraulic capacities of 5,511 cfs and 3,570 cfs, respectively. Due to efficiencies of the Kaplan units and modern components, the upgrades are expected to increase average annual generation at the Project compared to existing conditions by approximately 25,927 MWh. Upgraded

turbine and generator specifications are included in Volume I (Exhibit A) of this FLA and are also provided in the tables below for reference.

Table E.6-1. Byllesby Development Turbine and Generator Data – Proposed (Upgrades to Units 1, 2, and 4)

Turbines	
Number of Units	4
Type	**Units 1, 2, and 4:** Vertical Kaplan, Mavel **Unit 3:** Vertical Francis, I.P. Morris Co.
Design Head	**Units 1, 2, and 4:** 56 ft **Unit 3:** 49 ft
Rated Capacity	**Units 1, 2, and 4:** 7,371 hp / 5,528 kW (per unit) **Unit 3:** 6,000 hp / 4,500 kW
Minimum Discharge	**Units 1, 2, and 4:** 350 cfs (per unit) **Unit 3:** 325 cfs
Maximum Discharge	**Units 1, 2, and 4:** 1,348 cfs (per unit) **Unit 3:** 1,467 cfs
Operating Speed	**Units 1, 2, and 4:** 189.47 rpm **Unit 3:** 116 rpm
Generators	
Type	**Units 1, 2, and 4:** Vertical configuration, Mavel **Unit 3:** Vertical configuration, General Electric Co.
Rated Capacity	**Units 1, 2, and 4:** 5,885 kVA / 5,296.5 kW (per unit) **Unit 3:** 5,400 kW (per unit)
Power Factor	0.9
Phase	3 PH (per unit)
Voltage	13,200 V (per unit)
Frequency	60 Hz (per unit)
Synchronous Speed	**Units 1, 2, and 4:** 189.47 rpm (per unit) **Unit 3:** 116 rpm

Table E.6-2. Buck Development Turbine and Generator Data – Proposed (Upgrades to Units 1 and 3)

Turbines	
Number of Units	3
Type	**Units 1 and 3:** Vertical Kaplan, Mavel **Unit 2:** Vertical Francis, American Hydro
Design Head	**Units 1 and 3:** 42.4 ft **Unit 2:** 34 ft
Rated Capacity	**Units 1 and 3**: 4,400 hp / 3,300 kW (per unit) **Unit 2:** 4,480 hp / 3,360 kW
Minimum Discharge	**Units 1 and 3:** 300 cfs (per unit) **Unit 2:** 275 cfs
Maximum Discharge	**Units 1 and 3:** 1,195 cfs (per unit) **Unit 2:** 1,180 cfs
Operating Speed	**Units 1 and 3:** 156.52 rpm

	Unit 2: 97 rpm
Generators	
Type	**Units 1 and 3:** Vertical configuration, Mavel **Unit 2:** Vertical configuration, General Electric Co.
Rated Capacity	**Units 1 and 3:** 4,100 kVA / 3,690 kW (per unit) **Unit 2:** 2,835 kW
Power Factor	0.9
Phase	3 PH (per unit)
Voltage	13,200 V (per unit)
Frequency	60 Hz (per unit)
Synchronous Speed	**Units 1 and 3:** 156.52 rpm **Unit 2:** 97 rpm

The Licensee also proposes to continue the existing operation and maintenance of the Project, with updated or additional PM&E measures as follows:

- Continue to operate the Project in a run-of-river mode, maintaining the Byllesby reservoir between EL. 2,078.2 ft and 2,079.2 ft and the Buck reservoir between EL. 2,002.4 ft and 2,003.4 ft.

- Continue funding of the USGS New River at Galax and Ivanhoe gages.

- Continue to provide a minimum flow of 360 cfs, or inflow through the Project, whichever is less, to the New River downstream of each powerhouse.

- Implement a modified ramping rate for spillway gate operations at the Buck development; whereby, following periods of spill when a spillway gate has been opened 2 ft or more, water will continue to be released into the bypass reach through a 2-ft-gate opening for at least 2 hours, then the gate opening will be reduced to 1.0 ft for 2 hours and then to 0.5 ft for 2 hours before closing.

- Develop and implement a Bypass Reach Aquatic Resources Protection Plan in consultation with USFWS and VDWR and for FERC approval. The Bypass Reach Aquatic Resources Protection Plan will include provisions for the spillway gate and ramping rate procedures, measures to identify and address (through visual inspection and relocation, if appropriate) isolated incidents of fish stranding in isolated pools along the left descending bank in the Buck bypass reach, and measures to reduce impacts of scheduled powerhouse outages.

- Conduct Project maintenance and new license implementation activities, as applicable, in accordance the USFWS's prevailing eagle management guidance and regulations.
- Finalize and implement the Recreation Management Plan (RMP) in consultation with Project stakeholders, including provisions for improvements to existing Project facilities (Byllesby Boat Launch, Byllesby Dam Fishing Access, Byllesby Canoe Portage (Take-Out), New River Canoe Launch (Put-In), and Buck Canoe Portage (Take-Out and Put-In) as well as construction of the Non-Project Loafer's Rest Area and Fishing Trail.
- Finalize and implement the Historic Properties Management Plan (HPMP) in consultation with consulting parties (Tribes, State Historic Preservation Officer [SHPO], and FERC).

E.6.3 Alternatives

For the reasons described in FERC's SD3, Federal Government Takeover, issuance of a non-power license, and Project decommissioning are not considered to be reasonable alternatives based on the relicensing proceeding to date and are not expected to be analyzed in FERC's NEPA document.

E.7 Geology, Geomorphology, and Soils

E.7.1 Affected Environment

E.7.1.1 Geology

E.7.1.1.1 Regional Geology

The Blue Ridge Plateau begins just south of Roanoke, Virginia, and widens to nearly 50 miles, with Mount Rogers rising from the base. The Blue Ridge Plateau is a maturely dissected plain with rugged topography formed by numerous stream valleys that are 300 to 400 ft deep. The geologic structures comprising the region extend from the Roanoke, Virginia, area southwestward into Tennessee. The bedrock in this region has undergone folding and faulting (e.g., thrust faulting), which is apparent in cross-section. Thrust faults are shallow-dipping planar fractures which form in response to horizontal compressive stresses and oftentimes result in older rocks being placed on top of younger rocks. Lateral compression from the southeast formed these faults (as well as the northwestward displacements associated with them) during a mountain-building episode, or orogeny, during the late Paleozoic era (~200-245 million years ago). The original rocks from which these structures formed are of Precambrian and Cambrian age, and include igneous extrusive and intrusive rocks, sedimentary rocks, and several grades of derived metamorphic rocks. Overall, the regional geology of the Project area is quite complex, in part because the intense folding and southwest- to-northeast striking thrust faults have disrupted the original stratigraphic age relationships (Appalachian 1991a).

The effects of the late Paleozoic orogeny and subsequent erosion have resulted in the formation of parallel outcrops of rock ranging from less than one-tenth of a mile to several miles wide and extending many tens of miles trending in a southwest to northeast direction. The ages and geologic origins of adjacent rock units vary greatly and are often difficult to interpret due to overthrusting. Resistant rocks have formed ridges (i.e., sandstone and conglomerate) while less resistant rocks (i.e., limestone and shale) underlie valleys (Appalachian 1991a).

E.7.1.1.2 Local Geology

Although the Byllesby and Buck developments are within 1.2 miles of each other, they overlie different rock formations, both of Lower Cambrian age. The Byllesby Development is founded on a locally mapped arkosic unit of the middle member of the Unicoi Formation, and the Buck Development overlies the Erwin Quartzite, a slightly younger formation. These distinctions are explained below (Appalachian 1991a).

The Unicoi Formation occurs in a thin band about one mile wide, trending southwest to northeast between the Fries Overthrust to the southeast and the Byllesby Overthrust to the northwest. Approximately five miles southwest of the Byllesby Development, the Unicoi Formation bifurcates into westward and southwestward trending branches as it traces around the plunging Elk Creek Anticline. The Byllesby Development lies about 300 ft south of the Byllesby Overthrust. The Unicoi Formation contains arkosic, or feldspar-rich quartzite, shale, argillite, beds of conglomerate, and basalt flows. The middle member of this formation comprises the bedrock in the vicinity of the dam. Basalt flows with black argillite are present about 600 ft upstream of the dam, and a similar, locally mapped unit also containing arkose is found beneath the dam and on both abutments. The dam and its appurtenances are founded on bedrock because of very thin or absent soil cover in the area. The basalt is resistant to erosion and forms cliffs along the right side of the New River about one mile downstream of the dam (Appalachian 1991a).

Both abutments and the powerhouse of the Buck Development are founded on interbedded thin quartzite and dark shale of the lowest member of the Erwin Quartzite Formation. When exposed, the thinly bedded, dark-banded quartzite of this member weathers to a rust color. It is of medium hardness and is less resistant to weathering and erosion than the next younger member of the formation, known as the Ridge-making member. This Ridge-making member forms the caps of Farmer Mountain and Round top, about 0.7 miles southwest of the dam, and extends eastward forming prominent ledges along the river upstream of the Buck powerhouse. These ledges create falls in the river upstream (Appalachian 1991a).

E.7.1.1.3 Mineral Resources

Sandstone and quartzite are quarried in Carroll County for production of roadstone, concrete aggregate, asphalt stone, and manufactured fine aggregate (Virginia Division of Mineral Resources 1998). In the Blue Ridge Province, copper has been found in massive-sulfide zinc- and copper-bearing pyrrhotite deposits in the Late Precambrian Ashe Formation in Carroll County (Virginia Division of Geology and Mineral Resources 2015a).

E.7.1.2 Soils and Sediment

Soil types in the vicinity of the Project are variable and reflect the diversity of parent materials, the local topography, and the physiographic position of landforms (Woodward 1932). Mapped soils in the Project vicinity are shown on Figure E.7-1. The soils surrounding the Byllesby and Buck developments vary in depth from shallow to deep and include residuum from sandstone, granite, or greenstone. In the immediate Project area, soils consist of the Weikert and Ramsey soils series and are typified by high erosion potential.

The Weikert series consists of shallow, well-drained soils formed in material that weathered from interbedded gray and brown acid shale, siltstone, and fine-grained sandstone on gently sloping to very steep areas on uplands. Slopes range from 0 to 100 percent and permeability is moderately rapid (USDA 2009).

The Ramsey series consists of shallow and very shallow, somewhat excessively drained soils that formed in residuum or colluvium weathered from sandstone or quartzite. They are dominantly on plateaus and upper slopes of mountains. Runoff is moderate to rapid, permeability is rapid, and slopes range from 3 to 70 percent (USDA 2001).

The construction of the Project over a century ago contributed to sediment deposition and accumulation in the reservoirs; however, the rate of sediment deposition has stabilized over recent decades. As summarized in Appalachian's sedimentation study performed during the Claytor Project relicensing (Appalachian 2008), the New River carries a large amount of sand as bed material and suspended (during high flows) sediment from its headwaters to Claytor Lake. These high sand loads have filled the reservoir created by Fields Dam, and deposits extend past the Highway 94 Bridge near Galax. Downstream of Fields Dam, the reservoir formed by Fries Dam is also characterized by high rates of sediment deposition in the bay upstream of Fries Dam, which requires periodic "flushing". Downstream of Fries Dam, high sediment loads and bed sedimentation continue through to the Byllesby-Buck Project. Watershed sedimentation modeling completed for the Claytor study concluded that the run-of-river Byllesby-Buck reservoirs have little retention capacity, and suspended sediments are carried downstream to the Claytor Project, where it is deposited into long-term storage.

Findings of the study performed for the Claytor relicensing included the following (Appalachian 2008):

- Sedimentation occurred throughout Claytor Lake but was most pronounced in bays, coves, and tributary inlets, where sediments included a mixture of coarser sand and gravel from upstream channel sources, fine sediments from upland soil erosion, and organic matter deposits from terrestrial and aquatic sources.

- Due to the prevalence of bedrock and stable shorelines in Claytor Lake, shoreline erosion was not found to be significant sediment source to the Claytor Project.

- The largest source of contemporary sediment was determined to be soil erosion from watershed disturbances, primarily from agricultural lands.

A sedimentation study, consisting of desktop assessment and a field survey of the reservoir to try to estimate current storage volume, was also conducted for the Fries Project relicensing (Kleinschmidt 2017). The results of this study demonstrated the difficulty of comparing impoundment storage capacity measurements due to error introduced by different survey methods: the results of the study

(presumably erroneously) suggested an increase in storage volume compared to historical surveys. The authors of this study report suggested that the Fries reservoir has likely reached a period of sediment balance, where sediment is passing the dam (Kleinschmidt 2017).

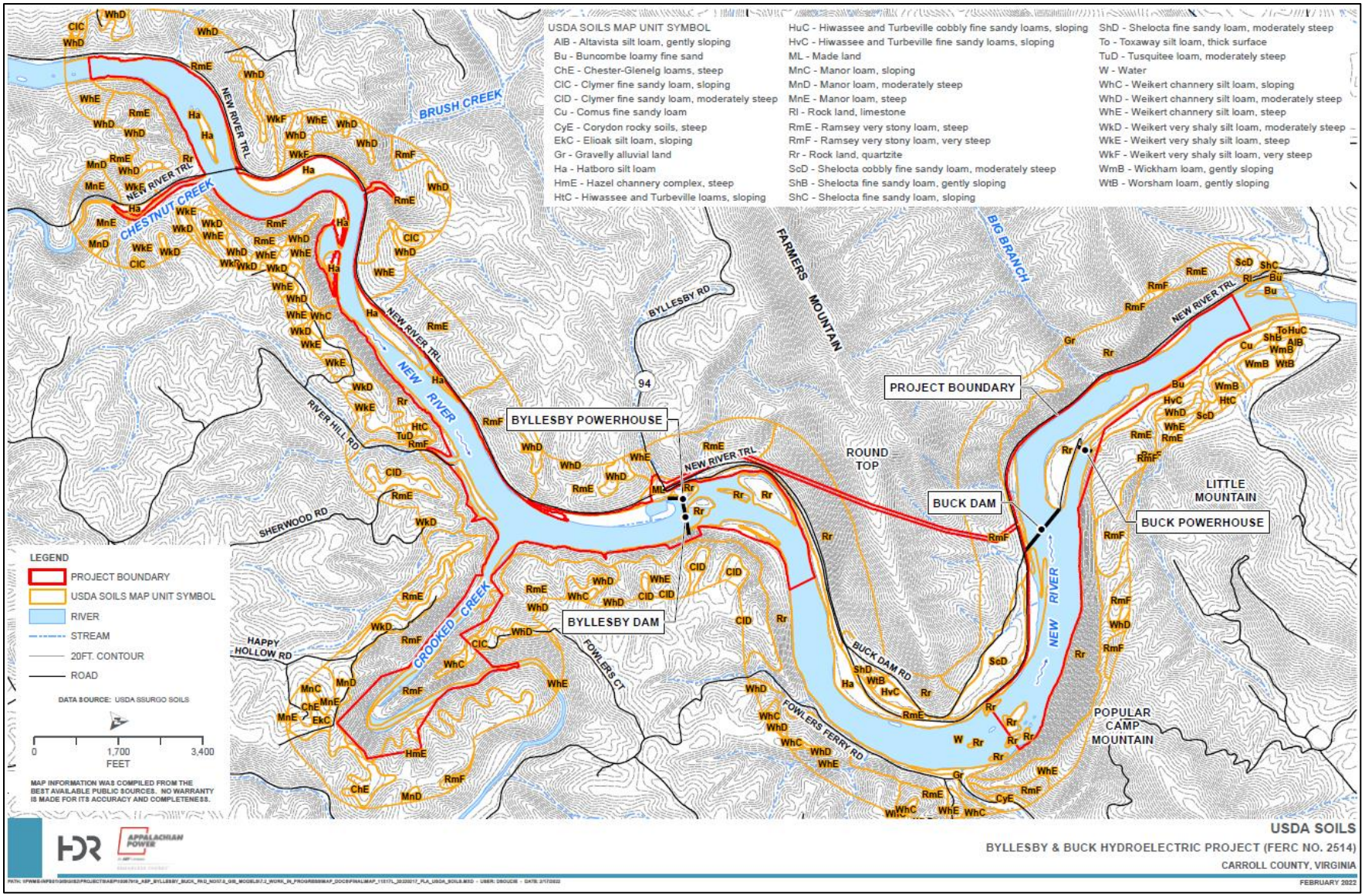


Figure E.7-1. Mapped Soils in the Vicinity of the Project

E.7.1.3 Shorelines and Streambanks

In the Project area, the New River has carved moderately steep valley walls, ranging in height from about 50 ft to several hundred feet (FERC 1994). Soils along the Project shoreline largely consist of steep to very steep, very stony Ramsey soil or quartzite rock. Because much of the shoreline is exposed bedrock, the limited extent and total thickness of soils limits the depth of erosion and slips, and such areas are expected to be limited to areas where vegetation cover is absent. Established vegetative cover is extensive along the shorelines of the Project, which helps to limit the extent and severity of erosion and movement of soils in the Project area that otherwise have high erosion potential. Additionally, accumulation of sediment along some portions of the Project shorelines has formed permanent riparian wetland communities, providing additional protection against shoreline erosion.

Appalachian conducted a Shoreline Stability Assessment for the Project in the summer of 2021 as one of the eight studies for the relicensing effort. Details are provided in Section E.7.2.1.1.

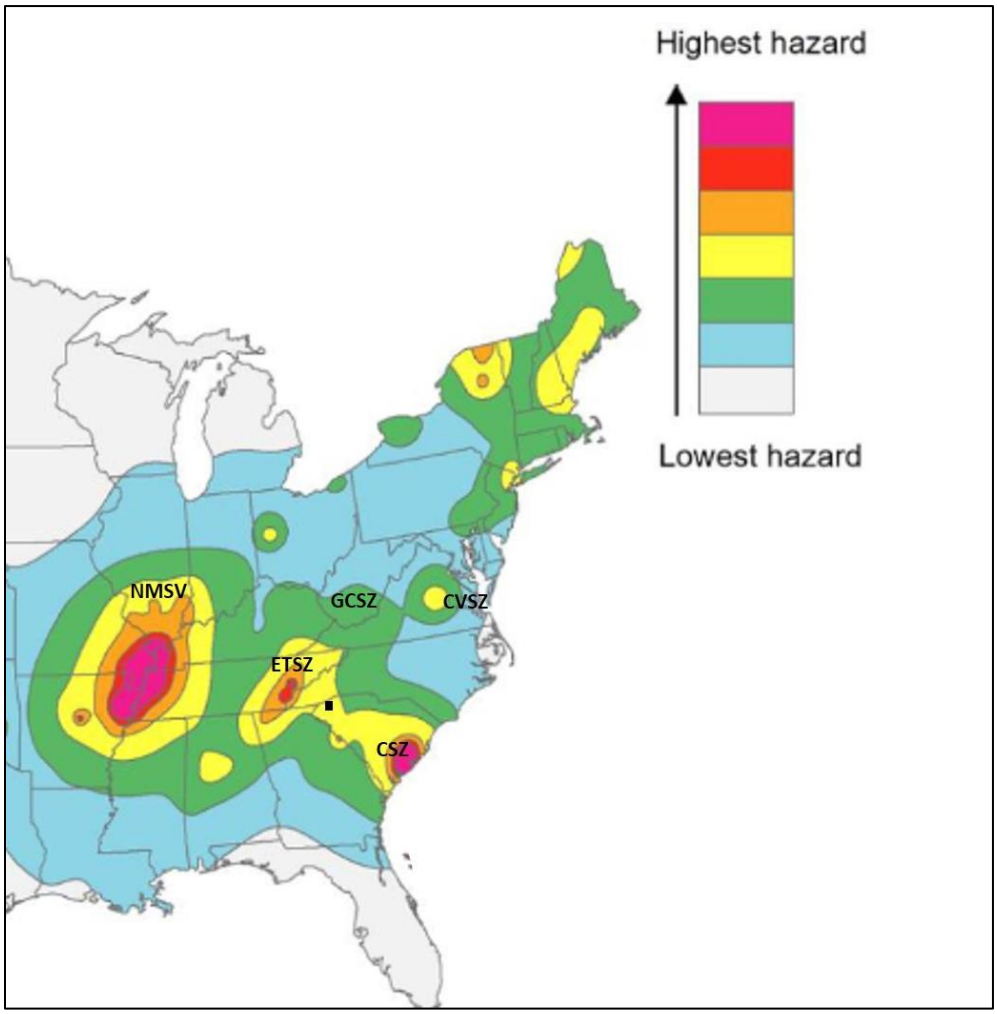
E.7.1.4 Seismicity

Most faults and fault sequences in the state of Virginia are considered inactive. Earthquakes that have occurred in the region are associated with three major seismic zones including the Central Virginia Seismic Zone (CVSZ), the Giles County Seismic Zone (GCSZ), and the Eastern Tennessee Seismic Zone (ETSZ). The GCSZ borders the state of West Virginia in southwestern Virginia and extends into the New River Valley, which includes Carroll County (Virginia Division of Geology and Mineral Resources 2015b). The Project is located to the east of the GCSZ and southwest of the CVSZ.

The Central Virginia Earthquake of August 23, 2011 (moment magnitude scale [M_w] 5.7 - 5.8) was the largest earthquake in the central and eastern United States since the 1886 Charleston, South Carolina earthquake (estimated M_w 6.8 - 7.0). The earthquake occurred on a north or northeast-striking plane with reverse faulting within the CVSZ. The CVSZ is located in the Appalachian Piedmont Province between Richmond and Charlottesville, Virginia (see Figure E.7-2). The depth of the earthquakes ranges from near surface to 12 kilometers, placing them above the Appalachian detachment (Chapman 2015) in contrast to the Eastern Tennessee Seismic Zone, where earthquakes occur below the detachment. The CVSZ has produced small and moderate earthquakes since at least the 18th century. The previous largest historical shock from the CVSZ occurred in 1875. Additionally, a magnitude VIII event (Modified Mercalli Intensity Scale) occurred in Giles County, Virginia in May of 1897. It was felt in the Project area with chimneys shaken down in Roanoke.

More recently, a 5.1-M_w magnitude occurred on August 9, 2020 with an epicenter near Sparta, approximately 25 miles southeast of the Project and just south of the Virginia-North Carolina border (Figure E.7-2). The earthquake caused damage to over 500 buildings and other infrastructure (Hill 2020). It has not been determined whether the isolated event is associated with the GCSZ or the CVSZ (or neither).

Regional seismic activity in the area is considered low, with low to moderate peak ground acceleration values as determined by the USGS (USGS 2018).



Note: GCSZ = Giles County Seismic Zone; ETSZ = East Tennessee Seismic Zone; CVSZ = Central Virginia Seismic Zone; CSZ = Charleston Seismic Zone; NMSZ = New Madrid Seismic Zone. Project location indicated by black square (source: USGS)

Figure E.7-2. Relative Seismic Hazard in the Southeastern U. S. with Identified Seismic Zones (modified from USGS 2018)

E.7.2 Environmental Analysis

E.7.2.1 Studies in Support of the Current Licensing

E.7.2.1.1 Shoreline Stability Assessment

Appalachian conducted a Shoreline Stability Assessment for the Project in June 2021 as one of the eight studies for the relicensing effort. The study area for the Shoreline Stability Assessment Study includes the reservoir shorelines, bypass reaches, and tailrace areas downstream of the Byllesby and Buck powerhouses. A summary of the methods and results of the Shoreline Stability Assessment is provided in this section and details are provided in Appendix F, Volume II of this FLA. The specific objectives of the Shoreline Stability Assessment are included below:

- Survey each development's reservoir, bypass reach, and tailrace area to characterize the shoreline, with the focus on erosion or shoreline instability using the Bank Erosion Hazard Index (BEHI; WVDEP 2015);
- Inventory, map, and document any areas of erosion or shoreline instability; and
- Prioritize any areas where remedial action or further assessment may be needed.

E.7.2.1.2 Existing Background Information

Soils along the Project shoreline largely consist of steep, stony Ramsey soil or quartzite rock. Established vegetative cover is extensive along the shorelines of the Project reservoirs, which helps limit the extent and severity of erosion and movement of soils in the study area. Common causes of normal bank/shoreline erosion include wave action, significant changes in water levels, rill/gullies, bank rotation, and seepage/frost wedge.

Accumulation of sediment along some portions of the Project shoreline has formed permanent riparian wetland communities, providing additional protection against shoreline erosion. Areas of shoreline erosion are mainly concentrated in areas absent of vegetation or in areas susceptible to high flows during run-off events, such as the transition areas between riverine and reservoir at the upper limits of the study area, the rapids between the dams and the tailrace below Buck Dam, and in the larger tributaries such as Crooked Creek and Chestnut Creek.

E.7.2.1.3 Methods

The Shoreline Stability Assessment was performed as a desktop analysis followed by field confirmation of shoreline areas within the study area, including the reservoir, bypass reach, and tailrace areas identified in the desktop analysis as requiring confirmation or additional investigation.

Relevant literature and data were reviewed including ESRI Geographic Information System data, Virginia Geographic Information Network aerial photos, USGS maps, and Natural Resources Conservation Service soil surveys to assess bank composition and erosion potential in the study area. The field surveys for the Shoreline Stability Assessment were conducted on July 20-22, 2021. Streambanks were assessed based on visual observations by two, two-person field crews either by canoe or walking along the streambanks. Best professional judgement was used to estimate root depths and density since bank materials were not disturbed or removed during the study.

Bank stability and erosion potential for this study effort was analyzed using the Rosgen (2001) BEHI method and the West Virginia Department of Environmental Protection (WVDEP) complete BEHI procedure (WVDEP 2015). The BEHI method assesses physical and geomorphic properties of the streambank to validate the probable sources of bank instability using streambank variables. The metrics used to estimate BEHI include ratio of bank height to bankfull height (BH), ratio of root depth to bank height (RDH, root density percentage (RD), surface protection percentage (SP), and bank angle in degrees (BA) (WVDEP 2015).

E.7.2.1.4 Results

Of the approximately 7.25 miles of New River shoreline assessed, results of the field investigation indicated that approximately 80 percent of the shoreline within the study area exhibited no signs of erosion. The areas identified as having some degree of shoreline erosion had average BEHI scores ranging from 11.75 (low) to 33.85 (high). There were no areas categorized as having very high or extreme erosion potential. The average scores for each area of erosion are provided in Table E.7-1 and Figure E.7.1 shows the locations of the erosion areas assessed within the study area.

Table E.7-1. BEHI Scores for Erosion Areas of Shoreline Stability Assessment

Erosion Area	Length (linear ft)	Average of BH Score	Average of RDH Score	Average of RD Score	Average of SP Score	Average of BA Score	Average of Total Score by Category	Category
Erosion Area 1	286	2.95	6.95	6.95	6.95	4.95	28.75	High
Erosion Area 2	92	4.95	8.50	8.50	6.95	4.95	33.85	High
Erosion Area 3	199	4.95	2.95	4.95	4.95	4.95	22.75	Moderate
Erosion Area 4	3,006	4.95	6.95	4.95	1.45	6.95	25.25	High
Erosion Area 5	423	6.95	4.95	6.95	2.95	4.95	26.75	High
Erosion Area 6	508	6.95	4.95	6.95	2.95	4.95	26.75	High
Erosion Area 7	190	4.95	4.95	4.95	2.95	6.95	24.75	Moderate
Erosion Area 8	141	4.95	4.95	4.95	2.95	6.95	24.75	Moderate
Erosion Area 9	92	6.95	4.95	4.95	4.95	6.95	28.75	High
Erosion Area 10	107	4.95	4.95	2.95	4.95	6.95	24.75	Moderate
Erosion Area 11	295	4.95	4.95	2.95	4.95	6.95	24.75	Moderate

Erosion Area	Length (linear ft)	Average of BH Score	Average of RDH Score	Average of RD Score	Average of SP Score	Average of BA Score	Average of Total Score by Category	Category
Erosion Area 12	261	1.45	4.95	2.95	4.95	6.95	21.25	Moderate
Erosion Area 13	215	4.95	4.95	2.95	4.95	6.95	24.75	Moderate
Erosion Area 14	1,587	1.45	4.95	2.95	4.95	6.95	21.25	Moderate
Erosion Area 15	1,550	1.45	2.95	1.45	2.95	2.95	11.75	Low

Note: bankfull height=BH, ratio of root depth to bank height=RDH, root density percentage=RD, surface protection percentage=SP, and bank angle in degrees=BA

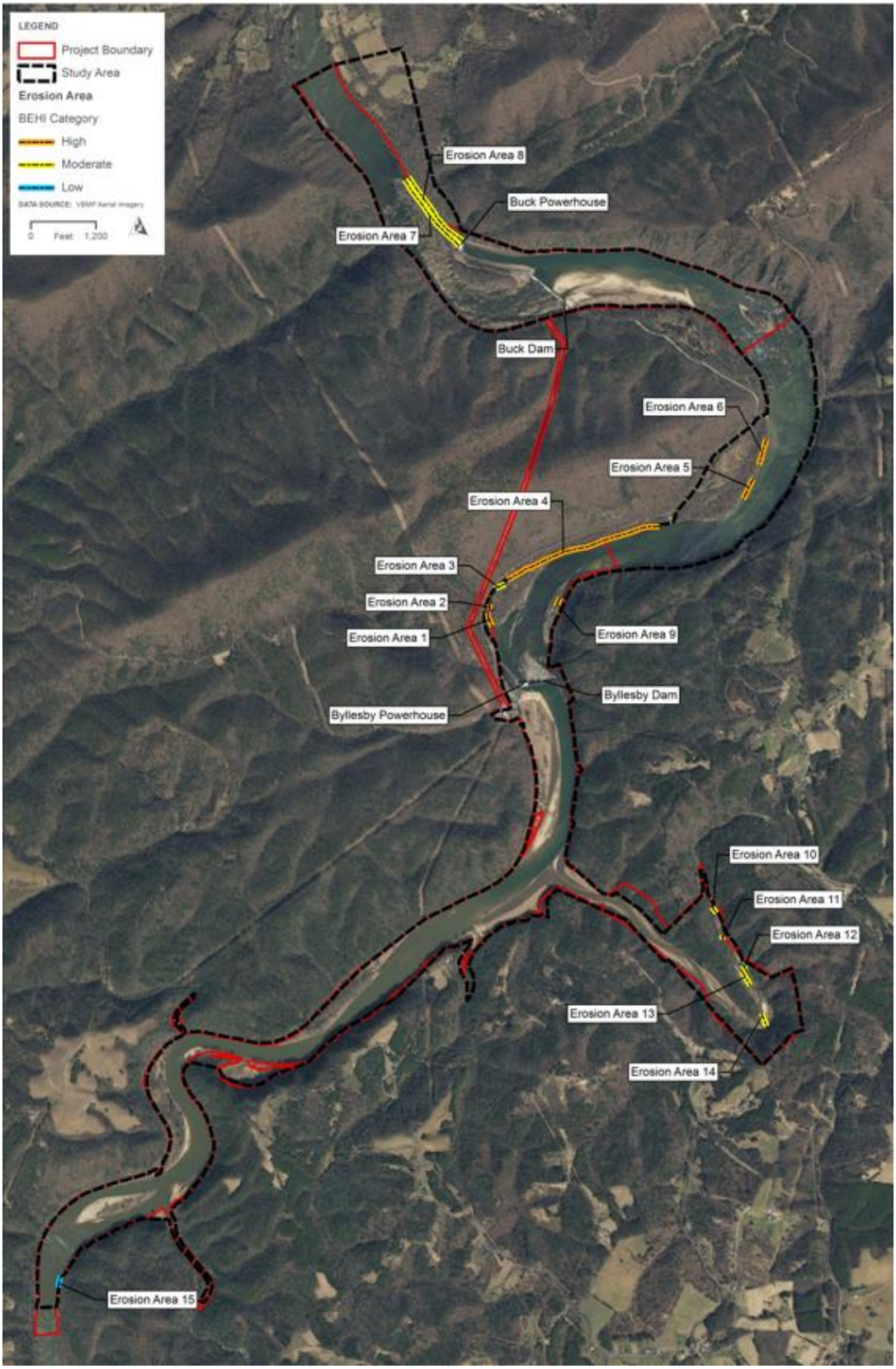


Figure E.7.1. Erosion Areas in the Study Area Categorized by BEHI

The Shoreline Stability Assessment provides an evaluation of the relative erosion hazard of 7.25 miles of New River shoreline based on the observed bank conditions. Study results indicated that approximately 80 percent of the shoreline within the study area exhibited no signs of erosion, with remaining areas ranging from "low" to "high" BEHI scores based on Rosgen's (2001) methods under present conditions. Erosion Areas 1, 2, 4, and 9, downstream of Byllesby Dam, are the most susceptible to erosion. Erosion Areas 1 and 2, which scored "high", are adjacent to the New River Trail State Park. Erosion Area 4 comprises one large area that was classified as "high" erosion potential; this area is also adjacent to New River Trail State Park, but the multi-use trail and road are farther from the river at these locations. Just downstream of Area 4, Areas 5 and 6 also scored "high"; these areas are farther away from the New River Trail State Park.

Under the new license term, Appalachian proposes to continue operating the Byllesby and Buck developments as they are presently operated, including run-of-river operations and maintenance of existing vegetated and buffer areas. Soils along the Project shorelines largely consist of steep to very steep, very stony Ramsey soil or quartzite rock. Because much of the shoreline is exposed bedrock, the limited extent and total thickness of soils limits the depth of erosion and slips, and such areas are expected to be limited to areas where vegetation cover is absent. Established vegetative cover is extensive along the shorelines of the Project, which helps to limit the extent and severity of erosion and movement of soils in the Project area that otherwise have higher erosion potential.

Overall, visual inspection of the Project shoreline during this study indicated stable banks, no noticeable aggradation/degradation, and only localized streambank erosion, which is an important process in maintaining habitat for aquatic resources. Appalachian does not, therefore, propose remediation of any shoreline areas in the Project Boundary or study area at this time.

E.7.2.1.5 Turbidity Study

Appalachian performed a turbidity study to evaluate the potential impact that Project operations, in particular drag rake operations, may have on turbidity concentrations in the Project tailraces[3]. The study was conducted in two phases under relatively low flow conditions during late-September and mid-October 2021. The first phase consisted of a one-week deployment of five Hydrolab data sondes equipped with turbidity sensors installed at each of the locations listed below (which coincide with the continuous water quality monitoring locations shown on Figure E.8.1).

[3] For the continuous turbidity monitoring study, HDR rented MS5 data sondes from OTT HydroMet. The turbidity sensors installed in the MS5 data sondes were provided by Turner Designs.

- One location in the upstream extent of the Byllesby reservoir (to characterize background turbidity levels)
- One location in the Byllesby forebay (approximate mid-depth)
- One location in the Byllesby tailrace below the powerhouse
- One location in the Buck forebay (approximate mid-depth)
- One location in the Buck tailrace below the powerhouse

The data sondes were deployed from September 28 through October 5, 2021 and set to record turbidity concentrations at 5-minute intervals. Appalachian operated the generating units and drag rakes at each Project under a normal operating regime. Due to the relatively low Project inflows which carried little debris, the drag rakes were set to operate just once per day during the morning hours (i.e., from 7–10 am) during the field collection effort. Results from this one-week deployment are provided in Appendix B of this FLA. Only the Byllesby upstream data sonde and Buck tailrace data sonde operated continuously during the one-week deployment; the other three data sondes ceased operating within hours of their deployment.

Due to the turbidity sensor failures and low frequency of drag rake operations during the one-week study period, a second phase was added to the original study to collect turbidity data at the Buck forebay and tailrace monitoring locations[4] over a one-day period on October 14, 2021. During this second phase, generation at the Buck Development was held relatively steady and the drag rakes were operated approximately every 30 minutes throughout the sampling period. This resulted in 15 discrete drag rake operating events (Figure E.7.2). Turbidity values in the tailrace were slightly higher than in the forebay, but low overall (ranging from approximately 5–12 Nephelometric turbidity units [NTU]). Drag rake operations are provided on this figure and there is no discernable effect on turbidity concentrations in the tailrace immediately following drag rake operations. A discrete measurement of turbidity concentrations at the Byllesby upstream monitoring location yielded a range of 4–6 NTU which represents turbidity concentrations of Project inflows during this second phase sampling event. Results indicate that during periods of low Project inflows, turbidity entering the Byllesby reservoir is correspondingly low, typically < 3.0 NTU. Turbidity concentrations in the Buck tailrace during the one-week study were also low and ranged from approximately 3.0–6.0 NTU[5].

[4] During the second phase of the turbidity study, Byllesby was in a planned maintenance outage to repair the intake structure trash racks. As a result, the Byllesby drag rakes were not operating and Project inflows were routed through the spillway structure instead of the powerhouse.

[5] The turbidity sensors use infrared wavelength to measure turbidity concentrations in the water column. The daily NTU cycling effect (see Water Quality Study Report – Volume II, Appendix B of this FLA) at the Byllesby upstream and Buck tailrace monitoring locations is likely due to sunlight interference with the turbidity sensors (which is inherent in continuous in-situ sampling). Baseline turbidity concentrations would be during nighttime hours when sunlight interference is minimized.

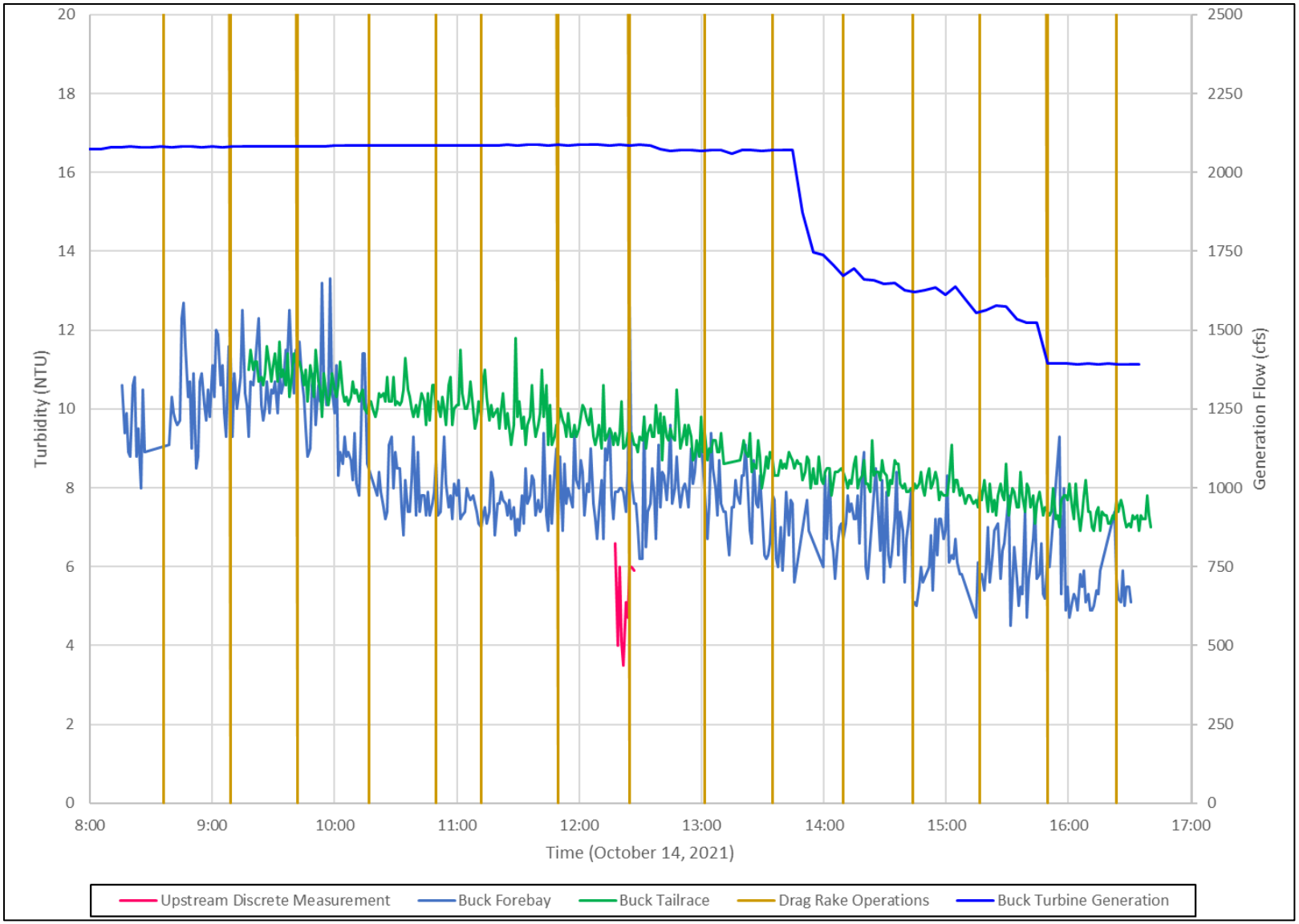


Figure E.7.2. Turbidity and Buck Generation and Drag Rake Operations, October 14, 2021

E.7.2.2 Project Impacts on Geology, Geomorphology, and Soils

In SD3, FERC identified two environmental issues related to geologic and soils resources to be addressed in its NEPA document:

- Effects of continued project operation and maintenance on shoreline erosion in the impoundments at each development (Buck and Byllesby).

- Effects of continued project operation and maintenance (including localized maintenance dredging via the project's drag rakes and more infrequent impoundment-wide dredging after large storm events) on sedimentation in the project impoundments and sediment transport through each development, including the potential for the remobilization of polychlorinated biphenyls (PCBs).

Appalachian anticipates that the existing run-of-river mode—including stable reservoir surface elevations—at the Project, in combination with the vegetated and undeveloped nature of the shorelines in the Project Boundary, provide protection against bank erosion. Periodic drawdowns for maintenance work do have the potential to contribute to shoreline erosion through localized bank failure and sloughing. Additionally, if a rain event would occur during a scheduled drawdown, the lower banks of the shoreline, which are typically covered by water, could be subject to erosion. However, areas of significant shoreline erosion were not observed during the Shoreline Stability Assessment performed for this relicensing.

Based on the results of the above-referenced sedimentation study conducted for the Claytor relicensing (Appalachian 2008), most of the sediment load that enters the Byllesby and Buck developments is expected to pass through the Project and be deposited downstream. The sediment that does accumulate in the Project reservoirs has resulted in minor loss of reservoir gross storage capacity, but this does not normally affect operation, hydraulic capacity, or generation. Over time, however, and at specific areas such as the dam and intake, sedimentation may affect specific Project operations. Historically, Appalachian has removed accumulated sediment on an as-needed basis. Significant maintenance dredging was performed at the Project in 1997. During this maintenance dredging project, accumulated sediment along a 250-ft by 350-ft area along the upstream face of the dam was hydraulically dredged to reestablish the intake area and maintain operability of the auxiliary spillway. The dredged material was used to create a new 6-acre area of emergent wetlands (Byllesby wetland; see Section E.10.1). All work was conducted in accordance with the terms and conditions of permits and approvals by USACE and the VDEQ, as further authorized by standard FERC license article 12. Prior to dredging, sediment was subject to sediment toxicity testing to confirm the

appropriateness of placing dredged materials in the proposed upstream mitigation site, as required by the VWP Permit issued for this maintenance activity. The most recent dredging activity at the Project was conducted at the Byllesby Development forebay in 2014 following flooding that occurred at the Project in 2013. This work was also conducted pursuant to the terms and conditions of approvals and permits issued by USACE and VDEQ, as authorized by FERC license article 12. Materials removed as part of dredging were beneficially reused off-site after being tested for various constituents. Based on visual observations, sediment that accumulates in the Byllesby forebay is sandy. The risk of PCB adsorption generally decreases with sediment particle size (Krauss and Wilcke 2002); this, combined with analyses from previous sediment sampling conducted in association with dredged material disposal, supports that sediment transport through the Project presents a low risk for PCB remobilization.

The recent installation of inflatable Obermeyer crest gates is expected to reduce the frequency and duration of maintenance drawdowns, thereby minimizing the resultant potential for shoreline erosion.

Over the course of this relicensing, Appalachian's consultants had the opportunity observe this reach of the New River under a range of flow conditions, including periods following significant precipitation events. Above, throughout, and below the Project area, turbidity levels (based on visual appearance) significantly increase during and following rainfall-runoff events and recede in between events. This naturally occurring phenomenon of increased water turbidity due to precipitation and overland runoff can also be seen in the lower New River (see, for example, turbidity data available for the past two years at USGS gage 03185400, New River at Thurmond, WV), and in rivers and streams throughout the region. As described above, Appalachian performed a turbidity study to assess the potential impacts of continued operation of the Project's drag rakes on turbidity in the reservoir and downstream. Results indicate that the effects of sediment resuspension (and potential subsequent transport of resuspended sediment) due to operation of the drag rakes is negligible relative to background turbidity levels. Maximum turbidity concentrations based on the grab sample data were 16.9 NTU and 8.0 NTU at the Byllesby and Buck forebay monitoring locations, respectively. The continuous turbidity monitoring study also yielded relatively low overall turbidity concentrations (typically < 12.0 NTU) and there were no discernible effects (i.e., increases in turbidity) resulting from station operations and maintenance activities such as routine intake structure drag rake operations.

The Licensee does not anticipate that operation and maintenance of the Project over the new license term will have any long-term, unavoidable, adverse impacts on geology, geomorphology, and soils.

E.7.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Appalachian proposes to continue operating the Byllesby and Buck developments as they are presently operated, including run-of-river operations and maintenance of existing vegetated and buffer areas.

Appalachian will evaluate opportunities to improve sediment transport through the Project's forebay and intake areas to reduce deposition and the frequency of periodic maintenance drawdowns through normal Project operations and maintenance over the new license term. Coordination of future sediment removal with USACE and VDEQ will be performed, when required, pursuant to standard license article 12 and any additional permits or approvals required for such activities. Any ground disturbance of shorelines or streambanks will be subject to the erosion control protections and requirements of the new license and the VWP permit.

Preliminary results of the Shoreline Stability Assessment indicated that banks are stable and do not show signs of mass wasting or slumping. The WMP required by Article 408 of the existing license and implemented by Appalachian is intended, in part, to provide a means of visually monitoring for bank erosion. No signs of shoreline erosion have, however, been identified during this annual visual monitoring. Appalachian does not propose to continue the WMP during the term of the new license.

Appalachian does not believe that additional PM&E measures beyond the standard license article requirements are required for the protection of geology, geomorphology, and soils.

E.8 Water Use and Quality

E.8.1 Affected Environment

E.8.1.1 Drainage Area

The drainage area for the Byllesby Development is 1,310 square miles. The drainage area for the Buck Development is 1,320 square miles. The USGS gage 3165500 (New River at Ivanhoe, VA) is located approximately 2.8 miles downstream of the Buck Development; the drainage area at this gage is 1,350 square miles.

E.8.1.2 River Flows

New River streamflow characteristics are typical of the southeastern U.S.; river flows are typically higher in the winter and spring and lower in the summer and fall. For the purposes of this document, flows at the Project were estimated from the downstream USGS gage 03165500 New River at Ivanhoe, VA, and prorated for the drainage areas at the Project developments. Annual and monthly flow duration curves have been developed for the Project using gage flow data (prorated for the drainage area of the Project developments). These flow duration curves are included in Exhibit B of Volume I of this license application.

The estimated daily flows are considered to be representative of discharge from run-of-river operation of the Project. Flow statistics for the Byllesby and Buck developments are shown in Table E.8-1 and Table E.8-2, respectively. Monthly daily average flows for the Project for the period of record (POR) range (at Byllesby) from 1,453 cfs to 3,068 cfs (Table E.8-1). A significant historic flood for which streamflow data is available occurred in August 1940 with a flow of 141,000 cfs

Table E.8-1. Byllesby Project Daily Flow Data (1996-2020)

Period	Minimum (cfs)	90% Exceedance (cfs)	Average (cfs)	10% Exceedance (cfs)	Maximum (cfs)
January	393	949	2,553	4,493	32,701
February	582	1,164	2,869	4,858	26,588
March	762	1,372	2,833	4,423	16,205
April	1,067	1,493	3,068	4,572	23,386
May	804	1,232	2,849	4,569	40,173
June	448	819	2,120	3,717	20,475
July	365	801	1,681	2,447	21,833
August	176	594	1,453	2,859	22,707

Period	Minimum (cfs)	90% Exceedance (cfs)	Average (cfs)	10% Exceedance (cfs)	Maximum (cfs)
September	244	564	1,564	2,747	29,693
October	263	595	1,596	2,826	29,111
November	440	652	1,892	3,359	27,753
December	551	817	2,360	4,062	19,310
Annual	508	921	2,236	3,744	25,828

Table E.8-2. Buck Project Daily Flow Data (1996-2020)

Period	Minimum (cfs)	90% Exceedance (cfs)	Average (cfs)	10% Exceedance (cfs)	Maximum (cfs)
January	396	956	2,572	4,527	32,951
February	587	1,173	2,891	4,895	26,791
March	768	1,383	2,855	4,457	16,329
April	1,076	1,505	3,092	4,607	23,564
May	811	1,242	2,871	4,603	40,480
June	452	825	2,136	3,746	20,631
July	368	807	1,694	2,466	22,000
August	177	599	1,464	2,881	22,880
September	245	568	1,576	2,768	29,920
October	265	599	1,608	2,847	29,333
November	443	657	1,906	3,385	27,964
December	555	823	2,378	4,093	19,458
Annual	512	928	2,254	3,773	26,025

Source: USGS 03165500 New River at Ivanhoe, Va, [URL]: https://waterdata.usgs.gov/monitoring-location/03165500

E.8.1.3 Water Uses

Waters impounded by the Byllesby-Buck Project are used for purposes of electric generation and for public recreation. There are no known discharges to or withdrawals from the New River within the Project Boundary or between the Byllesby and Buck developments. Existing instream flow uses of waters of the New River within the Project Boundary include various recreational activities (e.g. fishing and boating) and hydroelectric generation.

E.8.1.4 Water Quality

E.8.1.4.1 Approved Water Quality Standards

Existing relevant and reasonably available information regarding water quality in the Project vicinity was presented in Section 5.3 of the PAD (Appalachian 2019). The PAD included historical water quality data collected by the USGS and VDEQ. The data presented in the PAD indicates that temperatures and dissolved oxygen (DO) concentrations did not differ between impoundments and tailraces during collection efforts, and no evidence of thermal stratification was observed in either impoundment. Data from the historical studies also demonstrated that the Project waters meet the state water quality standards, including temperature maximums and DO minimums.

The VDEQ issues Virginia Pollutant Discharge Elimination System permits for all point source discharges to surface waters, to dischargers of stormwater from Municipal Separate Storm Sewer Systems, and to dischargers of stormwater from industrial activities. The VDEQ is responsible for carrying out the mandates of the State Water Control Law as well as meeting federal obligations under the CWA (VDEQ 2017a). Waters in the New River Basin are classified in 9VAC25-260-540. The New River in the vicinity of the Project is designated as Class IV (Mountainous Zone) (Table E.8-3). Numerical criteria for DO, pH, and maximum water temperature for these waters are identified in 9VAC25-260-50 and are summarized in Table E.8-4. In accordance with 9VAC25-260-50, these water quality criteria do not apply when flows are below the lowest 7-day average flow expected to occur once every 10 years (i.e., the 7Q10 flow).

Table E.8-3. Classification of Project Area Waters – New River

Section	Class	Special Standards	Section Description
2	IV	v, NEW-5	New River and its tributaries, unless otherwise designated in this chapter, from the Montgomery-Giles County line upstream to the Virginia-North Carolina state line.
2l	IV	PWS	New River and its tributaries inclusive of the Wythe County Water Department's Austinville intake near the Route 636 bridge, and the Wythe County Water Department's Ivanhoe intake on Powder Mill Branch just upstream of the Wythe-Carroll County line to points 5 miles above the intakes.

v – The maximum temperature of the New River and its tributaries (except trout waters) from the Montgomery-Giles County line upstream to the Virginia-North Carolina state line shall be 29 degrees Celsius (°C) (9VAC25-260-310).
NEW – nutrient-enriched waters; only includes New River and its tributaries, except Peak Creek above Interstate 81, from Claytor Dam upstream to Big Reed Island Creek (Claytor Lake) as per 9VAC25-260-350.
PWS – public water supply.

Table E.8-4. Numeric Water Quality Criteria for Class IV Waters

Parameter	Standard
Minimum DO	4.0 milligram per liter (mg/l)

Parameter	Standard
Daily Average DO	5.0 mg/l
pH	6.0 – 9.0
Maximum water temperature	29°C*

*The maximum temperature of the New River and its tributaries (except trout waters) from the Montgomery-Giles County line upstream to the Virginia-North Carolina state line shall be 29°C (9VAC25-260-310).

Multiple segments of the New River are listed as impaired for aquatic life or recreation uses due to *E. coli* concentrations. However, the source of *E. coli* is not associated with the Project and it is expected that continued operation of the Project will have no effect on *E. coli* concentrations in the New River.

E.8.1.4.2 Impaired Waters

The VDEQ develops and maintains a listing, referred to as a Section 303(d) list, of all impaired waters in the state, which provides details on the pollutant causing the impairment and the potential sources of each pollutant per requirements of the CWA and Virginia Water Quality Monitoring, Information, and Restoration Act. The VDEQ is required to develop and implement a Total Maximum Daily Load (TMDL) for waters listed on the Section 303(d) list. A TMDL is used to determine the total amount of a pollutant that a waterbody can handle without resulting in the impaired status of that waterbody (VDEQ 2017b).

Project waters listed as impaired in the 2020 Section 303(d) Water Quality Assessment Integrated Report include:

- Assessment Unit ID VAS-N08R_NEW03B98 – from Buck Dam downstream 0.9 miles. Recreational uses are impaired due to *E. coli* associated with livestock grazing and feeding operations. A TMDL is required for this reach of the New River (VDEQ 2017a).
- Assessment Unit ID VAS-N08R_NEW02B00 – a 5.0-mile reach of the mainstem public supply segment for Austinville from Buck Dam tailwaters downstream to the confluence with Mill Creek. Recreational uses are impaired due to *E. coli*.
- Assessment Unit ID VAS-N07R_CRK01A98 – a 12.1-mile reach of lower Crooked Creek from the confluence with the New River. Recreational uses are impaired due to *E. coli* and fecal coliform from unrestricted cattle access and other unknown sources. A TMDL is required for Crooked Creek (VDEQ 2017a).
- Assessment Unit ID VAS-N06R CST01A94 – an 8.7-mile reach of lower Chestnut Creek from the confluence with the New River. Aquatic life is impaired for benthic macroinvertebrate bioassessments; sedimentation and siltation were also observed. Recreation uses are impaired due to *E. coli* (VDEQ 2017a). A sediment and bacteria TMDL for Chestnut Creek

was finalized in 2015 (The Virginia Tech Department of Biological Systems Engineering 2015).

- Assessment unit ID VAS-N08R_NEW01L98 – a 3.1-mile reach in the mainstem New River extending from Buck Dam upstream to Byllesby Dam. Recreational uses are impaired due to *E. coli.*

E.8.1.4.3 Historical Water Quality Data from the Project Study Area

From May through October 1989, in support of the previous relicensing, DO and water temperature profiles were measured by Appalachian at four transects, one each located above and below the two developments:

- At the Byllesby Development, mean reservoir temperatures ranged from 11.3 to 25.1°C. Mean DO ranged from 6.9 to 10.1 mg/l in the reservoir and from 7.1 to 10.9 mg/l in the powerhouse tailrace, and percent saturation was never below 78 percent for any measurement.
- At the Buck Development, mean reservoir temperatures ranged from 10.9 to 25.3°C. Mean DO ranged from 6.7 to 11.1 mg/l in the reservoir and from 7.0 to 11.6 mg/l in the powerhouse tailrace, and percent oxygen saturation was never below 77 percent for any measurement.
- No evidence of thermal stratification was found in either reservoir.
    - For the Byllesby reservoir, at depths up to about 6 meters (m), the maximum surface-to-bottom temperature differential was 2.3°C, and the maximum DO differential was 1.2 mg/l.
    - For the Buck reservoir, at depths up to about 4.5 m, the maximum surface-to-bottom temperature differential was 1.0°C, and the maximum DO differential was 1.5 mg/l (Appalachian 1991a).

Additional water quality data was collected in the Project reservoirs, as well as free-flowing riffle/run areas above and below each development, as part of a fishery survey conducted by Appalachian from May to October 1990. These data are summarized in Appalachian (1991b) and below:

- DO and temperature did not significantly vary across the sampling locations.
- Conductivity varied very little, either spatially across the locations or temporally over the study period. Measurements were typically low, ranging from 46-60 micromhos per centimeter, with the highest measurements recorded in September (65-138 micromhos per centimeter).

- Secchi depth readings at the reservoir sampling locations did not vary significantly on a spatial scale, with mean values ranging from 1.33 m at the upper Buck reservoir to 3.08 m at the upper Byllesby reservoir. Minimum water clarity values were recorded in October, and maximum clarity was recorded in October.

More recently, water quality data have been collected approximately 3 miles downstream of the Buck Dam at the USGS 03165500 (New River at Ivanhoe, VA) gage. Due to the proximity of this monitoring location to the Project, the water quality data is expected to be indicative of the characteristics of Project outflows. Daily mean water temperature and specific conductance data were collected from March 2007 to September 2008; daily mean water temperatures ranged from 0.3°C in to 28.9°C and were below the maximum state criterion. Daily mean specific conductance ranged from 55 microsiemens per centimeter (µS/cm) to 108 µS/cm.

The VDEQ has also collected water quality data approximately two river miles downstream of Buck Dam at Site 9-NEW127.49. Water temperature, DO, pH, and specific conductivity data were collected at a depth of approximately 0.3 m from 1992 to 2017. Water temperatures ranged from 0.0 to 28.7°C and were below established state criterion. DO concentrations ranged from 5.3 mg/l to 14.8 mg/l and were well above the minimum state criterion. The pH ranged from 5.9 to 8.9 and were also within the state criteria range, except for a single day in December 1999. Specific conductivity ranged from 20 to 80 µS/cm.

On August 29, 2019, a site visit was conducted by HDR for Appalachian to collect water quality data and evaluate field logistics associated with potential water quality monitoring locations for the Byllesby and Buck developments. During the site visit, a calibrated multiparameter water quality data sonde was used to collect depth profiles in each development's forebay and discrete measurements were taken in each development's tailrace. Streamflow during the site visit was approximately 1,500 cfs measured at USGS gage 03165500, which is typical of average flow conditions in August at this location. During the site visit, the Byllesby forebay elevation was in the normal operating range,[6] however, the Buck forebay elevation was approximately 9 ft lower than the normal operating range[7] to facilitate construction activities associated with installation of the new Obermeyer gates.

[6] Normal operating range for the Byllesby impoundment is between 2,078.2 – 2,079.2 ft.

[7] Normal operating range for the Buck impoundment is between 2,002.4 – 2,003.4 ft. During the August 29, 2019 water quality sampling site visit, the forebay elevation was approximately 1,994 ft; or approximately 9 ft below the normal operating range.

All water quality measurements during the site visit were within applicable Virginia state water quality standards. As Figure E.8.1 and Figure E.8.2 indicate, the depth profiles in each forebay did not show any significant difference in water quality from top to bottom or laterally. The tailrace measurements were reflective of the water quality in each forebay.

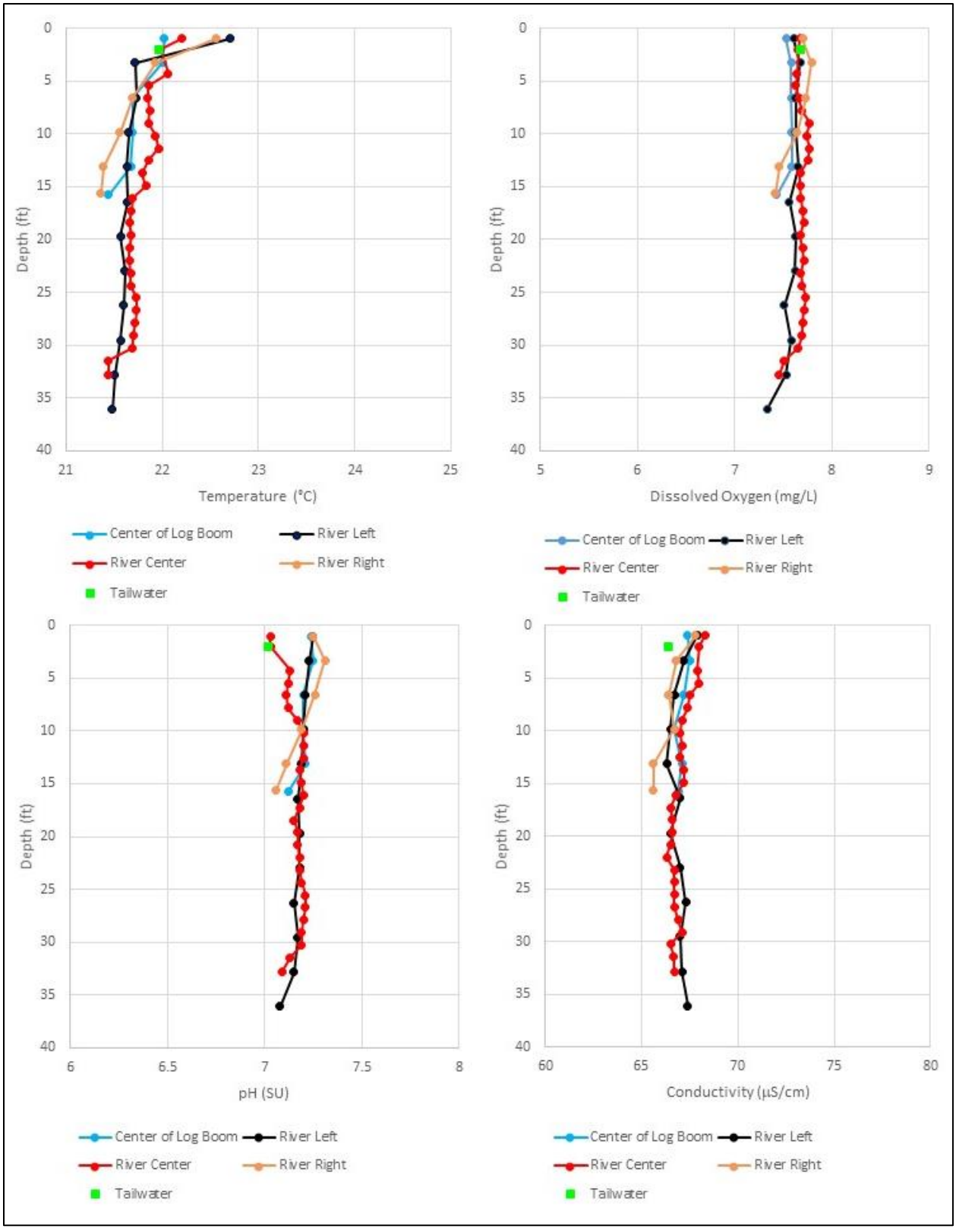


Figure E.8.1. Water Quality Parameters for Byllesby (August 29, 2019)

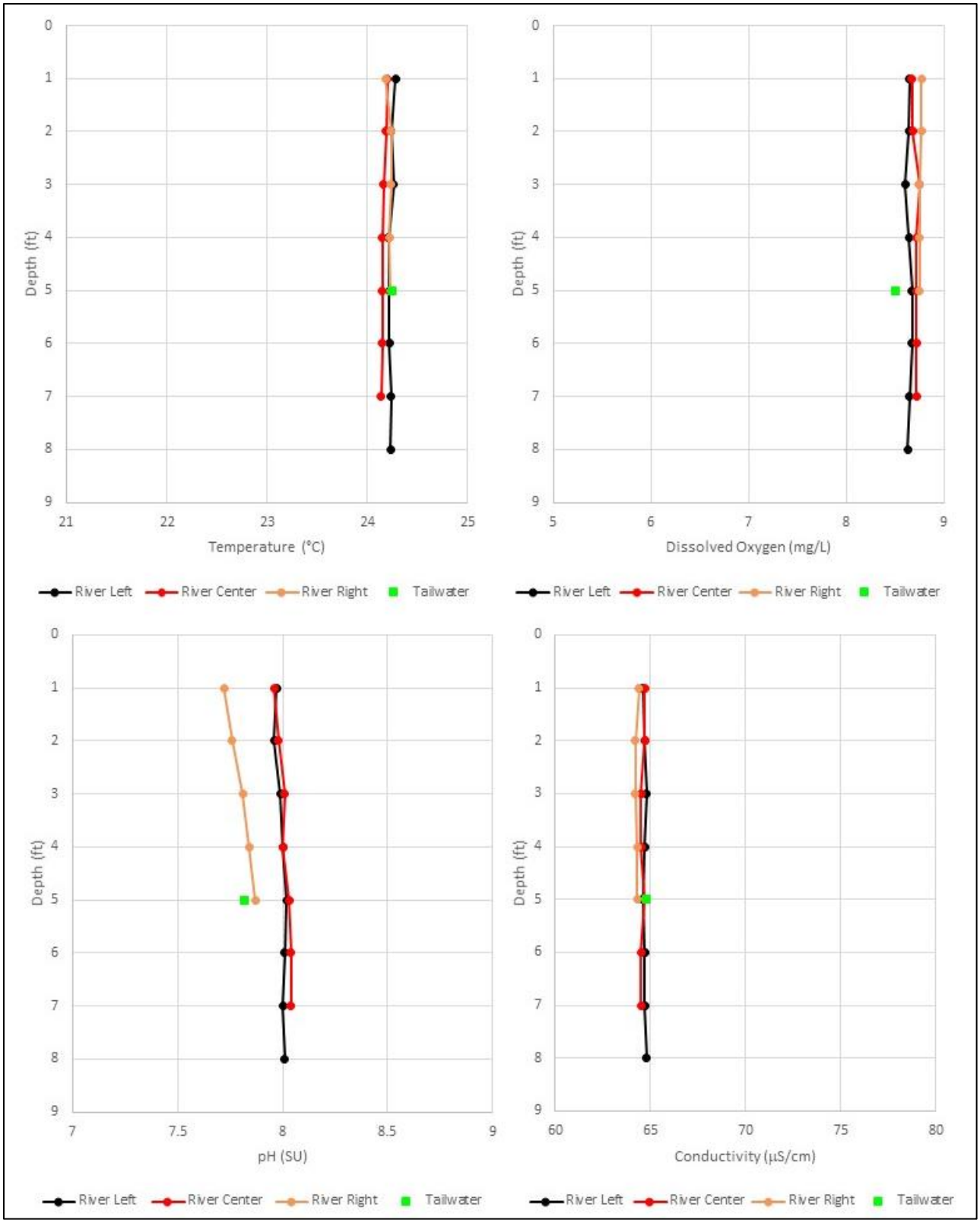


Figure E.8.2. Water Quality Parameters for Buck (August 29, 2019)

E.8.2 Environmental Analysis

E.8.2.1 Studies in Support of the Current Relicensing

In support of the current relicensing, Appalachian conducted a Water Quality Study in 2020 and 2021. A summary of the methods and results of the Water Quality Study is provided in this section, and details are provided in Appendix B, Volume II of this FLA. The specific objectives of the Water Quality Study are included below:

- Gather baseline water quality data sufficient to determine consistency of existing Project operations with applicable Virginia state water quality standards and designated uses (VAC Chapter 260).
- Provide data (temperature and DO concentration) to determine the presence and extent, if any, of thermal or DO stratification in the Byllesby and Buck impoundments.
- Provide data to support a Virginia Water Protection Permit application (CWA Section 401 Certification).
- Provide information to support the evaluation of whether additional or modified PM&E measures may be appropriate for the protection of water quality at the Project's developments.

The water quality monitoring sites included the following:

- **Byllesby Development**
  - One location in the upstream extent of the Byllesby reservoir
  - Three locations in the Byllesby forebay (near surface, mid-depth, and near bottom)
  - One location in the tailrace
  - One location in the Byllesby bypass reach
- **Buck Development**
  - Two locations in the forebay (near surface and near bottom)
  - One location in the tailrace
  - Two locations in the bypass reach (upstream and downstream)

The Water Quality study area is shown on Figure E.8.1.

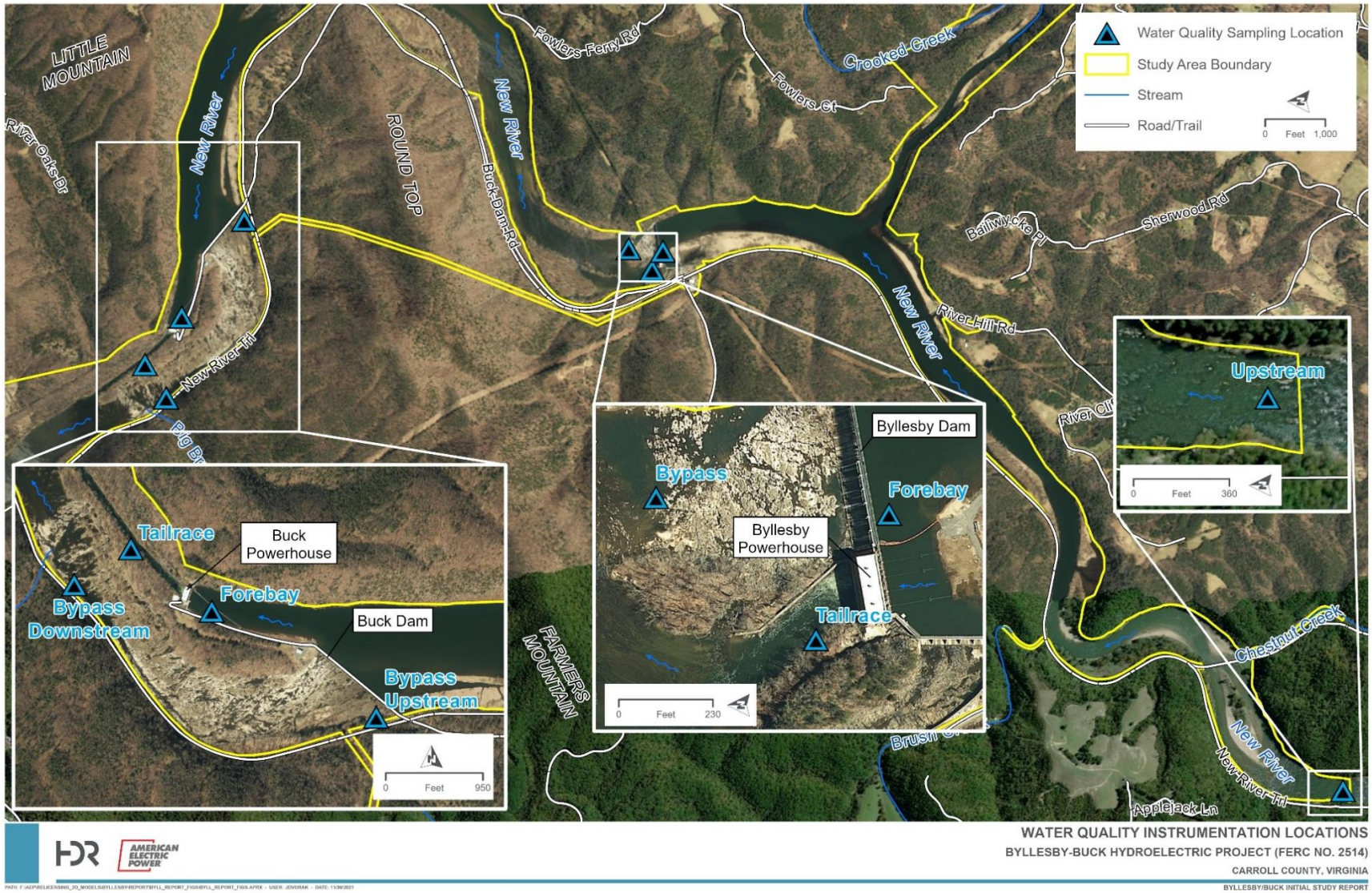


Figure E.8-1. Byllesby-Buck Water Quality Study Monitoring Locations

E.8.2.1.1 Methods

Byllesby Data Collection

Initial deployment of water quality instrumentation at the Project was scheduled for the week of August 17, 2020, however, due to high flow conditions and continuous flow release at the dam through a damaged flashboard section throughout the latter part of 2020, the only water quality instrumentation deployed at Byllesby was at the tailrace location. HDR deployed the remaining water quality instruments (i.e., DO and water temperature sondes) at Byllesby on June 15 – 16, 2021. The water quality monitor that was deployed in the tailrace in August 2020 was removed at the end of the 2020 study period and then reinstalled at the same location for the 2021 data collection effort. The equipment recorded data at 15-minute intervals. Data were downloaded from instrumentation at Byllesby approximately every 2 to 3 weeks[8] until September 28, 2021, at which time the data collection instruments were removed. A sonde was deployed near the surface, at mid-depth, and at the bottom of the forebay to help determine the extent of any thermal and/or DO stratification in the forebay area.

During the initial deployment and subsequent download events, discrete multi-parameter water quality measurements of temperature, DO concentration, pH, and specific conductivity were collected at each monitoring location using a Hach Hydrolab® MS5 (Hydrolab). For the upstream, tailrace, and bypass reach monitoring locations, discrete water quality data were collected at one location within the water column at a depth similar to the sondes. Profile data at the Byllesby forebay monitoring location were collected at approximately 2.0-ft intervals using the Hydrolab to document temperature and DO stratification at the time of the data sonde downloads.

Buck Data Collection

Water quality instruments (i.e., DO and water temperature sondes) were deployed at Buck at all five planned monitoring locations the week of August 17, 2020. The equipment recorded data at 15-minute intervals. Upper and lower data sondes were placed at approximately 3 ft and 14 ft below the surface in the forebay.

Data were downloaded from instrumentation at Buck during the field efforts from September 8 - 10, 2020, and at Byllesby (tailrace only) and Buck from October 7 – 8, 2020. Field staff downloaded data from sondes at each monitoring location using a data shuttle or directly to a laptop computer. Sondes were regularly cleaned and checked for operation, calibration, and battery life, and adjusted as

[8] The mid-August 2021 water quality download event was postponed due to a planned reservoir drawdown event to repair a section of broken flashboards. Immediately after the reservoir returned to normal pool elevation, Tropical Storm Fred resulted in a large rainfall runoff event that further delayed the equipment download event to late August.

necessary based on manufacturer's specifications. The cable, housing, and other installation materials were visually inspected for damage and repaired or replaced as necessary.

Discrete multi-parameter water quality measurements of temperature, DO concentration, pH, and specific conductivity were collected during the initial deployment and subsequent download events as described above for Byllesby. Profile data were collected at approximately 1.0-ft intervals.

Data Analysis and Processing

Upon completion of the field data collection effort, data was checked for errors and omissions. Data that more closely matched the discrete measurement readings made in the field during download events were preferentially reported and analyzed for each monitoring location.

Real-time flow data (15-minute) was obtained from the USGS New River at Ivanhoe, VA gage, which is approximately 3 river miles downstream of the Buck powerhouse and includes the combined flows from the powerhouse and bypass reach. Flows have been recorded since January 1996 at the USGS New River at Ivanhoe, VA gage and corresponding stage from August 2020 to present.

Turbidity and Chlorophyl A

Turbidity grab samples were collected at the Byllesby and Buck forebay surface monitoring locations on July 14, August 25, and September 29, 2021 and analyzed at Pace Analytical Services. Turbidity concentrations were 16.9, 6.1, and 1.0 NTU on these three sampling dates, respectively.

Appalachian also performed a more intensive turbidity study to evaluate the potential impact that Project operations, in particular drag rake operations, may have on turbidity concentrations in the Project tailraces; the first phase consisted of a one-week deployment of five Hydrolab data sondes equipped with turbidity sensors. The data sondes were deployed from September 28 through October 5, 2021 and set to record turbidity concentrations at 5-minute intervals. Appalachian operated the generating units and drag rakes at each Project under a normal operating regime; however, due to the relatively low Project inflows which carried little debris, the drag rakes were set to operate just once per day during the morning, as described above in Section E.7.2.1.5 (Turbidity Study). Due to the turbidity sensor failures and low frequency of drag rake operations during the one-week study period, a second phase was added to the original study to collect turbidity data at the Buck forebay and tailrace monitoring locations over a one-day period on October 14, 2021. During this second phase, generation at the Buck Development was held relatively steady and the drag rakes were operated approximately every 30 minutes throughout the sampling period (Figure E.7.2). All results of the turbidity study are presented in Appendix B, Volume II of this FLA.

Chlorophyll a grab samples were collected at the Byllesby and Buck forebay surface monitoring locations on July 14, September 9, and September 29, 2021 and analyzed at the certified laboratory Pace Analytical Services.

E.8.2.1.2 Results

All water quality data, figures, and tables are provided in Appendix B, Volume II of this FLA (Water Quality Study Report). Continuous and discrete measurements of water temperature, DO, pH, and specific conductivity were taken throughout the 2-year study.

Byllesby Development

The highest water temperatures occurred during the last week of July 2021 and peaked between 29.4–30.0 ºC during the afternoon hours that week. Diurnal temperature variation during the water quality study period ranged from approximately 2–4ºC. In 2020, water temperatures measured in the 21–26ºC range for the first three weeks of the study. In mid-September 2020, the average temperature decreased over a one-week period by approximately 7ºC. Temperature data at the forebay and tailrace monitoring locations at Byllesby for 2021 were similar to those recorded at the upstream end of the Byllesby reservoir. Water temperature differences between the surface and bottom forebay locations typically varied between 0–2ºC indicating minimal thermal stratification in the forebay, which is reflective of run-of-river operations. Tailrace water temperatures were generally similar to the forebay surface monitoring location, but with less daily fluctuation. Bypass reach water temperature magnitude and daily fluctuation was very similar to that at the Byllesby upstream reservoir monitoring location. While water temperature varied seasonally, there was little (i.e., <2.0ºC) to no thermal stratification at the forebay monitoring location.

At the upstream monitoring location, all continuous and discrete DO measurements were greater than the 5.0 mg/l daily average DO standard with daily fluctuations in the 1.0–2.5 mg/l range. DO concentrations were in the 6.0–9.0 mg/l range through the July–August 2021 period and then generally increased through September as water temperatures decreased[9]. In the Byllesby forebay monitoring locations, all measurements were greater than the 5.0 mg/l daily average DO standard with the exception of several days when DO concentrations measured at the forebay bottom monitoring location dipped below 5.0 mg/l. During these periods, thermal and DO stratification was present in the forebay, therefore, the surface DO concentration was used for comparison to the state water quality standards (all of which were above the 5.0 mg/l daily average DO standard). Differences in DO

[9] Generally, there is an inverse relationship between DO concentrations and water temperature. Colder water temperatures have a higher capacity for DO concentrations and vice versa.

concentrations between the upper and lower forebay monitoring locations typically ranged from 0–1.0 mg/l indicating minor stratification in the forebay area during the summer months. A planned reservoir drawdown occurred from August 6 – 13, 2021 to repair a section of broken flashboards at the Byllesby spillway. During this period, the reservoir was drawn down approximately 8 ft which impacted the results from the forebay middle and bottom monitoring locations as the DO sensors were likely resting on the bottom of the reservoir. A data gap between August 8, 2021 and August 25, 2021 resulted from a combination of the planned maintenance drawdown event (August 6 – 13, 2021) which was immediately followed by a large rainfall runoff event as the remnants from Tropical Storm Fred moved through the area. These two back-to-back events delayed the routine download trip to August 25, 2021. By this time, the DO sensors had experienced significant biofouling resulting in data that was not usable. Based on water temperature data (which decreased during the rainfall runoff period), it is expected that DO in the tailrace would have remained above the 5.0 mg/l daily average DO standard. In the bypass reach, all measurements were greater than the 5.0 mg/l daily average DO standard with daily fluctuations ranging from 1.0 mg/l up to 4.0 mg/l as temperatures cooled toward the end of September. Like the Byllesby tailrace monitoring location, the same data gap occurred at the bypass reach monitoring location (for the same reasons described above). Similar to the tailrace monitoring location, it is expected that DO concentrations in the bypass reach would have remained above the 5.0 mg/l daily average DO standard due to cooler water temperatures and higher flows in the bypass reach during the Tropical Storm Fred rainfall runoff event. DO vertical profile data showed minor indication of stratification of DO concentrations at this location.

Vertical profile data for pH in the forebay was between 6.8 and 8.9. Four of the sampling events indicated little to no stratification between the reservoir surface and bottom measurements; all closely grouped around a pH of 7.0. The other three sampling events indicated a higher pH range with some degree of stratification. Discrete pH measurements at each monitoring location during the initial instrument deployment and subsequent download events were between 6.9 and 8.9; these values meet state water quality standards for Class IV waters. The only pH value outside this range was a discrete measurement of 9.2 at the upstream monitoring location during the last download event on September 28, 2021 (see Appendix B, Volume II).

Discrete measurements of specific conductivity for all monitoring locations ranged from 55–69 µS/cm. These are consistent with historic ranges of specific conductivity, indicating a long-term, relatively consistent range of conductivity in the Project area. Chlorophyll a grab samples from the Byllesby forebay (July 14, September 9, and September 29, 2021) were “non-detect” indicating chlorophyll a concentrations in the samples were less than 5.0 milligrams per cubic meter.

Buck Development

Buck continuous and discrete water temperature data at the forebay and tailrace were similar to those recorded at the Byllesby tailrace. The Buck forebay and tailrace monitoring locations were within 0.5ºC of each other for most of the study period, which is reflective of run-of-river operations. Daily temperature fluctuations at the downstream monitoring location were approximately twice that observed at the upstream monitoring location. While both monitoring locations are in relatively small pools, the upstream location is shaded more hours of the day compared to the downstream location, thus daily temperature cycles at the upper location are lower in magnitude. While water temperature varied seasonally, there was little (i.e., <0.7ºC) to no thermal stratification at the forebay monitoring location.

Continuous and discrete DO concentration data at the Buck forebay and tailrace monitoring locations are provided in Appendix B. All measurements were greater than the 5.0 mg/l daily average DO standard. Daily fluctuations in DO concentrations were less than 1.0 mg/l during the study except for September 4–11 when the daily fluctuation increased to the 1.0–2.0 mg/l range at the forebay monitoring locations10. Similar to water temperature, there is little (i.e., typically < 1.0 mg/l) to no difference in DO concentrations between the forebay surface and bottom locations; indicating little to no stratification of DO concentrations throughout the forebay water column. DO concentrations in the tailrace were generally higher (by up to 1.0 mg/l) compared to the forebay monitoring locations. This suggests that unit generation and the trash sluice gate operation increase aeration into the tailrace. Tailrace concentrations typically fluctuated approximately 0.25 mg/l between day and night.

Continuous and discrete DO concentration data at the bypass reach upstream and downstream monitoring locations indicated DO was similar between the reach monitoring locations. All measurements were greater than the 5.0 mg/l daily average DO standard with daily fluctuations of up to 1.0 mg/l for the upstream location and up to 3.0 mg/l at the downstream location. Similar to the water temperature profile data, there was no stratification of DO concentrations in the forebay. The variation in pH was very small (between 7.3 and 7.7) and there was little to no stratification between the reservoir surface and bottom measurements. Discrete pH measurements at each monitoring location during the initial instrument deployment and two download events were between 7.2 and 8.9; these values meet state water quality standards for Class IV waters.

[10] Flows recorded at the Ivanhoe USGS flow gaging station from September 4 – 11, 2020 were relatively low and stable (compared to the weeks preceding and following) which likely contributed to slightly increased fluctuations in DO concentrations during this period. Flows recorded at the Ivanhoe USGS flow gaging station are shown on Figure 7-1 and 7-2 of Attachment 7.

Specific conductivity at the forebay monitoring location varied during each sampling event, but concentrations were typically the same from reservoir surface to bottom and ranged from 53 – 61 µS/cm over three sampling events during the study period. Discrete measurements of specific conductivity for all monitoring locations ranged from 52 – 62 µS/cm, which is consistent with historical data, indicating a long-term, relatively consistent range of conductivity in the Project area. Chlorophyll a grab samples from the Buck forebay (July 14, September 9, and September 29, 2021) were "non-detect" indicating chlorophyll a concentrations in the samples were less than 5.0 milligrams per cubic meter.

Turbidity grab samples were collected at the Buck forebay surface monitoring location on July 14, August 25 and September 29, 2021 and analyzed at Pace Analytical Services. Turbidity concentrations were 8.0, 4.3, and 1.5 NTU on these three sampling dates, respectively.

E.8.2.1.3 Conclusions

Continuous and discrete water quality data collected during the 2020 study period met Virginia Class IV (New River) water quality standards for temperature (<29ºC), DO (>4.0 mg/l instantaneous minimum; >5.0 mg/l daily average), and pH (range 6.0 – 9.0) at all monitoring locations during the study period.

Continuous and discrete water quality data collected during the 2021 study period met the Virginia Class IV standards described above with the exception of water temperature. New River water temperature flowing into the Byllesby reservoir exceeded 29ºC on an instantaneous basis approximately 13 days between late-July and late-August. Similarly, instantaneous water temperature exceeded 29ºC at the forebay surface monitoring location and bypass reach monitoring location on approximately 9 days each during the study period, respectively. During each of these events, the maximum instantaneous water temperature recorded was less than 30ºC and the daily average water temperature was less than 29ºC. Water temperatures recorded in the Byllesby tailrace were all less than 29ºC.

During the 2020 water quality study period (from August 17 to October 8, 2020), there were no station outages or flashboard failures at the Byllesby or Buck developments that would have impacted the water quality results.

During the 2021 water quality study period (from June 15 to September 28, 2021), a broken section of flashboards at the Byllesby spillway resulted in a spill of approximately 88 cfs into the bypass reach from the beginning of the study period until August 13, 2021 when the repair work was completed. During this period, the Byllesby reservoir was drawn down approximately 8 ft from August 6 – 13, 2021

to support the repair work. There were no other station outages at the Byllesby development that would have impacted the water quality results.

E.8.2.2 Project Impacts on Water Resources

FERC did not identify any environmental issues related to water use/quality to be addressed in their NEPA document.

Diversion of flows for power generation typically has the potential to impact water quality in the bypass reaches. Reductions of flow in the bypass reaches may increase the travel time of water through the reach and also reduce the dilution of any substances introduced into the bypass reach. Reduced discharge into the bypass reaches may also modify the temperature regime immediately downstream of the dams. Continuous and discrete water quality data collected during the 2020 and 2021 study periods, however, including the bypass reaches, met Virginia Class IV (New River) water quality standards for temperature (<29ºC), DO (>4.0 mg/l instantaneous minimum; >5.0 mg/l daily average), and pH (range 6.0 – 9.0) at all monitoring locations. The only exception was New River water temperature flowing into the Byllesby reservoir exceeded 29ºC on an instantaneous basis approximately 13 days between late-July and late-August 2021. Similarly, instantaneous water temperature exceeded 29ºC at the forebay surface monitoring location and bypass reach monitoring location on approximately 9 days each during the study period, respectively. (Though during each of these events, the maximum instantaneous water temperature recorded was less than 30ºC and the daily average water temperature was less than 29ºC).

The results from previous studies as well as the study conducted for this relicensing support a conclusion that due to the small size and short retention time of the Project reservoirs, the lack of thermal stratification in the reservoirs, and the run-of-river operation of the Project, under existing operations the Project has little to no adverse effects on water quality relative to VDEQ's water quality standards for DO and temperature.

Infrequent maintenance dredging has historically been conducted in the vicinity of the dam or intake at either development. Dredging has the potential to have short-term impacts on local water quality through the resuspension of sediment. Conducting all dredging operations in accordance with the terms and conditions of permits and approvals issued by USACE and VDEQ, including implementation of Best Management Practices (silt curtains, controlled return water, etc.), should maintain water quality at and downstream of the powerhouse. As described above, Appalachian performed a turbidity study to assess the potential impacts of continued operation of the Project's drag rakes on turbidity in the reservoir and downstream. Results of the turbidity study conducted as part of the Water Quality

Study indicate that the effects of sediment resuspension (and potential subsequent transport of resuspended sediment) due to operation of the trashracks is negligible relative to background turbidity levels.

The Licensee does not anticipate that operation and maintenance of the Project over the new license term will have any long-term, unavoidable, adverse impacts on water quality and use.

E.8.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Water quality in the streams flowing into the Project, tailrace, and bypass reach is consistent with applicable Virginia state water quality standards for temperature, DO, and pH for Class IV New River surface waters. While there is no state standard for specific conductivity, concentrations were above 150 µS/cm and less than 500 µS/cm, which is generally considered to be suitable for most fish (USEPA 2012). Based on the results of the Water Quality Study, and in consideration of results of other historic studies and data collection efforts, during the new license term Appalachian proposes to continue the existing run-of-river operating mode for the Project for the protection of water quality and other resources.

No resource agencies or other stakeholders have recommended PM&E measures for water quality.

Based on results of the Water Quality Study and historical data for the Project, normal Project operations are not impacting water quality in the New River downstream of the Project. Water quality in the upper New River upstream and downstream of the Project is periodically monitored by state agencies. Water quality data collection for the relicensing study at these developments required intensive field data collection efforts and significant equipment costs. Appalachian does not propose and does not believe it is necessary to conduct long-term or periodic water quality monitoring to address potential impacts of normal Project operations over the term of the new license.

As such, Appalachian does not propose any additional PM&E measures to protect water quality at the Project.

E.9 Fish and Aquatic Resources

E.9.1 Affected Environment

E.9.1.1 Aquatic Habitat

E.9.1.1.1 Impoundments

The Project consists of two reservoirs surrounded primarily by a dense forest with few natural wetland areas due to the relatively high topographic relief. The reservoir formed by the Byllesby Dam is approximately 16.8 miles long with a surface area of 239 acres at EL. 2079.2. The reservoir is characterized by shorelines that drop off steeply, converging toward the center of the channel, with vegetated floodplains on the left descending bank and steep rock facing on the right descending bank. The reservoir is generally sparse in woody debris and submerged aquatic vegetation. Substrates within the reservoir are predominantly sand (70%), silt (20%), gravel (5%), and boulder (5%). Recent water quality data collected during relicensing studies (see Section E.8) indicated that water quality parameters (temperature, pH, DO, and conductivity) met state water quality criteria and remained relatively consistent throughout the Byllesby reservoir. Diverse fish and benthic macroinvertebrate habitats exist in the deep impounded reach above Byllesby Dam as well as in shallower, swift-moving areas at the upper end of the impoundment.

The reservoir formed by the Buck Dam is approximately 5.8 miles long with a surface area of 66 acres at EL. 2,003.4 ft. Similar to the Byllesby reservoir, the Buck reservoir is also characterized by shorelines that drop off steeply with vegetated floodplains on the left descending bank and steep rock facing on the right descending bank. The reservoir is generally sparse in woody debris and submerged aquatic vegetation. Substrates within the reservoir are predominantly sand (60%), silt (20%), gravel (15%), and boulder (5%). The upper end of the impoundment, corresponding to the Byllesby bypass channel and tailrace, is relatively shallow with consistent water depths across the width of the channel. Water quality data collected during relicensing studies (see Section E.8) indicated that water quality parameters (temperature, pH, DO, and conductivity) met state water quality criteria and remained relatively consistent through the Buck reservoir, with exception of DO and velocities, which were much higher in the upper reach of the impoundment compared to the downstream, deeper section of the reservoir. These areas of the impoundment also provide a diversity of fish and benthic macroinvertebrate habitats.

E.9.1.1.2 Bypass Reaches

The Byllesby Development includes a 590-ft-long bypass reach consisting primarily of exposed bedrock and rock outcroppings. The bypass reach is fairly uniform downstream of the Byllesby

spillway, and water remains shallow and swift until converging with the tailrace channel further downstream. The Buck Development includes a 4,100-ft-long, steep bypass reach consisting primarily of exposed bedrock. The upper portion of the reach exhibits long vertical slabs of bedrock running parallel to river flow, preventing the accumulation of smaller particle substrates in the upper reach of the channel. The channel curves about midway down the bypass channel, so that the long vertical slabs of bedrock are positioned perpendicular to the stream flow and facilitating the accumulation of smaller substrates on the downstream side of the bedrock slabs. As such, the lower half of the Buck bypass reach generally contains a larger quantity and diversity of microhabitats for colonization and utilization by fish and benthic macroinvertebrates.

Availability of aquatic habitat in the bypass reach under varying flows is being evaluated by Appalachian for the Bypass Reach Flow and Aquatic Habitat Study; results of this study will be presented as supplemental information within 45 days of FLA filing.

E.9.1.1.3 Tailraces

The Byllesby tailrace consists of a 300-ft-long reach defined by a bedrock outcrop (island) on the left and a concrete wall on the right. The tailrace is relatively narrow and variable in depth compared to the spillway bypass channel. The tailrace flows into two potential pathways, either toward the left side of an island near the left descending bank (characterized by swift riffle and run habitats) or to the right toward and converging with the spillway bypass reach downstream of the island.

The Buck tailrace consists of a channel that is approximately 1,700 ft long and 70 ft wide. The depth of the channel is fairly uniform downstream of the immediate vicinity of the powerhouse, averaging 6.5 to 10 ft at a point 160 ft downstream of the powerhouse. This narrow, shallow tailrace likley results in relatively higjh water velocities which likely restricts its use as aquatic habitat to large-bodied fishes like Walleye (*Sander vitreus*).

E.9.1.1.4 Essential Fish Habitat

Based on a review of the NMFS online database, no EFH, as defined under the Magnuson-Stevens Fishery Conservation and Management Act or established by the NMFS has been identified in the vicinity of Project.

E.9.1.2 Resident Fish Community

The New River contains a variety of popular sportfish species such as Smallmouth Bass (*Micropterus dolomieu)*, Spotted Bass (*Micropterus punctulatus*), Largemouth Bass (*Micropterus salmoides*), Rock Bass (*Ambloplites rupestris*), Striped Bass (*Morone saxatilis*), hybrid bass (Striped Bass x White Bass

hybrid), Muskellunge (Esox masquinongy), Walleye, Black Crappie (*Pomoxis nigromaculatus*), Channel Catfish (*Ictalurus punctatus*), Flathead Catfish (*Pylodictis olivaris*), Redbreast Sunfish (*Lepomis auritus*), and Bluegill (*Lepomis macrochirus*).[11] Trophy Smallmouth Bass and Channel Catfish are known to occur between the upstream Fries Dam and Byllesby Dam. Channel Catfish are often found near the base of the Byllesby Dam, while Smallmouth Bass, Spotted Bass, and Walleye are found throughout the entire reach (VDGIF 2017a). State record Walleye have been caught near Buck Dam, and deep pools downstream of the dam have yielded trophy-size catfish and Muskellunge (VDGIF 2017a).

The New River is home to 44 native fish species and at least 57 introduced fish species (Carey et al. 2017). However, the number of endemic species[12] in the New River (8 species) is high in comparison to other eastern U.S. rivers; and has been attributed to the immobility of species. According to Orth (2017), the New River has a relatively high number of endemic species due to the immobility of species and natural barriers, which geographically isolated fishes during the Pleistocene. The eight endemic fishes include three minnows, two sculpins, and three darters, as follows: Bigmouth Chub (*Nocomis platyrhynchus*), Kanawha Minnow (*Phenacobius teretulus*), New River Shiner (*Notropis scabriceps*), Kanawha Sculpin (*Cottus kanawhae),* Bluestone Sculpin (*Cottus sp.),* Candy Darter (*Etheostoma osburni),* Kanawha Darter *(Etheostoma kanawhae),* and Appalachian Darter *(Percina gymnocephala)* (Orth 2017).

The Bigmouth Chub and Kanawha Minnow both prefer habitats of clear, rocky streams and rivers (Jenkins and Burkhead 1983). The New River Shiner inhabits cool, clear tributaries and the upper main channel of the New River. The Kanawha Sculpin is found in rocky areas of limestone streams and cave streams (Encyclopedia of Life 2017). The Bluestone Sculpin, Candy Darter, and Kanawha Darter all prefer swift riffles over gravel or rubble (Jenkins and Burkhead 1983; NRCS n.d.; NatureServe. 2013).

The Candy Darter is an endemic fish in the New River drainage basin. The Candy Darter prefers rock, rubble, or gravel riffles in creeks or small to medium rivers (Rohde et al. 1996). Five watersheds that contain known Candy Darter habitats are listed as critical habitat; all five watersheds are tributaries to the New River. The nearest critical habitat to the Project is the Cripple Creek tributary, which confluences with the New River, 5 river miles downstream of Buck Dam.

[11] In accordance with the "Common and Scientific Names of Fishes from the United States, Canada, and Mexico" (American Fisheries Society Special Publication 34; 2013), throughout this document, common names of fishes are capitalized.

[12] **A** species that is uniquely found in one part of the world, in geographically localized area only.

E.9.1.2.1 Previous Fishery Surveys and Assessments

1990 Byllesby-Buck Project Survey

In 1990, a fishery survey was conducted by Appalachian in the Project area as part of the previous relicensing of the Byllesby-Buck Project. Water quality, physical, hydrological, and operational data were collected and analyzed as part of the field data collection. The study consisted of six sampling events per month between May and October 1990 utilizing gill nets, hoop nets, and electrofishing (Appalachian 1991b). Adult and juvenile fish were sampled as follows:

- Electrofishing was performed at two stations within reaches upstream of the Byllesby reservoir, between the two dams, and downstream of Buck Dam.
- Electrofishing and hoop netting were performed at two stations each in the upper, middle, and lower portions of the Byllesby and Buck reservoirs.
- Gill netting was performed at two stations each in the upper, middle, and lower portions of the Byllesby reservoir.

A total of 2,679 fish and 34 distinct species were collected (Appalachian 1991b). A complete list of species collected during this study is provided in Table E.9-1.

Table E.9-1. Fish Community Documented near the Project in 1990 (Appalachian 1991b)[1]

Family	Common Name	Scientific Name	Number	Percent composition
Catostomidae	Northern Hogsucker	*Hypentelium nigricans*	96	3.6
	Redhorse	*Moxostoma* sp.	1	0.0
	Silver Redhorse	*Moxostoma anisurum*	1	0.0
	White Sucker	*Catostomus commersonii*	26	1.0
Centrarchidae	Black Crappie	*Pomoxis nigromaculatus*	3	0.1
	Bluegill	*Lepomis macrochirus*	35	1.3
	Hybrid Sunfish	*Lepomis* hybrid	3	0.1
	Largemouth Bass	*Micropterus salmoides*	2	0.1
	Pumpkinseed	*Lepomis gibbosus*	5	0.2
	Redbreast Sunfish	*Lepomis auritus*	237	8.8
	Rock Bass	*Ambloplites rupestris*	352	13.1
	Smallmouth Bass	*Micropterus dolomieu*	606	22.6
	Spotted Bass	*Micropterus punctulatus*	460	17.2
Cottidae	Sculpin	*Cottus* spp.	2	0.1
Cyprinidae	Bigmouth Chub	*Nocomis platyrhynchus*	14	0.5
	Bluehead Chub	*Nocomis leptocephalus*	16	0.6
	Bluntnose Minnow	*Pimephales notatus*	23	0.9

Family	Common Name	Scientific Name	Number	Percent composition
	Central Stoneroller	*Campostoma anomalum*	1	0.0
	Common Carp	*Cyprinus carpio*	76	2.8
	Golden Shiner	*Notemigonus crysoleucas*	11	0.4
	Mimic Shiner	*Notropis volucellus*	17	0.6
	New River Shiner	*Notropis scabriceps*	23	0.9
	Rosyface Shiner	*Notropis rubellus*	167	6.2
	Shiner	*Notropis* spp.	9	0.3
	Silver Shiner	*Notropis photogenis*	7	0.3
	Spotfin Shiner	*Cyprinella spiloptera*	123	4.6
	Spottail Shiner	*Notropis hudsonius*	20	0.7
	White Shiner	*Luxilus albeolus*	29	1.1
Esocidae	Muskellunge	*Esox masquinongy*	7	0.3
Ictaluridae	Channel Catfish	*Ictalurus punctatus*	141	5.3
	Flathead Catfish	*Pylodictis olivaris*	77	2.9
Percidae	Appalachia Darter	*Percina gymnocephala*	5	0.2
	Greenside Darter	*Etheostoma blennioides*	5	0.2
	Johnny Darter	*Etheostoma nigrum*	6	0.2
	Common Logperch	*Percina caprodes*	71	2.7
	Sharpnose Darter	*Percina oxyrhynchus*	1	0.0
	Yellow Perch	*Perca flavescens*	1	0.0
		Total	**2,679**	-
		Number of Species	**34***	-

[1] This list was compared with the undated species list provided by the VDWR for the entire New River; these species represent approximately 55 percent of the species diversity of the comprehensive list from the entire New River.
* *Lepomis* spp., *Moxostoma* sp., and *Notropis* spp. were not counted as distinct taxa, as additional individuals from these genera were collected and identified to the species level.

Smallmouth and Spotted basses were the most abundant fish collected in the 1990 study; however, Rock Bass, Redbreast Sunfish, Rosyface Shiner (*Notropis rubellus*), Channel Catfish, Spotfin Shiner (*Cyprinella spilopterus*), and Northern Hogsucker (Hypentelium nigricans) were also abundant. In comparing the three riffle/run sites (upstream of the Byllesby Development, between the developments, and downstream of the Buck Development), species catch per unit effort (CPUE) was highest at the site downstream of Buck Dam, while catch rates were fairly even between the other two riffle/run sites. The authors of the study report noted that this result may be attributable to the isolation of the two upstream sites by the Project dams and the upstream Fries Dam, limiting fish movement into this portion of the river (Appalachian 1991b).

1997 Survey Below Buck Dam

In 1997, Appalachian assessed the effectiveness of the ramping procedures for the Buck Dam spillway gate operations for the protection of fish communities in the bypass reach. Backpack electrofishing samples were collected from representative pools in the bypass reach following the cessation of spillway releases of flows in the range of 4,300 cfs to 6,140 cfs, which resulted in the collection of 734 fish representing 24 species. The final report on this assessment was filed with FERC by Appalachian on September 12, 1997 (Appalachian 1997).

The study report noted that there was much more flowing-water habitat (riffles/runs) in the area immediately downstream of the spillway compared to a greater number of isolated pools farther downstream, which contributed to the differences observed in the spatial distribution of the fish community. For example, Central Stoneroller (*Campostoma anomalum*), White Shiner (*Luxilus albeolus*), White Sucker (*Catostomus commersonii*), Northern Hogsucker, darters, and Walleye were collected more frequently in the riffle/run habitats within about 1,600 ft downstream of the spillway compared to collections from the downstream isolated pools, where species such as Rock Bass, Redbreast Sunfish, Green Sunfish (*Lepomis cyanellus),* and Bluegill were collected in greater numbers. Further, fourteen species collected during the 1990 fish surveys (Appalachian 1991b), primarily from impoundments, were not collected in the 1997 survey below Buck Dam (Appalachian 1997).

2016-2017 Fries Hydroelectric Project Survey (Upstream of Project)

The Fries Project is located approximately 8.6 river miles upstream of the Byllesby Dam. In association with the relicensing of the Fries Project, fish sampling was performed utilizing a variety of methods and gear types (i.e., backpack, raft, and boat electrofishing; snorkel surveys; cast netting; angling; night observations; set lines; gill netting; and minnow traps) from July to October 2016, and May to July 2017. Five study reaches were established within the Fries Project, including reference reaches upstream and downstream of the dam, the impoundment, the bypass, and the tailwaters (Table E.9-2) (Carey et al. 2017).

Table E.9-2. Summary of Study Reach Descriptions (Carey et al. 2017)

Reach	Location and Length	Description
1	Upstream Reference Reach (400 m)	The widest part of the river with heterogenous habitats, flows, and substrates; some submerged aquatic vegetation present.
2	Impoundment (2,300 m)	Within 1.4 river miles of the dam structure; characterized by sediment accumulations with sand substrate; some boulders and bedrock present; submerged aquatic vegetation growth in the lower half of the reach.
3	Bypass (150 m)	Approximately 150 m downstream of the dam structure; characterized by a scoured streambed with boulders or bedrock; little or no flow; some silt and algae present along the left descending bank.

4	Tailwater (800 m)	Just below the powerhouse; mostly non-wadeable, slow pools and glides with bedrock, boulder, sand, and silt substrates; transitional area in downstream end containing greater habitat diversity
5	Downstream Reference Reach Mainstem (400 m)	Riffles, runs, and glides with gravel and sand substrates.
	Downstream Reference Reach Side Channel (500 m)	Channel flowing along an island; characterized by slow-moderate flowing glides, riffles, and runs with sand, gravel, and cobble substrates and large woody debris present.

The study found 43 fish species across all five study reaches using multiple sampling techniques (Carey et al. 2017). Native and endemic species combined for 57 percent of the total number of fish collected, with the remaining 43 percent consisting of introduced species. A list of fish species documented in this study is provided in Table E.9-3.

Table E.9-3. Fish Community Documented near the Fries Project in 2016 (Carey et al. 2017)

Common Name	Scientific Name	Native/Endemic/Introduced
Catostomidae		
Northern Hogsucker	*Hypentelium nigricans*	N
White Sucker	*Catostomus commersonii*	N
Centrarchidae		
Black Crappie	*Pomoxis nigromaculatus*	I
Bluegill	*Lepomis macrochirus*	I
Green Sunfish	*Lepomis cyanellus*	N
Largemouth Bass	*Micropterus salmoides*	I
Pumpkinseed	*Lepomis gibbosus*	I
Redbreast Sunfish	*Lepomis auritus*	I
Rock Bass	*Ambloplites rupestris*	I
Smallmouth Bass	*Micropterus dolomieu*	I
Spotted Bass	*Micropterus punctulatus*	I
Clupeidae		
Gizzard Shad	*Dorosoma cepedianum*	I
Cyprinidae		
Bigmouth Chub	*Nocomis platyrhynchus*	E
Bluehead Chub	*Nocomis leptocephalus*	N
Bluntnose minnow	*Pimephales notatus*	N
Central Stoneroller	*Campostoma anomalum*	N
Common Carp	*Cyprinus carpio*	I
Golden Shiner	*Notemigonus crysoleucas*	I

Common Name	Scientific Name	Native/Endemic/Introduced
Kanawha Minnow	*Phenacobius teretulus*	E
Longnose Dace	*Rhinichthys cataractae*	N
Mimic Shiner	*Notropis volucellus*	N
New River Shiner	*Notropis scabriceps*	E
Rosyface Shiner	*Notropis rubellus*	N
Saffron Shiner	*Notropis rubricroceus*	I
Silver Shiner	*Notropis photogenis*	N
Spotfin Shiner	*Cyprinella spiloptera*	N
Spottail Shiner	*Notropis hudsonius*	I
Swallowtail Shiner	*Notropis procne*	N
Telescope Shiner	*Notropis telescopus*	I
Warpaint Shiner	*Luxilus coccogenis*	I
White Shiner	*Luxilus albeolus*	N
Whitetail Shiner	*Cyprinella galactura*	I
Esocidae		
Muskellunge	*Esox masquinongy*	I
Ictaluridae		
Channel Catfish	*Ictalurus punctatus*	N
Flathead Catfish	*Pylodictis olivaris*	N
Margined Madtom	*Noturus insignis*	N
Percidae		
Appalachia Darter	*Percina gymnocephala*	E
Fantail Darter	*Etheostoma flabellare*	N
Greenside Darter	*Etheostoma blennioides*	N
Logperch	*Percina caprodes*	N
Sharpnose Darter	*Percina oxyrhynchus*	N
Walleye	*Sander vitreus*	N
Yellow Perch	*Perca flavescens*	I

Species richness (number of distinct taxa) was greatest in Reach 4 (Tailwater location; refer to Table E.9-2 for reach descriptions and Table E.9-4 for study results), and lowest in the Main Channel of Reach 5 which contained the greatest percentage of native and endemic species followed by the Tailwater (Reach 4) and the Upstream Reference Reach (Reach 1). The increasing habitat complexity at the transition zone between Reach 4 and Reach 5 likely contributed to Reach 4 having the greatest species richness. Reaches 2 (Impoundment) and 3 (Bypass) contained the highest percentage of introduced species at 57 and 53 percent, respectively. Many of the introduced species consist of

sportfish, such as Rock Bass and Redbreast Sunfish, which were commonly collected throughout the study. Bigmouth Chub was the most dominant species collected in both reference reaches (which contained a greater amount of the riffle-run habitat preferred by this species) and was absent from the Impoundment (Reach 2). The impoundment exhibited a different fish community as compared to the other study reaches, with relative abundance dominated by White Sucker, Common Carp (*Cyprinus carpio*), Largemouth Bass, Bluegill, Channel Catfish, and Black Crappie, as well as the only instances of the pelagic Gizzard Shad (*Dorosoma cepedianum*) and Golden Shiner (*Notemigonus crysoleucas*) species. Notably, the Appalachia Darter was collected both above and below Fries dam, however, the Kanawha Minnow was only collected downstream of the dam.

Given that the Fries Project is in close proximity to the Byllesby Dam (approximately 8.6 river miles upstream), it would be expected that similar fish species are found within the Byllesby-Buck Project where habitat characteristics are similar to the study reaches.

Table E.9-4. Fries Project Survey Results by Study Reach (Carey et al. 2017)

Reach	Location	No. Species Collected	No. of Species [Percent Total]		
			Native	Endemic	Introduced
1	Upstream Reference Reach	17	9 [53%]	2 [12%]	6 [35%]
2	Impoundment	23	9 [39%]	1 [4%]	13 [57%]
3	Bypass	19	8 [42%]	1 [5%]	10 [53%]
4	Tailwater	30	16 [53%]	4 [13%]	10 [33%]
5	Downstream Reference Reach Mainstem	11	8 [53%]	3 [20%]	4 [27%]
	Downstream Reference Reach Side Channel	16	13 [62%]	3 [14%]	5 [24%]

Surveys and Assessments by VDWR

Fish surveys were conducted (VDGIF 2015) on the upper New River from 2004 to 2014. In spring 2014, electrofishing samples were collected at twelve sites from Allisonia in Pulaski County upstream to Fries Dam. Samples were dominated by Smallmouth Bass, followed by Rock Bass, Channel Catfish, Walleye, Flathead Catfish, and Redbreast Sunfish. A total of 232 adult Smallmouth Bass were collected, ranging in size from 7 to 22 inches (presumably total length, but not stated in original report). Results were used to calculated Proportional Size Distribution (PSD) scores for select sportfish species.

The PSD is a simple measure that summarizes the size structure of a fish population by categorizing each species by specific length classes (Gabelhouse 1984): stock (S), quality (Q), preferred (P), memorable (M), and trophy (T) lengths. Stock-length fish are generally defined as the age at which the fish enters the fishery, i.e., when it becomes vulnerable to gear and/or reproductively active, and when it becomes recreationally valuable (the minimum size of fish most anglers would like to catch). The most common metric used for PSD values is quality length (or PSD-Q), where PSD equals the number of fish greater than quality length, divided by the number of fish at stock length, multiplied by 100. PSD values range from 0 to 100. A low PSD value indicates there are very few large fish in the population, whereas a large PSD value indicates few small fish in the population. An ideal or balanced fish population should consist of a range of size structures and have predator species with a PSD range of 40-70 and prey species with a PSD range of 20-60 (Murphy and Willis 1996).

In 2014, the Smallmouth Bass PSD-Q downstream from Fries Dam was 45, indicating that 45 percent of Smallmouth Bass collected were of quality length (11 inches) or larger, and within the 40 to 60 range is considered (VDGIF 2015) representative of a healthy river Smallmouth Bass population. The remainder of the 2014 data indicated PSD-P was 28, PSD-M was 17, and PSD-T was 4. The average relative weight of Smallmouth Bass was 90, indicating that Smallmouth Bass in this section of the New River are healthy. Flathead and Channel catfish showed evidence of excellent reproduction in sampling, but no additional information was provided for these fish.

Rock Bass collected in 2014 ranged in size from 3 to 9 inches with an average size of 6 inches (VDGIF 2015). The Rock Bass PSD-Q was 27, which falls within the ideal PSD range for a prey species. Walleye length ranged in size from 13 to 29 inches, with an average of 17 inches. The Walleye PSD-Q was 95, well above the 30-60 range identified by Murphy and Willis (1996) as indicative of a balanced community, indicating that a large portion of the Walleye population is greater than or equal to quality length (15 inches). This may suggest limited recruitment (fewer younger fish) or gear bias

(Gouffaux et al. 2005). However, with a relative weight of 84, the Walleye population appears to be in moderately healthy condition (VDGIF 2015).

E.9.1.2.2 Temporal and Spatial Distribution of Fish Communities

No obligate long-run anadromous or migrant fish species (catadromous or anadromous) exist in the Project area, as movement of fish is currently limited by dams upstream and downstream of the Project. However, some species may exhibit local spawning migrations, such as Walleye or Muskellunge (Younk et al. 1996; Hayden et al. 2014). Although the movement of these species is largely precluded by the dams, the areas upstream and downstream remain a high-quality fishery.

Fish passage is not provided at any of the existing New River dams and there are currently no plans on record to install fish passage at any other dam on the New River.

E.9.1.2.3 Spawning Run Timing and Extent and Location of Spawning, Rearing, Feeding, and Wintering Habitats

As stated previously, the upper New River supports a cool-water fishery and is a popular fishing area for a variety of sportfish. Based on information provided by VDWR (VDGIF 2017a), the Project area is specifically known for the quality of Smallmouth Bass, Channel Catfish, Spotted Bass, Walleye, and Muskellunge fishing opportunities. These species exhibit a range of seasonal behaviors related to the timing of spawning activity, and the location of spawning, rearing, feeding, and wintering habitats. The life-history characteristics of these species are described below. Threatened or endangered fish or aquatic species are discussed separately in Section E.9.1.5.

Spawning characteristics of fish species likely to use the Project waters (VDGIF 2017c), as well as the fishery study conducted by Appalachian for the previous relicensing effort (Appalachian 1991b) are summarized below. These studies concluded that <1 to 13 percent of available spawning habitat within the Project area is potentially exposed under natural riverine conditions. Refer to Table 13 in Appalachian (1991b) for a listing of spawning characteristics of fish species in the Project area.

Smallmouth Bass

Smallmouth Bass are native only to the Tennessee and Big Sandy River drainages of southwest Virginia but have been introduced into, and are now abundant in, most large rivers and lakes in Virginia. Smallmouth Bass prefer slow-to-moderate currents and select areas of rocky shorelines. They are most active at temperatures between 67 °F to 72°F and are intolerant of silty, warm, polluted water (VDGIF 2017c).

Spawning usually occurs in late April to early June as temperatures exceed 60°F. Males build and guard a next constructed in sand, gravel, or rubble at a depth of two to four feet (Appalachian 1991b; VDGIF 2017c). Eggs hatch between 7 and 21 days, depending on water temperature (Smith 1985).

Spotted Bass

Spotted Bass are native to western Virginia. They are typically found in warm, slow-moving streams and stream-like or riverine arms of reservoirs. Spotted bass feed on crayfish, small fish, and larval and adult insects. They spawn in the spring when water reaches between 63°F and 68°F (Appalachian 1991b). Males sweep silt from gravel or rocky substrates on the bottom of streams and rivers to make nests near brush or logs; after hatching the males guard the eggs and fry (VDGIF 2017c).

Rock Bass

Rock Bass, although not a true bass, is part of the Centrarchidae family. The Rock Bass is native to the Mississippi River, Great Lakes, and Southern Hudson Bay drainage areas, although it has been introduced throughout the Atlantic slope drainages (Rohde et al. 2009). Rock Bass prefer pools and backwater areas of clear and cool, rock-bottomed streams, usually associated with structure such as rocks or logs. Rock Bass are generalists and when young, will feed on micro-crustaceans and aquatic insects, shifting to small fish and crayfish as adults. Males construct a circular nest in shallow water over sand for spawning, which occurs from April to June (Appalachian 1991b).

Channel Catfish

Channel Catfish are found in lakes and larger rivers with relatively clean sand, gravel, or stone substrate, over mud flats, and seldom in dense weedy areas; or in deep, slow pools of swift, clear-running streams; and are often found below dams in large reservoirs (VDGIF 2017c). Spawning occurs from late May through July when water temperatures reach the mid-70s (°F). Channel Catfish often deposit their eggs on rocky ledges, undercut banks, hollow logs, and other underwater structures (Appalachian 1991b). Males guard the nest and the eggs hatch in 7 to 10 days. The fry travel in schools, which are often herded and guarded by the male (VDGIF 2017c).

Walleye

Walleyes are native to the Tennessee and Big Sandy River drainages (VDGIF 2018a), as well as the New River drainage (Palmer et al. 2005) in Virginia. They are often found in cool water next to ledges, large rocks or logs, underwater islands, edges of large beds of aquatic vegetation, along old riverbed channels, and along reefs and bars (VDGIF 2017c).

Spawning begins as early as late February when water temperatures reach approximately 45 to 55°F

(7 to 12°C). Walleye in the New River are known to migrate upstream to spawn but are inhibited by the Byllesby and Buck dams. However, they will also spawn in lakes over rocky or gravel shoals or clean, low-growing emergent vegetation. Walleye are broadcast spawners (i.e., do not create nests); eggs are non-adhesive and unattended after being released. Eggs free-fall onto substrate or into cracks and crevices and hatch in about two weeks (Appalachian 1991b; VDGIF 2017c).

Spawning takes place primarily at dusk or night in relatively shallow, flowing habitats comprised of rocky substrates (Paragamian 1989; Smith 1985; McMahon et al. 1984; Ellis and Giles 1965). Walleyes prefer shallow shoreline areas, shoals, riffles, and dam faces with rocky substrates and good water circulation from waves or currents. Walleye typically display diurnal staging behavior at or just adjacent to spawning sites; however, studies have reported spawning during the day and in slack water habitats (Lowie et al. 2001; Corbett and Powles 1986). Males often arrive at spawning sites before females, where multiple males may spawn with one female. This usually involves a series of courtship behaviors including lateral pushing, rolling, and rapid bursts of swimming (Ellis and Giles 1965). Eggs and milt are simultaneously broadcast over the substrate when males and females are in close proximity. Fertilized eggs likely drift downstream and settle into interstitial spaces of the streambed substrate. Studies have shown that egg survival is greatest when larger, harder substrates such as boulders, rubble, and gravel dominate (Smith 1985; Johnson 1961). Hatching time varies depending on water temperature, and newly hatched fry may drift further downstream to lentic habitats and continue first-year development there (Corbett and Powles 1986; McMahon et al. 1984; Olson et al. 1978). Male Walleye usually mature at ages two to three (300–340 millimeters) and females at ages four to five (430 millimeters) (Smith 1985).

Muskellunge

Muskellunge are not believed to be native to Virginia, but have been introduced to the New River, as well as other drainages. Muskellunge prefer cool, clear lakes with abundant vegetation or long pool areas of rivers near fallen debris and other submerged structures. They spawn in early spring. Eggs are fertilized and discharged over muck or marl bottoms with aquatic vegetation in shallow bays and coves of lakes, or in eddies upstream or downstream of riffles. In Virginia, most Muskellunge populations are maintained through stocking (Appalachian 1991b).

E.9.1.2.4 Management Activities by VDGIF

Based on available stocking records, the VDWR stocks two species of management interest in the New River, Walleye and Muskellunge (VDGIF 2014). Stocking information for each of these species is summarized below.

Walleye

A two-year radio-telemetry study of the Walleye population of Claytor Lake and the upper New River found that two genetically distinct populations coexist within the New River system. One population originates from Walleye fingerlings obtained from outside of the New River drainage (i.e., not native to the New River), while the other is an indigenous population unique to the upper New River. The Claytor Lake Walleye generally spawn at the first riffle area above the reservoir, while those living in the New River spawn at two riffle areas well upstream of Claytor Lake (Palmer et al. 2005).

Since 2000, Walleye have been stocked and managed from Fries Dam downstream to Claytor Lake Dam in an effort to restore the fishery to a self-sustaining population level (VDGIF 2013). According to Palmer et al. (2005), the coexistence of the two distinct populations of Walleye within the upper New River and Claytor Lake may warrant different management strategies and suggested that management focus efforts on encouraging the exploitation of the Claytor Lake stock to reduce the nonindigenous population. To support the conservation of the indigenous population in the upper New River, Palmer et al. (2005) recommended the implementation of strict harvest regulations and the exclusive use of indigenous Walleye fingerlings (offspring from upstream spawning sites) as they may be better adapted to the New River environment and may exhibit higher recruitment to the fishery than the nonindigenous stocks. Since 2003, over one million indigenous Walleye from upstream spawning sites have been stocked in the New River between Allisonia, in Pulaski County, upstream to Fields Dam, near the community of Mouth of Wilson, in Grayson County (VDGIF 2017a) (Figure E.9.1).

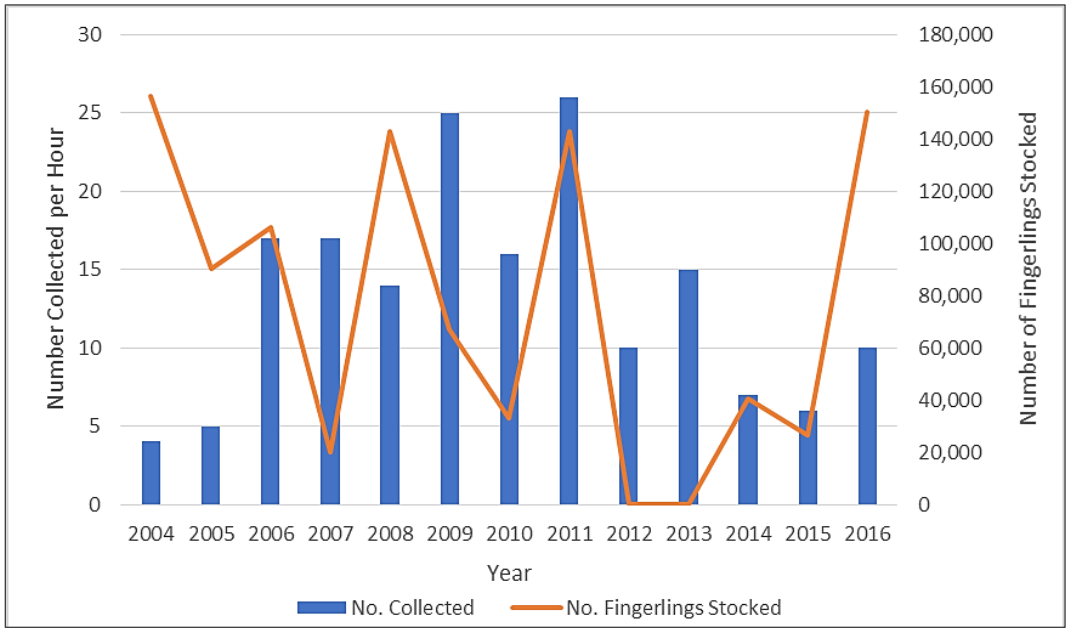


Figure E.9.1. Walleye Catch Per Hour and Annual Stocking Rates from the Upper New River – Allisonia Upstream to Fries Dam, 2004-2016 (VDGIF 2017b)

Based on recent surveys performed by VDWR, the largest numbers of Walleye were collected from 2006 to 2011, following years of consistently high stocking rates (an average of almost 95,000 fingerlings per year from 2004 to 2011). However, no Walleye were stocked between 2012 and 2013 as part of an evaluation of the need for continued stocking. A decline in Walleye was reflected in spring electrofishing catch rates, and the collection of limited numbers of naturally reproducing Walleye indicated the necessity of continued stocking to maintain a viable recreational fishery.

A recent upper New River Walleye Management Plan developed by the VDWR (VDGIF 2017b) outlines several objectives with the goal of maintaining the genetically unique, naturally reproducing upper New River Walleye stock. These objectives include: (1) maintaining an average spring electrofishing catch rate between 15 and 25 Walleye per hour; (2) sustaining angler catch rates of adult Walleye at one fish per four hours of fishing between February and April; (3) maintaining New River Walleye stock through allele frequency monitoring; and (4) increasing the Walleye spawning stock to adequate levels for natural reproduction in support of a viable recreational fishery. With these objectives, VDWR annually collects adult Walleye to use as brood stock in order to maintain the genetic structure of the population. Annual electrofishing surveys and allele frequency monitoring are conducted, as well as creel surveys and review of management strategies. Creel and slot limits are managed by river reach so that certain populations are protected for spawning and/or during spawning seasons.

Muskellunge

Since the 1970s, Muskellunge have also been stocked in the New River with the goal of establishing a reproducing, self-sustaining population. Muskellunge are managed primarily as a trophy fish and secondarily as a predator for forage fish control. In the New River, Muskellunge exhibit fast growth rates and regularly reach trophy sizes, suggesting that the conditions of the New River are well-suited to support this species. Management is implemented by minimum length and creel limit regulations. As with other Virginia Rivers, Muskellunge are stocked to the New River on a rotating priority system, where waterbodies not stocked the previous year are given higher priority than those that were stocked (Brenden 2005). According to the latest (available) warmwater fish production and stocking information 500 nine-inch-long Muskellunge were stocked in the upper New River in Wythe and Carroll Counties in 2014 (VDGIF 2014). However, as of 2014, in response to an increase in the population and evidence of natural production, Muskellunge stockings were discontinued in the New River downstream of Claytor Dam in 2011 (Copeland 2014) and upstream of Claytor Dam in 2018 (VDGIF 2019).

E.9.1.3 Benthic Aquatic Community

E.9.1.3.1 Macroinvertebrates

Benthic macroinvertebrates and crustaceans such as crayfish are an important component of riverine systems where they serve as a food resource for fish and as useful indicators of water quality and environmental stressors. Often, the presence of pollution-intolerant macroinvertebrates, or EPT taxa (Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]) can be indicative of a healthy stream.

No recent historical macroinvertebrate data is available from within the Project Boundary. However, during the 2016-2017 aquatic resource surveys conducted at the Fries Project, 17 species of Odonata representing 4 families were collected from Reaches 1, 2, 4, and 5; none were collected from Reach 3 (Carey et al. 2017). The pygmy snaketail (*Ophiogomphus howei*) was collected in Reaches 4 and 5. Additionally, the Allegheny river cruiser (*Macromia alleghanensis*), spine-crowned clubtail (*Gomphus abbreviates*) and green-faced clubtail (*G. viridifrons*) were also collected in the surveys.

Specific to the Project, the VDCR, in a letter from dated September 23, 2017, identified two species of aquatic insect as “species of greatest conservation need (SGCN)” with the potential to occur within the Project vicinity: the mustached clubtail (*Gomphus adelphus*) and the pygmy snaketail. Additional information regarding these rare species is provided in Section E.9.1.5.

E.9.1.3.2 Crustaceans

Crayfish function as an important prey item for sportfish species in the New River. In comments filed on the PAD for the Fries Project, Orth (2015) noted that a number of species of New River crayfishes live amongst the gravel and cobble substrates (Roell and Orth 1992, as cited by Orth [2015]). Many of the large-bodied fishes (Smallmouth Bass, Rock Bass, Flathead Catfish, Walleye) in the New River are highly dependent on crayfish as an energy source (Roell and Orth 1993, as cited by Orth [2015]) and these crayfish can support local bait harvest, when locally abundant (Nielsen and Orth 1988, as cited by Orth [2015]).

A 2008 crayfish survey in the New River for the Claytor Project relicensing effort collected 690 crayfish, representing three species, at multiple sites downriver from the Claytor Lake Dam. The three crayfish taxa included the invasive Northern Virile Crayfish (*Orconectes virilis*), Spiny Stream Crayfish

(*Orconectes cristavarius*), and the New River Riffle Crayfish (*Cambarus chasmodactylus*)[13]. The invasive Northern Virile Crayfish dominated overall crayfish densities (DTA 2008).

As part of the recent Fries Project relicensing studies, crayfish surveys were completed using a variety of sampling gear and methodologies (e.g., kick-net, seine-haul, D-frame dip nets, and snorkel surveys) (Carey et al. 2017). Over 800 live Spiny Stream Crayfish were collected within the study reaches upstream and downstream of the Fries Project (Reaches 1, 3, 4, and 5), but not within the Fries Project reservoir or bypass reach (Reaches 2 and 3). The Spiny Stream Crayfish was the only taxon of crayfish collected in the New River during the surveys. Based on the absence of suitable crayfish habitat (i.e., gravel and cobble substrates) in the Byllesby and Buck bypass reaches, Appalachian does not expect crayfish to be present in these reaches.

E.9.1.3.3 Freshwater Mussels

Existing relevant and reasonably available information regarding the mussel community in the Project vicinity was summarized in Section 5.4.5 of the PAD (Appalachian 2019). Eleven species of freshwater mussels have been documented in the upper New River in recent surveys of the upper New River (Pinder et al. 2002; Alderman 2008; Stantec 2016, 2017a, 2018a, 2018b).

Pinder et al. (2002) conducted a drainage-wide survey to determine the status and distribution of freshwater mussels in the New River in Virginia. Mussels were sampled at 134 sites, which included the mainstem and tributaries in the New River Basin between 1997 and 1998. Sampling was conducted in summer and early fall during low-flow, clear-stream conditions. Sites were sampled using snorkel or viewscope survey methods. Sample transect lengths were 500 m on the mainstem and 250 m on most tributary sections. Fifty of the 134 sites yielded mussels for a total of 1,181 individuals representing eight species (Table E.9-5). The two most widely distributed species were the purple wartyback (*Cyclonaias tuberculata*) and spike (*Eurynia dilatata*).

A 2007-2008 survey by Alderman (2008) identified six extant mussel species in Claytor Lake: giant floater (*Pyganodon grandis*), paper pondshell (*Utterbackia imbecillis*), purple wartyback, pistolgrip (*Tritogonia verrucosa*), pocketbook (*Lampsilis ovata*), and spike. In 2008, two of 16 sites surveyed in the New River located downstream of Buck Dam (Buck Downsteam 1 and Buck Downstream 2) produced a total of 125 pistolgrip, 134 purple wartyback, nine pocketbook, and seven spike mussels (Alderman 2008) (Table E.9-5). Specimen lengths were not reported by Alderman (2008).

[13] The New River crayfish is currently under federal review for listing under the Endangered Species Act (76 FR 59835).

In October 2015, Stantec (2016) performed a mussel survey on the New River in Virginia, using a combination of transect and quadrat sampling either by scuba diving or snorkeling. Two of the seven sample sites (Buck Downsteam 1 and Buck Downstream 2) were located less than a mile downstream of Buck Dam and were previously surveyed by Alderman (2008). After transects were surveyed, the areas with the highest abundance of mussels were determined and selected for quantitative sampling. A total of 130 live mussels were observed in the New River during the survey. The purple wartyback was the most abundant species with 96 individuals documented, followed by the pistolgrip with 26 mussels documented (Table E.9-5). Recruitment was observed for these two species as measured lengths indicated multiple-year classes were present.

Stantec (2017a) reassessed the mussel assemblage at sites along the New River in June 2017 to document reproductive behaviors, and in September 2017 to document abundance and population dynamics. A total of 129 live mussels were collected (Table E.9-5) from two sites sampled in June, with reproductive status assessed on 59 of those, none of which were observed to brood glochidia and divers did not observe any displaying females. Seven sites were surveyed in September 2017; three upstream of Claytor dam and four downstream (Stantec 2017b). A total of four species and 337 live freshwater mussels were collected during the survey, with the majority (307 mussels) collected at sites upstream of Claytor Lake. Nearly 25 percent of the mussels collected in the survey were collected at a site located less than a mile downstream of Buck Dam where 49 purple wartyback, 3 spike, and 30 pistolgrip were collected (Table E.9-5).

Appalachian consulted with USFWS and VDWR regarding freshwater mussels at the Byllesby-Buck Project in 2016 in support of the non-capacity amendment application for the installation of the inflatable Obermeyer crest gates. In correspondence to Appalachian, dated November 15, 2016, USFWS stated that green floater (*Lasmigona subviridis*) may be present in the Byllesby-Buck Project reservoirs. The green floater was included in a petition for listing of 404 southeastern species submitted to the USFWS in April 2010 by the Center for Biological Diversity (USFWS 2021b). Additional information on the green floater is provided in Section E.9.1.5.2.

During a riparian habitat assessment conducted at the Byllesby-Buck Project in April 2017, it was reported to Appalachian (and in turn reported to VDWR, USFWS, and FERC) that a weathered, dead shell of a green floater was found on a dry gravel bar along the New River, upstream of the Byllesby Dam (correspondence from W. Baltzersen of Environmental Solutions & Innovations, Inc. [ESI] to Appalachian, dated May 2, 2017).

Table E.9-5. Mussel Occurrences in the New River Basin

Common Name	Pinder et al. (2002)			Alderman (2008)		Stantec (2016)		Stantec				Stantec (2018a, 2018b)	
								June Survey (2017a)		September Survey (2017b)		April - May [1]	July [2]
	Historical Occurrence in New River	Main Stem of New River	Tributaries to New River	Site 080724.1-Below Buck Dam	Site 080724.2-Below Buck Dam	Above Claytor Lake	Below Claytor Lake	Above Claytor Lake	Below Claytor Lake	Above Claytor Lake	Below Claytor Lake	Above Byllesby dam	Above Buck dam
Purple wartyback (*Cyclonaias tuberculata*)	X	674	27	11	123	78	18	104	-	265	25	3	1
Spike (*Eurynia dilatata*)*	X	316	57	1	6	3	-	9	-	8	-	-	-
Pocketbook (*Lampsilis ovata*)	X	27	-	4	5	3	-	-	-	2	-	-	-
Pistolgrip (*Quadrula verrucosa*)	X	15	-	79	46	24	2	2	4	32	5	-	-
Wavy-rayed lampmussel (*Lampsilis fasciola*)	X	15	4	-	-	-	2	-	-	-	-	-	1
Elktoe (*Alasmidonta marginata*)	X	2	-	-	-	-	-	-	-	-	-	-	-
Green floater (*Lasmigona subviridis*)	X	7	17	-	-	-	-	-	1	-	-	1	-

Common Name	Pinder et al. (2002)			Alderman (2008)		Stantec (2016)		Stantec				Stantec (2018a, 2018b)	
								June Survey (2017a)		September Survey (2017b)		April - May [1]	July [2]
	Historical Occurrence in New River	Main Stem of New River	Tributaries to New River	Site 080724.1-Below Buck Dam	Site 080724.2-Below Buck Dam	Above Claytor Lake	Below Claytor Lake	Above Claytor Lake	Below Claytor Lake	Above Claytor Lake	Below Claytor Lake	Above Byllesby dam	Above Buck dam
Tennessee heelsplitter (*Lasmigona holstonia*)	X	-	20	-	-	-	-	-	-	-	-	-	-
Mucket (*Actinonaias ligamentina*)	X	-	-	-	-	-	-	-	-	-	-	-	-
Paper pondshell (*Utterbackia imbecillis*)	X	-	-	-	-	-	-	-	-	-	-	-	-
Giant floater (*Pyganodon grandis*)	X	-	-	-	-	-	-	-	9	-	-	-	-
Total Number	**-**	**1,056**	**125**	**95**	**180**	**108**	**22**	**115**	**14**	**307**	**30**	**4**	**2**
Number of Species	**11**	**7**	**5**	**4**	**4**	**4**	**3**	**3**	**3**	**4**	**2**	**2**	**2**

(x) Species detected but not enumerated.
(-) No specimens of this species collected at the referenced site.
(*) Formerly *Elliptio dilatata.*

Mussel salvage and relocation activities were conducted in the Byllesby reservoir from April 30-May 1, 2018, during a planned reservoir drawdown for the Obermeyer gate replacement at Byllesby Dam (Stantec 2018a). The mussel salvage and relocation efforts were performed along 500-m-long areas of the exposed channel margins above Byllesby Dam. Search areas were surveyed, and where suitable substrates were observed, a visual search for mussels was performed. Four live mussels, three purple wartyback and one green floater, were identified and measured (Table E.9-5), and then relocated upstream of the impoundment in areas with suitable substrate with a similar mussel assemblage.

E.9.1.4 Invasive Aquatic Species

Invasive species are those which do not naturally occur in a specific area and cause ecological and economic damage. Invasive aquatic species of concern to the Project are discussed in the following sections.

E.9.1.4.1 Alabama Bass

The presence of Alabama Bass (*Micropterus henshalli*), a species of black bass that is native to Alabama and Georgia, has recently been confirmed in Claytor Lake (VDWR 2020). Alabama Bass are an aggressive species that outcompetes native Largemouth Bass and frequently hybridize with Spotted Bass and Smallmouth Bass where they co-occur. Although this species has not been documented previously within the Byllesby or Buck Project boundaries, it is feasible that the Alabama Bass will eventually move further upstream into the lower reach of the Project Boundary, below Buck Dam. However, even if this species expands its range further upstream in the New River, it is unlikely to establish within the Project Boundary, downstream of Buck Dam due to a lack of their preferred deep pool habitats. Further, Buck Dam serves as a barrier of further upstream movement of this non-native potentially invasive fish, thus Alabama Bass are not anticipated to be collected within the Byllesby Project Boundary. Due to their potential to impact native fish through competition and hybridization, VDWR requested that pelvic fin clips and lateral line scale counts be collected from specimens of Alabama Bass, should they be collected during fish the 2020 fish sampling efforts. No Alabama Bass were collected during the fisheries surveys performed for the Project in 2020 and 2021 (see Section E.9.2.1.2).

E.9.1.4.2 Northern Virile Crayfish

The invasive Northern Virile Crayfish have been documented throughout the New River (DTA 2008). It is found in streams with moderate flow and turbidity, abundant cover, and stable water levels. It is believed that anglers use of this species as a live bait has been a major factor contributing to its spread throughout the country (USFWS 2015a). The Northern Virile Crayfish are known to modify aquatic

macrophyte and macroinvertebrate communities, which in turn can lead to a decline and reconfiguration of the fish community. They may also consume eggs of sunfish, Bluegill, and other fish leading to reduced population sizes. As described above in Section E.5.3.1 and in Section 5.4.5 of the PAD, this species dominated overall densities of crayfish observed in the 2008 crayfish survey conducted in the New River for the Claytor Project relicensing (DTA 2008).

As part of the recent Fries Project relicensing studies, crayfish surveys were completed using a variety of sampling gear and methodologies (e.g., kick-net, seine-haul, D-frame dip nets, and snorkel surveys) (Carey et al. 2017). Although more than 800 live Spiny Stream Crayfish were collected within the study reaches upstream and downstream of the Fries Project, no Northern Virile Crayfish were collected from within the Fries Project Boundary.

The Northern Virile Crayfish has not previously been documented within the Project Boundary. Given the potential environmental impact of this invasive species, the VDWR was interested in understanding their current distribution near the Project. At the request of VDWR in Scoping Document 2 (dated November 11, 2019), Appalachian included survey efforts for crayfish with the macroinvertebrate study in the Project RSP.

E.9.1.5 Threatened or Endangered Aquatic Species and Aquatic Species of Special Concern

E.9.1.5.1 Candy Darter

The Candy Darter is endemic to the upper Kanawha River basin and is found in the New River drainage basin. Extant populations of Candy Darter are currently threatened from a variety of factors including in habitats where they co-occur with the Variegate Darter (*Etheostoma variatum)* which hybridizes with this species, swamping the gene pool. The Candy Darter was federally listed as endangered in the Federal Register (83 FR 58747) on November 21, 2018 (USFWS 2018a). The Candy Darter prefers rock, rubble, or gravel riffles in creeks or small to medium rivers (Rohde et al. 1996). Five watersheds that contain known Candy Darter habitats were listed as critical habitat when the USFWS finalized the critical habitat designation for the species on April 7, 2021 (USFWS 2021a); all five watersheds are tributaries to the New River. The critical habitat nearest to the Project is the Cripple Creek tributary, which confluences with the New River, five river miles downstream of Buck Dam.

The Ridge and Valley province terminates just upstream of Cripple Creek, and Candy Darter are not known to occur upstream of this location, currently or historically. No Candy Darter were collected during recent fish sampling activities within the Project Boundary.

E.9.1.5.2 Green Floater

The green floater is a small, dull yellow to brownish green mussel with a subovate to trapezoidal shape. Shells, especially of younger specimens, may exhibit dark green rays of variable width. Green floater shells are quite thin and when held up to the light, the colors and patterns of the periostracum may be visible through the nacre. The green floater is a hermaphroditic species with a reproductive season extending from August to May. Host fish species have not been determined for the glochidial life stage; however, prior research documented direct transformation of glochidia into juvenile mussels (Barfield and Watters 1998; Lellis and King 1998). The historical distribution of the green floater is from the Cape Fear River Basin in North Carolina to the Hudson River Basin, to the Genesee River of New York, and includes the New and Greenbrier Rivers in Virginia, West Virginia, and North Carolina.

The green floater was included in an April 2010 petition for listing of 404 southeastern aquatic species submitted to the USFWS by the Center for Biological Diversity. The USFWS is currently reviewing the petition for listing and by the end of fiscal year 2022, are anticipating the issuance of a Species Status Assessment Report and expects to make a listing determination for the green floater (USFWS 2021b). The green floater is listed as threatened in Virginia (VDWR 2021).

E.9.2 Environmental Analysis

E.9.2.1 Studies in Support of the Current Relicensing

Several studies related to Aquatic Resources were carried out in support of the current relicensing including the (1) Bypass Reach Flow and Aquatic Habitat Study, (2) Fish Community Survey, (3) Fish Impingement and Entrainment Study, (4) Macroinvertebrate and Crayfish Community Survey, and the (5) Freshwater Mussel Survey. Methods and results of these individual studies are summarized in the sub-sections that follow and details were reported in the USR and associated appendices. Complete results and PM&E measures will be detailed in the Bypass Reach Flow and Aquatic Habitat Study Report (Appendix A) and the Aquatic Resources Study Report (Appendix C), which will be filed as supplemental information after the FLA filing.

E.9.2.1.1 Bypass Reach Flow and Aquatic Habitat Study

In support of the current relicensing, Appalachian conducted a Bypass Reach Flow and Aquatic Habitat Study in 2020 and 2021. A summary of the methods and results of the Bypass Reach flow and Aquatic Habitat Study is provided in this section, and preliminary results were provided in the USR. The revised Byllesby-Buck Bypass Reach Flow and Aquatic Study Report will be submitted as supplemental information within 45 days of the FLA filing (by April 14, 2022). The specific objectives of the study are included below:

- Delineate and quantify aquatic habitats and substrate types in the Byllesby and Buck bypass reaches.
- Identify and characterize locations of habitat management interest located within each bypass reach.
- Develop an understanding of surface water travel times and water surface elevation responses under variable base flow and spillway release flow combinations in the tailrace and bypass reach of each development to:
    - Demonstrate the efficacy of existing ramping rates required by the existing license.[14]
    - Demonstrate the efficacy of the existing powerhouse minimum flow requirement (i.e., 360 cubic feet per second [cfs] minimum flow to maintain aquatic resources, including resident fish species, downstream of each development consisting of the tailrace areas below each powerhouse and the bypass reaches below the main spillways).
    - Evaluate the impacts of providing seasonal minimum flows to the bypass reaches.

Bypass Reach Flow and Aquatic Habitat Study Areas

The Study Area for the Flow and Bypass Reach Aquatic Habitat Study includes the tailrace, bypass reach, and a short stream segment downstream of where the tailrace and bypass reach waters join (see Figure E.9.2 for the Byllesby Study Area and Figure E.9.3 for the Buck Study Area).

[14] In accordance with existing FERC spillway gate operating requirements for the Buck Development, Appalachian discharges flows through a 2.0-ft gate opening for at least three hours following any spills released through a gate opened 2.0 ft or more. Appalachian must then reduce the opening to 1.0 ft for at least an additional three hours, after which time the gate may be completely closed. The gradual reduction of flow allows time for fish to respond to the receding water levels, thus avoiding stranding that can occur with sudden flow discontinuation.

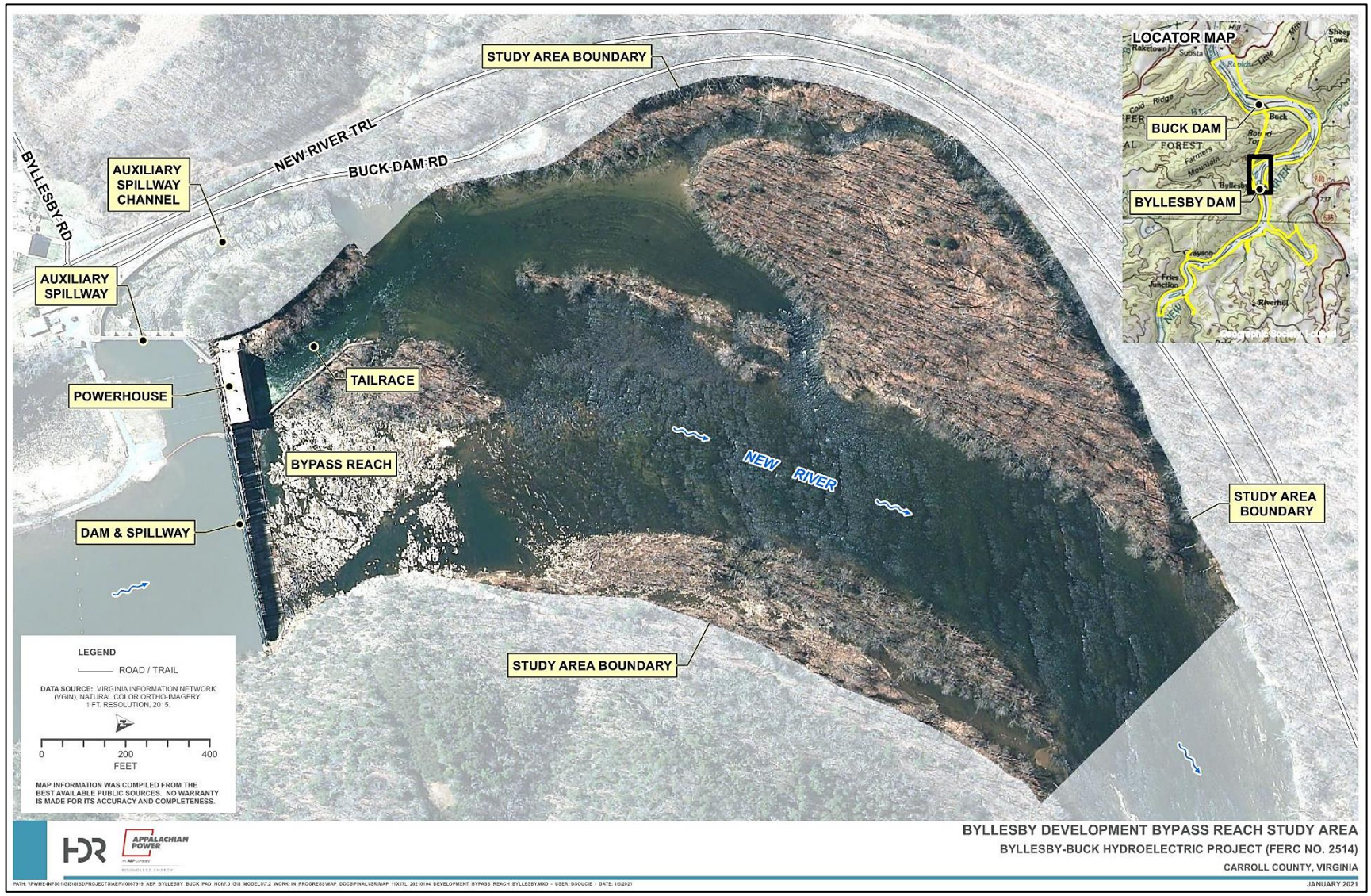


Figure E.9.2. Byllesby Development Bypass Reach Study Area

Figure E.9.3. Buck Development Bypass Study Area

Bypass Reach Flow and Aquatic Habitat Study Methods

HDR reviewed the hydrologic record for the Project study reaches, spillway and trash sluice gate operating procedures and design capacity, existing topographic and geologic maps, and available recent and historical aerial imagery. Light detection and ranging data (LiDAR) were collected to support development of comprehensive three-dimensional elevation and visual surface layers of the bypass reach. These data were used for desktop mesohabitat mapping of each bypass reach according to substrate size (e.g., sand, gravel, cobble, etc.), cover (e.g., no cover, overhead vegetation, etc.), and mesohabitat types (e.g., pools, riffles, runs, bedrock, shoals). The topographic information was then incorporated as a GIS base layer to support field data collection and hydraulic modeling efforts.

In 2020, field data was collected to support development of a two-dimensional (2-D) hydraulic model of the Buck tailrace and bypass reach. The hydraulic model is based on the Innovyze Infoworks Integrated Catchment Model (ICM) software (version 7.0), which is capable of simulating depth and velocities in a 2-D triangular pattern over a wide range of flow conditions. Target model calibration/validation flows were released into the Buck bypass reach in September 2020 for purposes of collecting depth, water surface elevations, velocities, and wetted area data under various bypass flow regimes. For the Buck Development, the target flow scenarios were designed to evaluate the effect of the existing ramping rate requirements. Detailed descriptions of the ICM model development process and results were provided in the USR that was filed with the FERC in November 2021 and will also be included in the Bypass Reach Flow and Aquatic Habitat Study revised report that will be submitted as supplemental information by April 14, 2022.

Similar field data collection efforts under a range of proposed target flows were conducted in the Byllesby bypass reach in 2021. For the Byllesby Development, the target flow scenarios were designed to evaluate the effect of passing the entire minimum downstream flow requirement of 360 cfs through the bypass reach.

The mesohabitat mapping results and the 2-D model depth and velocity simulation results were used in combination with aquatic species habitat suitability criteria (i.e., using depth, velocity, substrate, and cover habitat preferences) to evaluate potential available aquatic habitat in each tailrace and bypass reach under each modeled flow scenario. Walleye was selected as a standalone target species for this study along with a total of eight species-guild representatives including three shallow-slow, one shallow-fast, two deep-slow, and two deep-fast guilds. Guild representatives were selected from a variety of regionally representative sources, represent a wide range of habitat characteristics, and were selected to represent a wide range of species.

Aquatic habitat modeling results for the each of the eight species-guild representatives (i.e., two deep-fast, two deep-slow, one shallow-fast, and three shallow-slow) and Walleye (adult, fry, juvenile, and spawning) life stages for each modeled flow scenario will be included in the Bypass Reach Flow and Aquatic Habitat Study Report to be filed as supplemental information by April 14, 2022. In addition, the amount of usable area in the bypass reaches for each guild representative and Walleye over the range of model calibration flows will also be provided.

Byllesby Bypass Reach Flow and Aquatic Habitat Study Results

Aquatic Habitats and Substrate Types

The Byllesby bypass reach primarily consists of deep and shallow pool and shoal habitat types dominated by larger substrate sizes (i.e., bedrock and large boulders). The tailrace is a relatively deep and swift man-made channel lined with bedrock and large boulders. The cross-over channel between the tailrace and main channel is primarily comprised of run-type habitat with gravel, cobble, and sand substrate. The main channel downstream from the bypass reach consists of relatively wide riffles and runs with undulating bedrock/boulder substrate which provides instream cover. The side channel is also comprised of run/riffle habitat but is much narrower than the main channel with gravel/cobble substrates. In all, the bypass reach study area contains a wide variety of aquatic habitat and substrate types.

Target Model Calibration Flow Releases

Field data collection to support the Byllesby aquatic habitat model calibration occurred from July 26 – September 13, 2021. During this period, the four target model calibration flow releases provided in Table E.9-6 were released into the bypass reach and flow, depth, and water surface elevation data was collected throughout the study area after each flow stabilized.

Table E.9-6. Byllesby Habitat Model Calibration Flows

Tainter Gate #6 Opening (ft)	Bypass Reach Flow (cfs)	Powerhouse Flow (cfs)
Day 1: Closed (Leakage Flow)	11	1,144
Day 2: Broken Flashboards (Low Flow)	88	1,555
Day 3: 0.5 (Mid Flow)	158	1,216
Day 4: 1.0 (High Flow)	194	1,335

Surface Water Travel Times and Water Surface Elevation Responses

Level logger data collected during the field data collection period were used to determine surface water travel times in the Byllesby bypass reach as well as water surface elevation responses

throughout the bypass reach study area under the target flow releases. A summary of key findings is provided below:

- Water depths increased in the bypass reach approximately 0.8 ft from Leakage Flow to Low Flow range (11 cfs to 88 cfs), approximately 0.2 ft from Low Flow to Mid Flow (88 cfs to 158 cfs), and approximately 0.5 ft from Mid Flow to High Flow (158 cfs to 194 cfs). The overall depth increase was approximately 1.5 ft from Leakage Flow to High Flow (11 cfs to 194 cfs).

- Changes in water depth in the main channel immediately downstream from the bypass reach were smaller than the bypass reach, increasing by just 0.25 ft (maximum) between Leakage Flow and High Flow.

- Bypass flow releases did not influence water surface elevations in the tailrace, cross-over channel, or side channel areas. These areas are influenced by powerhouse flow releases and not bypass flow releases.

- Because the Byllesby bypass reach is relatively short (i.e., 590 ft long), travel times of flow releases from Tainter Gate #6 to the downstream end of the bypass reach are also relatively short. For example, the Mid Flow and High Flow releases reached the downstream end of the bypass reach in 6 minutes and 2 minutes, respectively.

Aquatic Habitat Model Results

Aquatic habitat model results for the Byllesby bypass reach indicate suitable habitat for species and life stages that prefer deep and/or slow-moving water (e.g., Redbreast Sunfish adult and Walleye adult, juvenile, and fry). The bypass reach is relatively wide and comprised of deep and shallow pools and shoal habitat types. Therefore, increasing flow in the bypass reach only has a marginal effect on depths and velocities. As a result, the amount of available habitat in the bypass reach is very similar over the modeled flow range (between 11–194 cfs).

The bypass reach itself is only a small portion of the overall study area. The tailrace, cross-over channel between the tailrace and main channel, the main channel downstream from the bypass reach, and side channel areas all provide a wide range of available habitat and substrate types. Habitat model results indicate these areas provide suitable habitat for each of the guilds and Walleye life stages under the four modeled flow scenarios. From an aquatic habitat perspective, maintaining run-of-river operations through the Byllesby powerhouse is more beneficial than increasing flows in the bypass reach because the tailrace, cross-over channel, main channel, and side channel are all fed by generation flows whereas only the main channel would be fed by increased bypass flows.

Efficacy of Existing Powerhouse Minimum Flow Requirement

The 360 cfs minimum downstream flow requirement is rarely triggered at Byllesby but did occur during the POR evaluated for this study (i.e., 1996 – 2020). A review of daily average flow statistics over the POR resulted in 14 days (or 0.15 percent of total days in the POR) that Project inflows were less than or equal to 360 cfs. Six of these days occurred during August 2002 and the remaining eight occurred during August 2008, corresponding to the two most severe droughts on record. The average Project inflows during the six days in August 2002 and eight days in August 2008 were 354 cfs and 328 cfs, respectively at Byllesby.

When the minimum downstream flow requirement is triggered, Project inflows at Byllesby are either passed downstream via powerhouse generation flows or via spillway gate releases into the bypass reach. A comparison of the ICM model results for these two downstream flow release scenarios indicates routing Project inflows through the powerhouse is preferable as it helps maintain flows in the side channel which is on the powerhouse side of the river channel. Routing the minimum downstream flow requirement through the spillway gates instead of the powerhouse can result in dewatering portions of the side channel as the flow path exiting the bypass reach is along the river channel opposite the side channel area.

Seasonal Minimum Flow Evaluation

The habitat model results do not show significant differences in the amount or location of suitable habitat between the four modeled flow scenarios. As a result, seasonal minimum flows in the bypass reach would likely have little to no effect on species and life stages that may use the bypass reach seasonally. For example, Walleye spawning habitat is minimal in the bypass reach under all four of the modeled flow scenarios. However, Walleye spawning habitat is available in the cross-over channel between the tailrace and main channel and main channel itself. Both of these areas receive flow from run-of-river powerhouse operations which do vary seasonally.

Buck Bypass Reach Flow and Aquatic Habitat Study Results

Aquatic Habitats and Substrate Types

The Buck bypass reach consists of a complex assemblage of aquatic habitat and substrate types, dominated by angular bedrock. The key difference between the Buck upper reach versus the middle to lower reaches is that the orientation of the bedrock slabs is parallel to the flow, which facilitates scour and sediment transport, while the middle to lower reaches are dominated by bedrock slabs oriented perpendicular to streamflow, which facilitates sediment deposition (on the downstream side of the slab). As a result, the Buck upper reach is approximately 50 percent bedrock while the middle to lower reaches, while still dominated by bedrock, contain more smaller-sized particles. The middle

to lower transects display zones of sediment deposition and lower-velocity shelters, which create a variety of aquatic habitat for a wider range of aquatic species and life stages.

Target Model Calibration Flow Releases

Field data collection to support the Buck aquatic habitat model calibration occurred from September 8 – 17, 2020. During this period, the four target model calibration flow releases provided in Table E.9-7 were released into the bypass reach and flow, depth, and water surface elevation data was collected throughout the study area after each flow stabilized.

Table E.9-7. Buck Habitat Model Calibration Flows

Tainter Gate #1 Opening (ft)	Bypass Reach Flow (cfs)	Powerhouse Flow (cfs)
Day 1: Closed (Leakage Flow)	17	1,700
Day 2: 0.5 (Low Flow)	211	1,700
Day 3: 1.0 (Mid Flow)	354	2,700
Day 4: 2.0 (High Flow)	714	1,925

Surface Water Travel Times and Water Surface Elevation Responses

Flow releases from the right (looking downstream) side of the Buck spillway structure (via Tainter Gate #1) generally travel across the bypass reach toward the apex of the channel bend along the left descending bank. From there, the main flow path is along the left descending bank to the end of the bypass reach. As a result, water surface elevations spanning a large area of the upper bypass reach along the toe of the spillway from the center of the channel to the left abutment were not affected by the target flow releases. This is due to a large island of higher topography in this area. Because the island area separates the right and left channels in the upper portion of the bypass reach, flow releases from Tainter Gates 1–6 and Obermeyer Gates 7–10 travel a similar path.

Bypass reach flow travel time (from the spillway to the downstream end of the reach) was approximately 2 hours and 30 minutes at Low Flow (211 cfs), 1 hour and 40 minutes at Mid Flow (354 cfs) and 1 hour at High Flow (714 cfs).

From the Leakage Flow to Low Flow range (17 cfs to 211 cfs), depths increased approximately 1.0 - 1.5 ft along the main flow path (i.e., right descending channel in the upper portion of the bypass reach and along the left descending bank in the lower portion of the reach). As the target flows increased to the Mid (354 cfs) to High (714 cfs) flow range, corresponding depths along the main flow path increased an additional 1.0 ft; or a total of approximately 2.5 ft deeper than at leakage flow.

Aquatic Habitat Model Results

Habitat model results for the shallow-fast and deep-fast guilds generally show little to no potential habitat available under leakage conditions as fish species represented by these two guilds prefer moderate velocities. As flows increase, potential habitat increases along the main flow pathway (described above) throughout the bypass reach. The largest area of potential habitat is located immediately downstream from the confluence of the bypass reach and tailrace which is largely influenced by powerhouse flows.

For the shallow-slow and deep-slow guilds, habitat model results generally show available habitat at all four flows evaluated. Preferred habitat is located along the main flow pathway at lower flows but shifts away from the main flow path to the stream margins, backwater areas, and behind rock outcrops that provide velocity shelters as areas in the main flow path become either too deep and/or too fast. A large area of potential habitat is also available near the shoal at the downstream end of the bypass reach.

For the Walleye adult life stage, habitat model results indicate little to no suitable habitat under any of the target flow scenarios. This life stage prefers relatively deep, slow-moving water and the only potential habitat in the Buck Bypass reach is located in very small, sporadic, and isolated areas.

Walleye juvenile results are similar to the adult results, but with a few more areas in the lower half of the bypass reach providing potential available habitat (e.g. along the edges of the main flow path and backwater areas) at the higher modeled flows (i.e., 354 cfs and 714 cfs). An area of potential habitat is also present along the backside of the island area near the downstream end of the study reach at all modeled flows. Walleye fry results are similar to the juvenile results with a slight preference for potential available habitat at the lower two modeled flow scenarios (i.e., leakage and 211 cfs) as compared to the higher two modeled flow scenarios (i.e., 354 cfs and 714 cfs).

Spawning Walleye prefer higher velocities (i.e., > 2.0 ft per second), a depth range of 2–6 ft, and larger substrate sizes. While some potential Walleye spawning habitat is available in the main bypass flow channel along the left descending bank (at higher bypass flows), the largest area of potential spawning habitat is located just downstream from the confluence of the tailrace and bypass reach as this area is influenced by powerhouse generation flows.

Aquatic habitat model results for the Buck study area under the four modeled flow scenarios provided in Table E.9-7 are discussed in greater detail in the USR that was submitted in November 2021 and will be provided in the Bypass Reach Flow and Aquatic Habitat Study Report, to be submitted as supplemental information by April 14, 2022.

Efficacy of Existing Ramping Rate Requirements (Buck Development)

Under the existing FERC operating license, ramping rates are required for the Buck bypass reach to help protect fish communities. Appalachian is required to discharge flows through a 2-ft gate opening for at least three hours following any spills released through a gate opened 2 ft or more. Appalachian is then required to reduce the opening to 1 ft for at least an additional three hours, after which Appalachian may close the gate. The gradual reduction of flow allows time for fish to respond to the receding water levels, thus avoiding stranding that can occur with sudden flow discontinuation.

During the target flow field measurements, level loggers (set to record at 5-minute increments) captured the impact that the existing ramping rate requirements have on bypass reach water surface elevations. The decrease in water surface elevation from a 2-ft gate opening (High Flow) to a 1-ft gate opening (Mid Flow) was approximately 0.5 ft in the main flow path. From a 1-ft gate opening to a closed position, the water surface decreased an additional 1.5 – 2.0 ft in the main flow path. The seemingly disproportionate change in depth from a 2-ft to 1- ft gate opening, and a 1-ft to closed position is likely the result of the dominant bypass reach substrate type which is angled bedrock. These bedrock slabs block and trap flows in the bypass channel and their effect on water surface elevations is more pronounced at lower flows.

Efficacy of Existing Powerhouse Minimum Flow Requirement

The 360 cfs minimum downstream flow requirement is rarely triggered at Buck but did occur during the POR evaluated for this study (i.e., 1996 – 2020). A review of daily average flow statistics over the POR resulted in 14 days (or 0.15 percent of total days in the POR) that Project inflows were less than or equal to 360 cfs. Six of these days occurred during August 2002 and the remaining eight occurred during August 2008, corresponding to the two most severe droughts on record. The average Project inflows during the six days in August 2002 and eight days in August 2008 were 357 cfs and 331 cfs, respectively at Buck.

When the minimum downstream flow requirement is triggered at Buck, Project inflows can be passed through the trash sluice gate into the tailrace and/or through a Tainter or Obermeyer gate into the bypass reach. Because the minimum downstream flow requirement is rarely triggered and typically occurs only during August for about a week at a time; the effect on aquatic habitat is likely negligible when considering whether the flow is released to the tailrace and/or bypass reach.

Seasonal Minimum Flow Evaluation

Seasonal minimum flows were evaluated using the habitat modeling results provided in Attachment 3 for the various habitat guilds and standalone Walleye species/life stages. Spawning life stages were of particular interest since there is a seasonal component to this life stage.

At Buck, Redbreast Sunfish spawning life stage was used as one of the representative species for the Shallow-Slow Guild (i.e., finer substrate sizes and no cover). The amount of potential spawning habitat available is similar under all four modeled flow scenarios. The difference between modeled scenarios is the location of the potential habitat shifts from the main flow path under Leakage Flow conditions (i.e., 17 cfs) to the stream margins, backwater areas, and behind velocity shelters created by rock outcrops as flows in the bypass reach increase.

Potential Walleye spawning habitat was also modeled for the four target flow scenarios at Buck. While the High target flow (714 cfs) produced a minimal amount of potential habitat along the left descending channel in the lower portion of the bypass reach, the largest area of potential habitat is located just downstream of the tailrace/bypass reach confluence. Powerhouse flows of at least 1,925 cfs created the largest amount of potential available habitat in the area immediately below the confluence.

As a result, seasonal minimum flows in the Buck bypass reach are not likely to provide a significant amount of additional available habitat for the target species/life stages of interest.

E.9.2.1.2 2020-2021 Fish Community Survey

A summary of the methods and results of the Fish Community Study is provided in this section and details were provided in the USR which was filed with the Commission in November 2021. The revised Byllesby-Buck Aquatic Resources Study Report, of which the Fish Community Survey is a part, will be submitted as supplemental information by April 14, 2022. The specific objectives of the Fish Community Survey are included below:

1. Collect a comprehensive baseline of existing aquatic resources near the Project
2. Compare recent aquatic resource data to historical data to identify changes or trends of significance to species composition or abundance

To achieve these objectives, a Fish Community Survey consisting of a spring and fall sampling effort was scheduled to begin in Spring 2020 as originally proposed in the RSP. However, spring sampling activities were not accomplished during the 2020 calendar year due to delays resulting from unforeseeable circumstances including heavy precipitation and high flows and the COVID-19 global pandemic. Boat electrofishing and gill net sampling was completed during fall 2020, but the ongoing

weather delays resulted in the fall 2020 backpack electrofishing methods being rescheduled for spring 2021; therefore, an ISR covering the fall 2020 sampling effort was submitted on January 18, 2021. The spring fish sampling activities were completed successfully in 2021, and the combined results of the fall 2020 and spring 2021 efforts are summarized in the following sections. Details of this study were included in the 2020-2021 Fish Community Survey in the USR and will also be provided in the revised Aquatic Resources Study Report to be submitted as supplemental information after license filing.

At the initiation of sampling in fall 2020, multiple proposed locations did not correspond well with the habitat targets identified during the desktop-based site selection process. As such, sampling methods for those locations were adjusted in the field to provide the best possible sample collection effort from the sampling locations identified in the RSP. Two sites upstream of a high gradient riffle complex, located between Byllesby and Buck dams, and originally identified as boat electrofishing sites were switched to backpack electrofishing methods based on the presence of boulder habitat with swift currents. One proposed backpack electrofishing site (at the mouth of Crooked Creek in the Byllesby pool) was replaced with boat electrofishing methods as the site consisted of pool habitat and was not conducive to backpack electrofishing methods.

Boat electrofishing and gillnet sampling techniques were employed to target specific sites based on the habitat types present in the Project area. Boat electrofishing was used to target near-shore pool habitats and gillnetting targeted mid-channel pool habitats. Seven boat electrofishing sites were located in the Byllesby pool and 10 were located in the Buck pool. Six gillnetting sites were located in the Byllesby pool to target Walleye. Field sampling activities were completed during relatively low flow and clear stream conditions by state permitted fish biologists covered under Virginia Scientific Collecting Permit (No. 068630) issued to EDGE Engineering and Science, LLC (EDGE).

Fish Community Survey Methods

Boat Electrofishing

Each boat electrofishing site consisted of a 100-m-long transect marked with start and endpoint coordinates with a GPS unit. At each sample site, habitat characteristics (e.g., substrate, estimated water velocity, depth, and instream cover) and water quality parameters (e.g., pH, water temperature, DO, and conductivity) were measured and recorded. In addition, a Secchi disk reading was taken at each sample site at the time of sampling. Multiple points for habitat and water quality measurements were taken if there was large variation within a single site. Prior to initiating sample collection, electrofishing equipment was calibrated based on the water conductivity at each sample site. Sampling effort (i.e., time electrofishing) was also recorded during each sampling event.

Starting at the downstream end of the transect and moving upstream, all available habitat types (i.e., shallow shoreline, deep shoreline, emergent vegetation, submerged wood, etc.) were candidates for sampling throughout the reach and particular care was taken to thoroughly sample complex habitat and instream structures. For each 100-m transect, a minimum of five minutes electrofishing was performed unless habitat complexity necessitated additional time. Fish samples were held in a live well until sampling and sample processing were completed at each site. Each fish was identified to the lowest taxonomic level practicable, enumerated, and examined for signs of external parasites, disease, or physical abnormalities. In addition, total length and weight were recorded for the first 30 individuals of a species per sample site. In the event that more than 30 individuals of a single species were collected at a given sample site, the additional fish were counted, and length measurements were recorded for specimens that exceed the upper or lower maximum recorded lengths from the 30 individuals previously measured. Photos were taken in the field for a representative specimen of each fish taxon collected during the study and for those fish that could not be identified to species (e.g., minnows, juvenile *Moxostoma sp*.), representative specimens were preserved and identified in a laboratory setting based on sampling permit specifications. When Spotted Bass and/or suspected Alabama Bass were captured, a voucher photo was taken and a thumbnail-sized portion of one of the pelvic fins was clipped and stored dry in an envelope (along with length and weight) for VDWR notification.

Backpack Electrofishing

Backpack electrofishing surveys were performed at 13 riffle/run sites along 100-m transects (or two 50-m transects if habitat was limited longitudinally). Backpack electrofishing transects were delineated in riffle/run habitat and the start and endpoint coordinates were recorded. Site photos, field conditions, habitat characteristics, and water quality parameters were recorded in the same manner as boat electrofishing sites. Multiple data points were collected for habitat and water quality measurements when large variation was observed within a single site. Prior to initiating sample collection, electrofishing equipment was calibrated based on the conductivity of stream water at each sample site. Sampling effort (i.e., electrofishing time) was also recorded during each sampling event.

Starting at the downstream end of the transect and moving upstream, all major riffle/run habitats along the transect were sampled and particular care was taken to thoroughly sample complex habitat and instream structures, while a netter(s) actively captured stunned fish with a dip net. In areas of elevated stream velocities, a stationary seine (2.4 m wide by 1.8 m tall with 0.48-cm mesh) was positioned downstream of the sample location perpendicular to stream flow. The operator of the backpack electrofishing unit performed kicks/sweeps of the transect while working in a downstream manner toward the seine, driving fish toward the seine net. Stunned fishes were driven into the net with the

aid of stream currents and the seine was then swept upward and fish retrieved for processing. For each 100-m transect, a minimum of five minutes electrofishing time was expended, with additional time added when necessary, depending on the complexity of the habitat. Collected fish were kept in aerated buckets and/or instream live wells during surveys and processed in the same manner as boat electrofishing methods (described above in Boat Electrofishing section) before being returned to the stream at the survey location.

Gillnetting

Gillnetting techniques were used to survey the fish community at six pool sites with 36.5-m-long by 2.4-m-deep gillnets. Each gillnet was comprised of eight 4.6-m-long panels with mesh sizes of 1.9, 2.5, 3.2, 3.8, 5.1, 6.4, 7.6, and 10.2 cm, and nets were anchored so that the top of the net was at least 0.5 m below the surface. Starting on the shoreward side, and with the smallest mesh size, gillnets were pulled taught as the boat operator moved towards the channel and slightly downstream of and perpendicular to shore. The start and endpoint coordinates were recorded for each gillnet deployment. Site photos, field conditions, habitat characteristics, and water quality parameters were recorded in the same manner as boat electrofishing sites. Nets were set for 24 hours before they were retrieved with a grappling hook and checked for fish, which were placed in live wells for processing. Nets were reset in the same location and fish were processed in the same manner as boat electrofishing methods (described above in Boat Electrofishing section), except processed fish were released at least 100 m from the site so they did not immediately become entangled when the gillnets were reset. Nets soaked for another 24 hours and were checked again and pulled from the location after a total of 48 hours of soak time per site.

Fish Community Survey Results

Boat electrofishing surveys were conducted according to methods outlined in the RSP between October 22 and 24-25, 2020, and April 25-26 and May 27, 2021. Backpack electrofishing surveys were conducted between April 20-23, 2021. Gillnet surveys were conducted between November 9-11 and 18-20, 2020, and April 20-24, 2021. Sample collection occurred during relatively low-flow and clear stream conditions. Results of physiochemical data collected at sample sites met the state water quality standards established for the New River, indicating that water quality within the Project area is capable of supporting fish communities.

A total of 404 fish representing 26 distinct species were collected upstream of Byllesby Dam from seven boat electrofishing sites (sampled fall 2020 and spring 2021), three backpack electrofishing sites (sampled spring 2021), and six gillnet sites (sampled fall 2020 and spring 2021). Five of the 26 species collected were found exclusively upstream of Byllesby Dam. A total of 509 fish representing

33 species were collected from 10 boat electrofishing sites (sampled fall 2020 and spring 2021) and six backpack electrofishing sites (sampled spring 2021) located between Byllesby Dam and Buck Dam. Seven fish species were collected exclusively between Byllesby Dam and Buck Dam. A total of 206 fish representing 17 species were collected from four backpack electrofishing sites (sampled spring 2021) below Buck Dam. Two species were collected exclusively below Buck Dam.

The fish community results were divided and analyzed in three distinct sections to facilitate an evaluation of potential differences in the fish community throughout the Project Area – upstream of Byllesby Dam, between Byllesby Dam and Buck Dam, and downstream of Buck Dam. Backpack electrofishing results (from spring 2021) were compared between these three sections. Boat electrofishing results (from fall 2020 and spring 2021) were compared between the Byllesby pool and Buck pool. Gillnetting results in the Byllesby pool were primarily used to investigate the presence and distribution of Walleye. Understanding how the fish community changes throughout the Project area provides insight into the impact, or lack thereof, that the Project has on the New River.

Boat Electrofishing - Byllesby and Buck Reservoirs

The substrates at boat electrofishing sites in the Byllesby and Buck reservoirs were comparable; with both predominantly consisting of sand (>60%), silt (20%), and a mix of gravel (5%) and boulder (5-15%). The left descending bank of both reservoirs were characterized as low-gradient, with a vegetated floodplain; while the right descending bank exhibited a high-gradient, rock face. The Byllesby reservoir and the lower reach of the Buck reservoir exhibited steep banks, while the banks along the upper reach of the Buck reservoir were shallow and gently sloping. Both pools exhibited very little habitat structure, with sparse woody debris, submerged aquatic vegetation, and scattered boulders. Water quality parameters (temperature, pH, DO, velocity, and conductivity) remained relatively consistent throughout the Byllesby and Buck impoundments; however, slightly higher velocities (Byllesby and Buck) and increased DO (Buck) were documented near the head of the impoundment.

A total of 244 fish (20 species) were collected in the Byllesby reservoir from seven boat electrofishing sites, compared to 353 fish (24 species) in the Buck reservoir from 10 boat electrofishing sites. The most abundant species collected during boat electrofishing surveys in the Byllesby reservoir were Telescope Shiner (*Notropis telescopus*) (29.5%), Bluegill (15.2%), and Redbreast Sunfish (9.8%); however, Telescope Shiner were only collected at one site. The most abundant species collected in the Buck reservoir were Redbreast Sunfish (28.9%), Smallmouth Bass (20.4%), and Whitetail Shiner (*Cyprinella galactura*) (11.6%), each of which being captured at a minimum of five sites. Distribution of individuals was relatively consistent throughout each pool and correlates with habitat preference

and complexity. The Byllesby reservoir was dominated by the invertivore-piscivore trophic guild and the water column habitat guild, whereas the Buck reservoir was dominated by the invertivore trophic guild and the water column habitat guild (McCormick et al. 2001).

Shannon's diversity index (H') is a measure of diversity that combines species richness (the number of species in a given area) and their relative abundances. Boat electrofishing sample data were to facilitate the calculation and comparison of (H') for and between the Byllesby and Buck impoundments. Overall, species diversity resulting from boat electrofishing surveys was negligibly higher in the Byllesby reservoir (H' = 2.32) than in the Buck reservoir (H' = 2.26). CPUE ranged from 0.3 to 14.2 individuals per minute in the Byllesby reservoir (averaging 2.9) and CPUE ranged from 0.5 to 9.5 individuals per minute in the Buck pool (averaging 2.8). CPUE was 54 percent higher in the spring than the fall in the Byllesby reservoir and 214 percent higher in the spring than the fall in the Buck reservoir.

Backpack Electrofishing

The substrate at backpack electrofishing sites located in the upper reach of the Byllesby impoundment (above Byllesby Dam) and Buck impoundments (tailrace and bypass channel below Byllesby Dam) generally consisted of bedrock (25 to 35%), boulder (25%), cobble (20%), gravel (15%), and sand (5 to 15%). Habitat structure at these sites primarily consisted of well-developed, swift riffles varying from a few centimeters to a meter in depth, with substrates consisting of bedrock, cobble, and gravel. Backpack electrofishing samples were collected from all types of riffle/run habitat present in both areas, from low-gradient riffles with relatively small substrate and no instream cover to high-gradient riffles with relatively large substrate and substantial instream cover. In the bypass channel downstream of Buck Dam, the percentage of bedrock increased (35%) and the percentage of sand (5%) decreased in comparison to substrates above and below Byllesby Dam. Sample sites downstream of the Buck bypass reach were located in run to riffle-run habitats adjacent to undercut banks and overhanging vegetation, with substrates dominated by bedrock (25%), boulder (25%), cobble (20%), gravel (15%), and sand (15%). Water quality parameters (temperature, pH, DO, velocity, and conductivity) remained relatively consistent throughout all backpack electrofishing sites except velocity, which often changes dramatically within a short distance in response to the complex substrate and habitat structure.

A total of 48 fish (11 species) were collected upstream of the Byllesby Dam from three backpack electrofishing sites, compared to 156 fish (18 species) in six sites between the Byllesby Dam and Buck Dam, and 206 fish (17 species) from four sites downstream of the Buck Dam. The most abundant species collected upstream of the Byllesby Dam were Whitetail Shiner (39.6%) and Rosyface Shiner (16.7%), with Whitetail Shiner being the only species captured at all three sites. The most abundant

species collected during backpack electrofishing surveys between the Byllesby Dam and Buck Dam were Telescope Shiner (43.6%) and Whitetail Shiner (14.7%). The least productive site, which accounted for only 2.5 percent of total abundance, between the Byllesby and Buck dams was in the Byllesby bypass reach. The most abundant species collected below Buck Dam during backpack electrofishing surveys were Central Stoneroller (28.6%) and Telescope Shiner (25.7%). The complex habitat in the Buck bypass reach resulted in the collection of 142 fish, compared to only 14 fish collected from the bedrock dominated Byllesby bypass reach.

Overall, species diversity resulting from backpack electrofishing surveys was comparable between the sites upstream of the Byllesby Dam, between the Byllesby Dam and Buck Dam, and downstream of the Buck Dam (H' = 1.92, 1.97, and 1.98, respectively). In contrast, the average CPUE for sites upstream of the Byllesby Dam was 1.7 individuals per minute, between the Byllesby Dam and Buck Dam was 3.5 individuals per minute, and downstream of the Buck Dam was 7.6 individuals per minute. The doubling of CPUE moving downstream through the Project area may have resulted from increasing complexity and availability of habitat or efficacy of sampling techniques in select habitats. However, it is also understood that dams can serve as barriers to upstream fish migration, impacting species abundance and/or distributions, thus abundance may generally increase in the downstream direction in some rivers.

Gillnetting

The substrate at gillnetting sites within the Byllesby reservoir generally consisted of sand (70%), silt (25%), and gravel (5%); however, the near-shore substrates ranged from vertical rock face and boulder to sand and silt flats. Sample sites located along the left descending bank were low gradient and adjacent to vegetated floodplains, while sample sites on the right descending bank were located in high gradient areas adjacent to steep faced rock outcrops.

A total of 112 fish representing 10 species were collected from gillnet sites in the Byllesby reservoir. No fish were collected from one of the gillnet sites which was set in an area with relatively swift current within the thalweg of the river, on the outside bank of a meander, and may not be suitable for consistent fish utilization. The gillnet surveys in the Byllesby reservoir were dominated by Common Carp (51.8%), Channel Catfish (24.1%), White Sucker (8.0%), and Walleye (8.0%). Distribution of individuals was relatively consistent throughout the Byllesby reservoir and likely correlates with habitat preference and complexity; however, a large majority of the Common Carp (most abundant species) were collected at one site.

Overall, species diversity (H' = 1.43) resulting from gillnetting surveys in the Byllesby reservoir was relatively low, although there were no direct comparisons to be made as gillnetting did not occur

anywhere else in the Project area. CPUE ranged from 0.5 to 22 individuals per net set (averaging 6.2), and like boat electrofishing methods, CPUE was 62% higher in spring than in fall.

Fish Community Survey Conclusions

The Project has historically influenced habitat availability through formation of two reservoirs (creating pool habitat and eliminating riffle habitat), which dictates what species inhabit the Project area; however, the habitats present within the Project area appear to support a relatively diverse fish community with little evidence of physical abnormalities or stressors.

Twenty species were collected using boat electrofishing from seven sites in the Byllesby reservoir, and 24 species were collected from 10 sites in the Buck reservoir. Species diversity was negligibly higher in the Byllesby reservoir than in the Buck reservoir and CPUE was nearly identical. The additional species (at Buck) may be attributable to a greater number of sites surveyed or slight differences in habitat availability. Overall, the Byllesby reservoir and Buck reservoir exhibit similar fish community characteristics. Boat electrofishing yielded two game fish species in the Byllesby reservoir that were not present in the Buck reservoir (i.e., Muskellunge and Rainbow Trout [*Oncorhynchus mykiss*]). In contrast, boat electrofishing in the Buck reservoir yielded nine species (darters, minnows, shiners, suckers, and sunfish) that were not present in the Buck reservoir.

With regards to backpack electrofishing, 11 species were collected upstream of the Byllesby Dam from three sites, 18 species were collected between the Byllesby Dam and Buck Dam from six sites, and 17 species were collected downstream of the Buck Dam from four sites. Differences in species diversity were negligible between each Project area. The general abundance of fish in riffle/run habitats increased in the downstream direction, with CPUE doubling from upstream sites to middle sites and doubling again from middle sites to downstream sites. No fish species were exclusively collected using backpack electrofishing methods upstream of Byllesby Dam; however, Kanawha Darter and Saffron Shiner (*Notropis rubricroceus*) were only collected between Byllesby and Buck dams and Kanawha Sculpin and White Shiner were only collected downstream of Buck Dam.

Gillnetting methods were implemented in the Byllesby reservoir, by request from VDWR, to target Walleye, which was the only species of fish exclusively captured using gillnets. A total of nine Walleye were captured at three of six gillnet sites, characterized as low gradient sites with substrates consisting primarily of sand and silt. Further, the three sites where Walleye were captured were in the upper, middle, and lower sections of the Byllesby reservoir, indicating that they are using most of the impoundment at some point. Six Walleye were collected in fall 2020 and three were collected in spring 2021. Six of the nine Walleye were collected at the downstream most site in the Byllesby impoundment, indicating that they may be occupying the deeper sections more often.

In a historical study of the Project area, Appalachian (1991b) employed boat electrofishing, gillnetting, and hoop netting techniques. Although they did not use backpack electrofishing techniques, they used boat electrofishing techniques in both pool and riffle habitat. The historical study sampled a similar number and distribution of sites throughout the Project area. Both the current study and Appalachian (1991b) sampled a total of 36 sites using differing techniques; however, the previous study collected samples six times at each site for a total of 216 samples, whereas the current study only sampled fall and spring resulting in 59 total samples. Additionally, for each pair of sites surveyed in Appalachian (1991b), one was sampled during the day and the other at night. The current study did not include nighttime electrofishing due to safety concerns.

In Appalachian (1991b), a total of 2,679 individuals were collected representing 34 species. The current study collected 1,119 individuals representing 40 species. Therefore, although the survey effort differed, there was an increase in overall richness of fish species within the Project area. Both studies yielded a low incidence of parasites and physical abnormalities. Four species were captured in the previous study that were not captured in the current study and 11 species, including Walleye, were captured in the current study that were not captured in the previous study. The overall diversity of the fish community was greater in the current study (H'=2.91) than in the previous study (H'=2.53). Smallmouth Bass and Redbreast Sunfish were two of the four most abundant species in both studies and many of the other mutual species were found in similar relative abundance. Neither study collected any federally or state listed threatened or endangered species. Overall, distribution of fish abundance and richness throughout the Project area during the current study closely matched that of Appalachian (1991b). For example, the highest average CPUE and richness per sample for riffle/run habitat was recorded downstream of the Buck Dam.

For the purposes of this study, a comparison of species richness at boat electrofishing sites in 2020/2021 and Appalachian (1991b) were used to help identify any trends in the fish community within the Project area. Species richness observed in the current study during boat electrofishing in pool habitats were 20 species and 24 species in the Byllesby impoundment and Buck impoundment, respectively. Species richness observed in the previous study during boat electrofishing in pool habitats were 9 species and 11 species in the Byllesby impoundment and Buck pool, respectively. Overall, fish community composition was quite similar between the two studies, but richness in the study area seems to have increased, indicating that the New River within the Project area continues to support an abundant and diverse fish community.

E.9.2.1.3 Impingement and Entrainment Study

A summary of the methods and results of the Fish Impingement and Entrainment Study is provided in this section and details were provided in the USR. The revised Byllesby-Buck Aquatic Resources Study Report, of which the Impingement and Entrainment Study is a part, will be submitted as supplemental information by April 14, 2022. The specific objectives of the Fish Impingement and Entrainment Study are included below:

- Confirm flow velocities at the Byllesby and Buck dam intake structures located to facilitate a desktop assessment of entrainment and impingement potential at the Project.
- Perform an updated desktop review of entrainment potential at the Project during hydropower generation.
- Perform a blade strike evaluation of the existing and proposed turbine configurations at the two-development Project using the USFWS Turbine Blade Strike Analysis Model (2020). This model is a probabilistic Excel-based Visual Basic for Applications implementation of the methods outlined by Franke et al. (1997) for evaluating fish mortalities due to turbine entrainment.

Methods

Characterize the Intake Structures, Velocities, and Turbine Specifications

The physical specifications of the turbines and each intake structure at the Project developments were compiled and used to calculate velocities at the intake structures. Approach velocities (i.e., at a point approximately one foot upstream of the trashracks) were calculated using site-specific intake dimensions. Per the Project RSP and Commission's SPD, intake velocities would be measured using an acoustic Doppler current profiler along the upstream face of the angled trash racks to determine the approximate approach velocity immediately upstream of the intake structure. During the 2020 field season, a combination of high flow events and inoperable units prevented field data collection efforts. As a result, approach velocity was calculated using the intake structure and trash rack dimensions along with the design maximum flow capacity of the generating units.

Evaluate Intake Avoidance and Impingement Risk

An assessment of entrainment and impingement potential at each of the Project developments was performed in accordance with the RSP and the Commission's SPD. Intake avoidance and impingement were considered at both intakes based on the calculated approach velocities and 2.28-inch clear bar spacing of trash racks at each of the Project developments. Species-specific fish swim speeds were compared with calculated intake velocities, as well as estimating minimum fish lengths that would be excluded or impinged by the trash racks for each of the target fish species. A scaling factor relating fish length to body width was used for the impingement assessment to determine

minimum sizes of the target fish species that would physically be excluded by the trash racks (Smith 1985).

Evaluating Entrainment Risk

A database developed by EPRI (1997) provides detailed results of fish entrainment studies from 43 hydroelectric projects. This database was designed specifically to facilitate the desktop analysis of available data to assess entrainment and impingement impacts at a hydroelectric facility.

Although some facilities included in the EPRI database may not match the exact specifications of the developments at the Project, using as many data points as possible from the EPRI database allows the analysis to account for the natural variability of aquatic ecosystems and fish populations, while providing a robust dataset for calculating average monthly entrainment rates for a wide range of species. This is a commonly applied approach in desktop entrainment evaluations and has been readily accepted by FERC in relicensing efforts for other projects.

Site characteristics (i.e., reservoir size, usable storage, plant capacity, operating mode, average velocity at trash racks, trash rack spacing) and available data (i.e., entrainment data, collection efficiency) were reviewed for applicability to the Project using the EPRI (1997) database. Entrainment data from five facilities were eliminated for having trash rack clear bar spacing that was considerably wider (e.g., double the clear spacing) than specifications at the Project. Therefore, data from 33 facilities were retained for use in this analysis with the understanding that entrainment rates developed for the Project would be conservative (i.e., overestimated) since some fish species may be excluded by the trash racks at the Project, which have a narrower open bar spacing than many of the facilities in the EPRI database.

The EPRI (1997) entrainment database provides results from field studies conducted at hydroelectric facilities using full-flow tailrace netting by placing a conical net in the immediate tailrace to collect the entire discharge on a seasonal or monthly basis. This results in the calculation of entrainment rates (fish/volume of water if recorded, or fish/hour per cfs of sampled unit capacity), including the number, species, and size of entrained fish.

The studies included in the EPRI (1997) database recorded number of hours sampled and hydraulic capacity of the sampled units. Using this information, data was standardized to the number of fish/hour of unit capacity, and then used to calculate fish entrainment rates (fish/hour) at maximum turbine discharge at the Projects based on existing development-specific turbine design capacity (5,868 cfs for the Byllesby Development and 3,540 cfs for the Buck Development). Entrainment rates were calculated and summarized by month, season (winter = December, January, and February; spring =

March, April, and May; summer = June, July, and August; and fall = September, October, and November) and annually.

While the use of the EPRI (1997) database provides a means to quantitatively estimate entrainment risk at the Project at multiple time scales (i.e., month, season, year) based on empirical data collected at comparable hydroelectric projects; it is important to note that the resultant entrainment rate estimates do not consider the other site-specific factors likely to influence species-specific entrainment risk at the Project. Various comprehensive reviews of entrainment and mortality data (FERC 1995) as well as fish behavior relative to turbine passage (Coutant and Whitney 2000) suggest that one or more factors may influence the risk of turbine entrainment or mortality.

Therefore, an additional traits-based qualitative assessment modified from Cada and Schweizer (2012) of entrainment risk at the Project was performed that ranks entrainment risk as low, moderate, or high based upon break points in relative entrainment risk. The overall risk categories are defined as:

- Low: species-life stage is generally not present in the forebay; utilizes shallow, shoreline habitats away from the intake structures; and/or not susceptible to approach intake velocities
- Moderate: species-life stage may routinely or seasonally occupy the forebay or utilize habitats near the intake structures; and some life stages/ages may be susceptible to intake velocities
- High: pelagic species that reside or spawn in or near the forebay and intake structures and are susceptible to intake velocities, species with life stages that are expected to reside in the forebay or encounter intake structures during seasonal activities, and species-life stages that broadcast spawn buoyant eggs in open waters in lake or reservoir habitats

These qualitative risk categories were utilized to describe entrainment potential of the target fish species on a monthly basis. A matrix of monthly Project entrainment risk for the target species was constructed using the empirical seasonal entrainment rates estimated from the EPRI (1997) database using maximum turbine discharge frequency (full generation), swim burst speed comparison to intake velocities, size exclusion by trash racks, species periodicity, abundance, habitat utilization, migratory behavior, and expected distributions.

Turbine Blade Strike Model Analysis

A turbine blade strike evaluation, as proposed in the RSP and modified to also cover the turbine upgrades proposed by Appalachian, was performed and results from the analysis were provided in the USR. The analysis was performed using the most recent version of the USFWS Turbine Blade Strike Analysis Model (USFWS 2020), mean and standard deviation of fish lengths based on fish data

collected during the 2020-2021 Fish Community Study, and site-specific inputs for required model parameters. Walleye have been documented in the New River at lengths of up to 29-inches. However, based on the impingement risk assessment, 18.5-inch-long (or longer) Walleye would be excluded on the bar racks at the Byllesby and Buck intake structures. As such, additional model runs were performed for Walleye based on the maximum estimated entrainable fish length of 18.5 inches with a standard deviation of 1.5 inches.

Information on the physical and operational characteristics of the Project, including trashrack bar spacing, intake velocities and flows, and intake proximity to feeding and rearing habitats was used to determine the impingement and entrainment potential at the Project using a desktop study approach. A species list was developed based on data from recent and historical (Appalachian 1991b) fish community studies (i.e., composition, abundance, listed or protected status, recreational significance), as well as known occurrence records from the VDWR for the New River at the time of the historical fish community study.

The Turbine Blade Strike Analysis Model was used to model the downstream passage survival under two operational scenarios for each of the Project developments: 1) fish that are subject to dam passage through the powerhouse and turbines or 2) fish that are subject to dam passage through the powerhouse and turbines or the spillway leading into the bypass channel. The probability of a fish passing through a turbine or via spill was assumed to be in direct proportion to the volume of flow passing through each route. A spillway and bypass passage survival rate of 97 percent was assumed based on the average of 136 survival tests conducted with juvenile salmonids on the Columbia River (Amaral et al. 2013).

Based on a review of the spillway design drawings, the vertical distance from the downstream extent of the Byllesby and Buck spillway aprons to bedrock is approximately three feet or less, depending on exact location (drawings are included in Volume IV [CEII] of the FLA). Since these distances represent the dewatered condition, the drop is less (or non-existent) as spillway flows cover the bedrock and elevations approach or exceed that of the spillway aprons at each of the dams; therefore, fish are not likely to experience a significant vertical drop (if any), depending on spillway flows. As such, the absence of a plunge pool is not expected to result in increased mortality risk for fish passing over the spillway during spill events. Based on similar apron-to-bedrock dimensions at the facilities described in Amaral et al. (2013) a bypass passage survival rate of 97 percent from Amaral et al. (2013) is a valid, representative passage survival rate for performing the turbine blade strike analysis at the Project.

Flow exceedance percentile data were reviewed to determine the volume of spillage at the range of percentiles where river discharge exceeded turbine capacity. Downstream passage survival was estimated by the model for each spillage scenario.

Two scenarios were evaluated for existing conditions at each Project development and rerun for proposed conditions (proposed turbine upgrades) at each Project development:

1. Typical/normal conditions (i.e., no spill beyond required bypass minimum flow)
    a. Byllesby existing condition:
        i. Routes: Turbine Units 1 through 4, each with 25 percent of flow (1,467 cfs/unit).
        ii. Fish size classes: 2, 4, 6, 8, 10, 15, 20, 25, and 30 inches.
    b. Byllesby proposed condition:
        i. Routes: Three Kaplan (Proposed Kaplan) turbine Units with 24.7 percent of flow each (1,348 cfs/unit and a single existing Francis (Existing Francis) turbine unit with 26.0 percent flow (1,467 cfs).
        ii. Fish size classes: 2, 4, 6, 8, 10, 15, 20, 25, and 30 inches.
    c. Buck existing condition:
        i. Routes: Turbine Units 1 through 3, each with 33 percent of flow (1,180 cfs/unit).
        ii. Fish size classes: 2, 4, 6, 8, 10, 15, 20, 25, and 30 inches.
    d. Buck proposed condition
        i. Routes: Two Proposed Kaplan turbine units (1,195 cfs/unit) and one Existing Francis turbine unit (1,180 cfs); each with 33 percent of flow.
        ii. Fish size classes: 2, 4, 6, 8, 10, 15, 20, 25, and 30 inches.
2. Spilling conditions - Flow exceedance percentile data were reviewed to determine the volume of spillage at the range of percentiles where river discharge exceeded turbine capacity. A downstream passage survival estimate was calculated for each spillage scenario and based on the average length of Walleye collected in the 2020 – 2021 Fish Community Survey (Appalachian 2021) conducted in the Project area.
    a. Byllesby existing condition:
        i. Routes: Turbine Units 1 through 4, each with equal amounts of flow (1,467 cfs/unit) and spillage at 4, 3, 2, and 1 percent exceedance.
        ii. The fish length input (mean=18.5 inches and standard deviation=1.5 inches) for Walleye was based on the maximum likely length anticipated to be susceptible to entrainment through the bar racks or unable to overcome approach velocities at the intake or spillway.
    b. Byllesby proposed condition:

i. Routes: Three Kaplan (Proposed Kaplan) turbine Units with 24.7 percent of flow each (1,348 cfs/unit and a single existing Francis (Existing Francis) turbine unit with 26.0 percent flow (1,467 cfs) and spillage at 4, 3, 2, and 1 percent exceedance.

ii. The fish length input (mean=18.5 inches and standard deviation=1.5 inches) for Walleye was based on the maximum likely length anticipated to be susceptible to entrainment through the bar racks or unable to overcome approach velocities at the intake or spillway.

c. Buck existing condition:

i. Route: Turbine Units 1 through 3, each at 1,180 cfs/unit and spillage at 12, 10, 8, 6, 4, 2, and1 percent exceedance.

ii. The fish length input (mean=18.5 inches and standard deviation=1.5 inches) for Walleye was based on the maximum likely length anticipated to be susceptible to entrainment through the bar racks or unable to overcome approach velocities at the intake or spillway.

d. Buck proposed condition:

i. Route: Two Proposed Kaplan turbine units (1,195 cfs/unit) and one Existing Francis turbine unit (1,180 cfs) and spillage at 12, 10, 8, 6, 4, 2, and1 percent exceedance.

ii. The fish length input (mean=18.5 inches and standard deviation=1.5 inches) for Walleye was based on the maximum likely length anticipated to be susceptible to entrainment through the bar racks or unable to overcome approach velocities at the intake or spillway.

Results

Entrainment and Impingement Assessment

Using the Byllesby intake opening structure dimensions, the calculated approach velocity in front of the intake is approximately 2.0 ft per second (fps) (i.e., 5,868 cfs/(143 ft x 14 ft x 1.5)). This approach velocity is consistent with the value presented in the historical Project entrainment report (Appalachian 1991b). A comparison of fish swim speeds for target or representative species were compared to the estimated intake velocity to evaluate whether fish may be susceptible to intake flows at the Project. Using the Buck intake opening structure dimensions, the calculated approach velocity in front of the intake structure is approximately 1.6 fps (i.e., 3,540 cfs/(104 ft x 14 ft x 1.5)).

Fish swim speeds obtained from literature indicate that all target species and life stages evaluated, with the exception of eggs, larvae, and juvenile Spottail Shiner, would be able to avoid entrainment at the Project given that estimated swim burst speeds are greater than approach velocities at the intake. Although most species were considered of entrainable size (i.e., smaller than the 2.28- inch clear-

spacing width of the trash racks at both Byllesby and Buck), it is likely that juvenile and adult fish can avoid the intake.

According to the EPRI (1997) database, fish measuring less than six inches in length were the majority (88 percent) of entrained fish, and fish less than eight inches exhibit the highest entrainment rates throughout the year. Rock Bass, catfishes, suckers and redhorses, *Lepomis* sunfishes, and Black Crappie, Largemouth Bass, darters and logperch, and shiners, chubs, and minnows represent the top 90 percent of target species and species groups potentially susceptible to entrainment at the Byllesby and Buck developments. Peak months of entrainment for these species and species groups varied. Smallmouth Bass, Walleye, and Muskellunge, species often sought after by anglers, have some of the lowest entrainment rates of the target species and groups. Entrainment rates were highest from April to October, with peaks in April, July, and October. Peaking months may correspond to spawning movements (April), recruitment to catchable size (July or October), or large storm/flow events. Susceptibility to entrainment is variable depending on species and time period, however most target species and species groups have low entrainment potential for most of the year.

Turbine Blade Strike Model Analysis

Turbine blade strike probabilities for entrained fish of varying sizes were estimated for each Project development under the existing and proposed conditions. For the size classes evaluated, blade strike probabilities at the Buck Development ranged from 4.5 - 65.9 percent under existing conditions and 2.9 - 42.2 percent under the proposed conditions (Table E.9-8). For the size classes evaluated, blade strike probabilities at the Byllesby Development ranged from 4.5 - 66.6 percent under existing conditions and 2.8 - 41.0 percent under the proposed conditions (Table E.9-8). The probability of blade strike increased with increasing fish length. The existing Francis units have estimated blade strike probabilities that are more than double those of the proposed Kaplan units. During the 2020-2021 Fish Community Survey, a total of 1,119 fish were collected in the Project area. The average length was 4.65 inches and 72.5 percent of fish collected were smaller than 6 inches. While larger fish theoretically have a greater potential for blade strike, they are more likely to be excluded by the trash racks.

Table E.9-8 summarizes fish body length to width ratios and determines the minimum length at which fish species would be excluded by the trash racks. For the larger bodied fish species such as Largemouth Bass, Walleye, White Sucker, Channel Catfish, and Common Carp that attain sizes that could be excluded by the trash racks, the minimum size of exclusion ranged from 14.5 to 18.5 inches.

Table E.9-8. Turbine Blade Strike Probability by Project Configuration and Fish Length Under No Spill Operations[1]

Project Dam	Turbine Type	Fish Length Class (inches)								
		2	4	6	8	10	15	20	25	30
Existing Conditions – Francis Turbines Under No Spill Operations										
Byllesby	Existing (4 Francis Turbines)	4.5%	8.8%	13.3%	17.8%	22.1%	33.3%	44.5%	55.4%	66.6%
Buck	Existing (3 Francis Turbines)	4.5%	8.7%	13.2%	17.7%	21.9%	32.9%	44.0%	54.8%	65.9%
Proposed Conditions – Upgraded Turbines Under No Spill Operations										
Byllesby Proposed Condition	New Kaplan (Units 1, 2 & 3)	2.2%	4.3%	6.5%	8.7%	10.8%	16.3%	21.7%	27.1%	32.5%
	Existing Francis	4.5%	8.8%	13.3%	17.8%	22.1%	33.3%	44.5%	55.4%	66.6%
	Average Strike Probability[2]	2.8%	5.4%	8.2%	11.0%	13.6%	20.5%	27.4%	34.2%	41.0%
Buck Proposed Condition	New Kaplan (Units 1 & 2)	2.1%	4.0%	6.1%	8.1%	10.1%	15.2%	20.3%	25.3%	30.4%
	Existing Francis	4.5%	8.7%	13.2%	17.7%	21.9%	32.9%	44.0%	54.8%	65.9%
	Average Strike Probability[2]	2.9%	5.6%	8.4%	11.3%	14.0%	21.1%	28.2%	35.1%	42.2%

1) Assumes all flows directed to turbine units and with only minimum required bypass flows or spillage.
2) Reflects blended average strike probability for the 1 remaining Francis turbine and the 2(Buck), 3(Byllesby) proposed Kaplan turbines.

The Turbine Blade Strike Analysis tool was also used to estimate the downstream passage survival of Walleye under a variety of spill conditions. This approach allows for the inclusion of alternate routes such as the spillway and individual turbines to be combined into an overall passage survival estimate. The percentage of Walleye that would experience blade strike, spillway mortality, or pass downstream successfully was estimated for the range of flow conditions summarized in Table E.9-9 below. It is important to note, that the results of this analysis only reflect the potential outcomes for fish that pass downstream of the project and does not include fish that remain in the Project impoundments. Due to the assumed survival rate of 97 percent for spillway passage, the overall downstream passage survival rate increased with the increasing volume of spill for the range of flow percentiles evaluated. For the Byllesby and Buck developments, spillage first occurred at 4 percent and 12 percent annual exceedance flow probabilities, respectively.

Table E.9-9. Walleye Downstream Passage Survival Estimates for Existing and Proposed Project Configurations Under Four Spill Scenarios

Project	Turbine Configuration	Flow Exceedance %	Volume Spill (CFS)	Spill Route Selection Probability	Turbine Strike Mortalities	Spillway Mortalities	Cumulative Downstream Passage Survival
Byllesby	Existing	4	230	0.0389	39.8%	0.0%	60.1%
Byllesby	Existing	3	1128	0.1657	34.6%	0.2%	65.2%
Byllesby	Existing	2	2355	0.2931	29.2%	0.7%	70.1%
Byllesby	Existing	1	5094	0.4728	21.2%	1.6%	77.3%
Byllesby	Proposed	4	425.6	0.0720	24.2%	0.2%	75.7%
Byllesby	Proposed	3	1324.3	0.1945	21.1%	0.8%	78.1%
Byllesby	Proposed	2	2551.2	0.3175	17.6%	1.1%	81.3%
Byllesby	Proposed	1	5290.3	0.491	14.0%	1.4%	84.6%
Buck	Existing	12	123	0.0336	41.0%	0.1%	58.9%
Buck	Existing	10	421	0.1063	38.3%	0.4%	61.3%
Buck	Existing	8	816	0.1874	29.9%	0.7%	69.5%
Buck	Existing	6	1427	0.2872	30.2%	1.0%	68.8%
Buck	Existing	4	2370	0.4010	27.3%	1.2%	71.5%
Buck	Existing	2	4495	0.5594	17.0%	1.5%	81.5%
Buck	Existing	1	7234	0.6714	12.6%	2.3%	85.1%
Buck	Proposed	12	92	0.0253	27.7%	0.0%	72.2%
Buck	Proposed	10	391	0.0987	22.8%	0.4%	76.8%
Buck	Proposed	8	786	0.1805	17.9%	1.0%	81.2%
Buck	Proposed	6	1397	0.2812	20.2%	0.6%	79.1%
Buck	Proposed	4	2340	0.3959	14.5%	1.0%	84.4%
Buck	Proposed	2	4465	0.5557	10.3%	1.6%	88.2%
Buck	Proposed	1	7204	0.6687	8.3%	1.9%	89.8%

For the Byllesby Development, the percentage of Walleye that would survive downstream passage ranged from 60.1 to 77.3 percent under the existing conditions and from 75.7 to 84.6 percent under the proposed conditions. For the Buck Development, the percentage of Walleye that would survive downstream passage ranged from 58.9 to 85.1 percent under the existing conditions and from 72.2 to 89.8 percent under the proposed conditions.

While the greatest opportunity for fish mortality through a facility lies in potential contact with the turbine runner blades, injuries and mortalities can result from other mechanisms including extreme pressure changes, shear stress, water turbulence, cavitation, and grinding (Deng et al. 2005); however, the historical study (Appalachian 1991b) determined that these factors are minimal at the Project. Since no significant changes have occurred at the facility that would change these parameters since the last relicensing, injuries and mortalities caused by factors other than turbine strikes are expected to be negligible.

Conclusions

In summary, the findings of the current study concur with the historical entrainment study completed for the prior relicensing in that effects of Project operation on the fish community in the Project vicinity are expected to be minimal. Most fish would not be excluded by the intake trashracks at Byllesby and Buck intake structures; however, velocities in front of the intakes are comparable to normal flow conditions of the New River and would therefore likely be navigable by most juvenile and adult fish in the area. Entrainment of early life stage fishes (eggs and larvae) is likely minimal given the life history characteristics of species in the vicinity of the Project. Susceptibility to entrainment is variable depending on species and time period, however most target species and species groups have low entrainment potential for most of the year.

E.9.2.1.4 2020-2021 Macroinvertebrate and Crayfish Community Survey

A summary of the methods and results of the Macroinvertebrate and Crayfish Community Survey is provided in this section and details were provided in the USR. The revised Byllesby-Buck Aquatic Resources Study Report, of which the Macroinvertebrate and Crayfish Community Survey is a part, will be submitted as supplemental information by April 14, 2022. The specific objectives of the Macroinvertebrate and Crayfish Community Survey are included below:

- Collect a baseline of existing macroinvertebrate and crayfish communities in the vicinity of the Project; and
- Compare current aquatic resources data to historical data to determine any significant changes to species composition or abundance.

On behalf of Appalachian, EDGE conducted a Benthic Aquatic Resources Study to document a comprehensive representation of the Project area and to correlate with previous sampling efforts (Appalachian 1991a) for comparison. Macroinvertebrate and crayfish sampling efforts targeted representative habitat at 16 sites throughout the Project area using sampling methods derived from the National Rivers and Streams Assessment Field Operations Manual and VDEQ Biological Monitoring Program Quality Assurance Project Plan and included quantitative and qualitative sampling methods that target different habitats (USEPA 2019; VDEQ 2008). Quantitative sampling methods targeted riffle/run habitats and qualitative sampling methods targeted available microhabitats in pools habitats. Sampling was performed by an EDGE state and federally permitted astacologist under Virginia Scientific Collecting Permit No. 068630. All macroinvertebrate sites were sampled between October 6 and 8, 2020 during the fall sample index period defined by VDEQ (September 1 – November 30) (VDEQ 2008). The spring 2020 sampling effort was completed during the spring 2021 index period (March 1 – May 31).

Macroinvertebrate and Crayfish Community Survey Methods

Quantitative Sampling

Benthic macroinvertebrate and crayfish sampling efforts were completed at eight riffle/run sites along 100-m transects. Macroinvertebrate sampling was conducted holding the D-frame net on the bottom of the stream perpendicular to flow and kicking substrate to agitate and dislodge organisms, thus allowing dislodged organisms to flow into the net. A single quantitative sample consisted of a composite of six kick sets, each disturbing approximately 0.33 m^2 above the dip net for a duration of 30-90 seconds and totaled an area comprising 2.0 m^2. For quality assurance measures, replicate sampling was conducted at one quantitative site within close proximity (not in the same locations as the first set of samples) of the initial sampling area.

To assess the crayfish community, additional kick samples and seining efforts were performed following benthic macroinvertebrate sampling to ensure all crayfish habitat had been covered.

Qualitative Sampling Methods

Benthic macroinvertebrate and crayfish were also sampled at five qualitative sites (i.e., multi-habitat) along 100-m transects following guidelines defined by USEPA (2019) and VDEQ (2008). Sampling was conducted by performing 20 jabs with a D-frame net into suitable, stable habitats (snags, vegetation, banks, and substrate) 20 times. A single jab consists of forcefully thrusting the net into a microhabitat for a linear distance of 1.0 m, followed by 2-3 sweeps of the same area to collect dislodged organisms for 20-90 seconds per jab, sweep, or kick. Different types of habitat were sampled

in rough proportion to their frequency within the reach. Sampling effort was proportionally allocated (20 jabs/sweeps/kicks) to shore-zone and bottom-zone, 20-90 seconds per jab, sweep, or kick.

Macroinvertebrate and Crayfish Community Survey Results

Benthic macroinvertebrate and crayfish community metrics can be used as indicators of water quality, as these organisms often exhibit sensitivity to changing water quality conditions, and because they serve as a food resource for fish and other fauna in the riverine community. A healthy stream generally includes habitat diversity and limited pollution, often indicated by a high VSCI and Hilsenhoff Biotic Index (HBI) score (standard biological metrics).

Macroinvertebrate samples were collected from 16 sites between October 6 and 8, 2020, during the fall sample index period (September 1 – November 30) and between April 20 and 23, 2021, during the spring sample index period (March 1 – May 31), as defined by VDEQ (2008). Sampling was performed by EDGE's state and federally permitted astacologist under Virginia Scientific Collecting Permit No. 068630. The physiochemical data from each of the sample sites met the state water quality standards established for the New River (VAC Chapter 260), indicating that water quality conditions within the Project area are capable of supporting macroinvertebrate communities. Additional water quality data are provided in the Water Quality Study Report provided in Appendix B of Volume II.

A total of 49 macroinvertebrate taxa were collected upstream of Byllesby Dam from two quantitative sites and four qualitative sites, along with the Spiny Stream Crayfish, which was collected from a qualitative site near the dam. The average VSCI score for sites sampled upstream of Byllesby Dam in fall 2020 was 41.9 (impaired), and only a single site resulted in a "similar to reference" score above 60, with a score of 62.7. However, four sites above Byllesby Dam had HBI values indicating "Good" to "Excellent" water quality. In spring 2021, one site upstream of Byllesby Dam had a VSCI score greater than 60, with a score of 75.1. The average VSCI score for all sites above Byllesby Dam and for both sampling seasons was 38.0. Similar to the fall sample, four sites in this Project area had HBI values indicating "Good" to "Excellent" water quality based on the tolerance of the macroinvertebrate community.

A total of 53 macroinvertebrate taxa were collected between the Byllesby Dam and Buck Dam from four quantitative sites and four qualitative sites. The average VSCI score for sites sampled between the Byllesby Dam and Buck Dam in fall 2020 was 52.5 (impaired); however, four sites (three quantitative and one qualitative) resulted in a "similar to reference" score above 60. Four sites in this section of the Project area had HBI values indicating "Good" to "Excellent" water quality. In spring 2021, only three sites resulted in a VSCI score greater than 60, and the average VSCI score for sites between Byllesby and Buck dams was 46.5. In contrast to the fall sample, seven of eight sites in the

area between Byllesby and Buck dams had HBI values indicating “Good” to “Excellent” water quality based on the tolerance of the macroinvertebrate community.

A total of 30 macroinvertebrate taxa were collected from two quantitative sites located downstream of the Buck Dam. The average VSCI score for sites sampled downstream of the Buck Dam in fall 2020 was 58.8 (impaired). One of two sites scored above 60 with a total of 63.0, which was classified as “similar to reference”, and had an HBI value indicating “Very Good” water quality. However, the HBI value at the downstream site was classified as “Fair”. In spring 2021, one of two sites resulted in a “similar to reference” score of 62.2. The average VSCI score for the sites downstream of Buck Dam was 59.0, which is just below the threshold for “similar to reference”. In contrast, both sites below Buck Dam in the fall 2020 sample, had HBI values indicating “Very Good” and “Good” water quality based on the tolerance of the macroinvertebrate community.

VSCI scores recorded at each site were greater on average in the fall than in the spring. The average VSCI scores upstream of Byllesby Dam, between Byllesby and Buck dams, and downstream of Buck Dam all indicated “impaired” conditions during the fall and spring samples. Downstream of Buck Dam had an overall average VSCI score (58.9) just below the threshold of “similar to reference” conditions (60). During both seasonal collections, the lowest VSCI scores were recorded upstream of Byllesby Dam and the highest were recorded downstream of Buck Dam, which indicates less impairment as you move downstream through the Project area. Seven sites throughout the Project area resulted in VSCI scores greater than 60 during at least one season of survey; the locations and results of the macroinvertebrate and crayfish study were provided in the USR and will be attached to the Aquatic Resources Study Report, which will be filed as supplemental information by April 14, 2022.

One of two species of crayfish was collected upstream of Byllesby Dam, but both species were collected between the Byllesby and Buck dams, and downstream of Buck Dam. There were zero crayfish captured at the two quantitative sites upstream of Byllesby Dam and both species of crayfish were captured at both quantitative sites below Buck Dam. These sites had similar substrate and habitat composition and relatively similar physiochemical parameters. Conhoway Crayfish were observed under large boulders both near the bank and further channelward, while the Spiny Stream Crayfish were concentrated within cobble substrates and near shore cover. Overall, the presence of two relatively abundant native crayfish species and zero invasive crayfish species in the Project vicinity may indicate a healthy community.

The mustached clubtail and the pygmy snaketail were identified as species with potential to occur in the Project vicinity by VDCR in a letter dated September 23, 2017. The presence of these “species of greatest conservation need” would indicate relatively high water quality. The pygmy snaketail was

collected from the New River near the Fries Project (Carey et al. 2017), which is located approximately 13 river kilometers upstream of the Byllesby-Buck Project. Prior to the present study, no macroinvertebrate data were available for the Project and the presence of the mustached clubtail and pygmy snaketail were unknown for the Project reach of the New River. Although dragonfly larvae were collected during the fall and spring sampling efforts from 2020-2021, no mustached clubtail or pygmy snaketail dragonfly larvae were collected.

Crayfish surveys were also completed as part of the Fries Project, where spiny stream crayfish were the only species collected (Carey et al. 2017); however, prior to the current study, no site-specific information on crayfish populations in the Project reach of the New River were available. Approximately 33 species of crayfish, including non-indigenous and/or invasive species such as the northern virile crayfish, have been documented in waterbodies throughout Virginia (VDGIF 2018; VISAC 2018). The northern virile crayfish was collected at the Claytor Project (DTA 2008) located 70 river kilometers downstream of the Byllesby-Buck Project.

E.9.2.1.5 Freshwater Mussel Community Study

A summary of the methods and results of the Freshwater Mussel Community Study is provided in this section and details were provided in the USR. The revised Byllesby-Buck Aquatic Resources Study Report, of which the Freshwater Mussel Community Study is a part, will be submitted as supplemental information by April 14, 2022. The specific objectives of the Freshwater Mussel Community Study are included below:

- Collect a more comprehensive baseline understanding of the mussel community within the Project area;
- Compare current mussel survey data to historical data to determine any significant changes in species composition or abundance; and
- Assess spatial distribution of mussel species within the Project area.

Stantec completed all components of the Freshwater Mussel Survey in 2020 in accordance with the RSP and the Commission's SPD; the study report was provided in the ISR and is summarized below. Methods used to survey mussels were based on Freshwater Mussel Guidelines for Virginia (USFWS and VDGIF 2018) and consisted of visually identifying potential mussel habitats within the approximately 3,000-m long reach between Byllesby Dam and the Buck impoundment islands as well as downstream of Buck Dam. These areas were chosen to fill information gaps based on available data from historic studies completed for the majority of the surrounding habitats (Pinder et al. 2002; Alderman 2008; Stantec 2018a, 2018b). This study did not examine the Buck or Byllesby reservoirs due to the availability of data from recent studies completed during drawdown activities (Stantec 2018a, 2018b).

To assess the Buck Dam tailrace, exposed riverbanks were observed to identify any spent valves or evidence of suitable mussel habitat. The high velocities and unknown depths in the narrow channel were not conducive for safe in-water surveys such as wading, SCUBA, or snorkeling. Ten areas identified as potential mussel habitats in the reach between Byllesby Dam and Buck impoundment Islands were assessed using wandering timed searches (two shallow shoals, three deep shoals, three pools, and two side channels). Surveyors used SCUBA, surface supplied air diving, and snorkeling to conduct 200-minute wandering searches of the substrates in each area. Search tactics included moving gravel/cobble and woody debris, hand sweeping away silt, sand, and/or small detritus, and disturbing/probing the upper 5 cm of substrate where possible. Total search time was 33.3 hours.

Nine *Cyclonaias tuberculata* were identified during the survey of the ten habitat units. Live mussels were only found in two of the ten surveyed areas and overall mussel densities were lower than the sites downstream of Buck Dam. Quality habitat within the survey area was limited as bedrock and overlying silt deposits were the most predominant substrate types. A reconnaissance level habitat assessment of the Buck Dam tailrace was also conducted. No evidence of spent valves or viable mussel habitat were observed within the Buck Dam tailrace, where high velocities resulting from a narrow, confined channel most likely preclude mussel occupancy.

Existing relevant and reasonably available studies of mussels within the Project area were reviewed and compared to results of summer 2020 field surveys. In total, data from six other mussel surveys conducted within the Project area between 1997 and 2018 were compiled to form a more comprehensive understanding of the mussel community in the vicinity of Project operations. Six species were observed within the Project area: *Cyclonaias tuberculata*, *Eurynia dilatata, Tritogonia verrucosa, Lampsilis fasciola, Lasmigona subviridis,* and *Lampsilis ovata.* Survey sites downstream of Buck Dam (downstream of the confluence of the tailrace and bypass channel) supported the highest density mussel habitats. *Cyclonaias tuberculata* and *Tritogonia verrucosa* were the most abundant species and mussel size data suggests that recent recruitment has occurred for these species. Results of 2020 field surveys are consistent with findings of historical surveys. High quality mussel habitat within the Project area is limited and does not support a diverse or abundant mussel community.

E.9.2.2 Project Impacts on Aquatic Resources

In SD3, FERC staff identified the following environmental issues to be addressed in their NEPA document:

- Effects of continued Project operation and maintenance on water quality, including DO concentrations, water temperature, and turbidity upstream and downstream of each development, including the Buck bypass reach.

- Adequacy of the existing 360-cfs minimum flow for aquatic resources, including resident fish species, downstream of each development (Buck and Byllesby).
- Whether there is a need for a minimum flow (beyond leakage) in the Buck bypass reach.
- Effects of continued project maintenance (periodic impoundment drawdowns to replace flashboards and periodic dredging to remove sediments from the impoundments) on aquatic resources, particularly freshwater mussels and fish spawning habitat in the impoundments of each development.
- Effects of continued Project operation on aquatic resources, including entrainment and impingement mortality of resident fishes, such as Walleye, Smallmouth Bass, and Spotted Bass at each development.
- Effects of continued project operation and maintenance on species of special concern such as Eastern hellbender, freshwater mussels (including green floater and pistolgrip), and New River crayfish.
- Adequacy of the existing ramping rate to prevent fish stranding in the Buck bypass reach.

For the reasons discussed below, the Licensee does not anticipate that operation and maintenance of the Project over the new license term will have any long-term, unavoidable, adverse impacts on aquatic resources.

E.9.2.2.1 Effects of Continued Project Operation on Water Quality and Turbidity

Effects of continued and Project operations on water quality are summarized in Section E.8 of this FLA and data collected for this relicensing are presented in the Water Quality Study report in Appendix B, Volume II of this FLA. The results of the studies conducted support a conclusion that due to the relatively small size and short retention time of the Project reservoirs, the lack of thermal stratification in the reservoirs, and the run-of-river operation of the Project, the Project does not affect ambient water quality (i.e., water temperature and DO levels) in this reach of the upper New River during normal Project operations. Additionally, Appalachian conducted a focused study on the impacts of drag rake operation on turbidity; those results are summarized in Section E.8.

E.9.2.2.2 Minimum Flows for Protection of Aquatic Resources (Byllesby)

In comments on the DLA (dated January 18, 2022), the USFWS and VDWR noted that a bypass flow release through Tainter Gate 6 (near the center of the spillway structure) was not preferred as the main flow channel in the bypass reach is closer to the right descending bank. The agencies recommended evaluation of bypass flow releases through Obermeyer Gates 11 or 12 as these gates are immediately upstream of the bypass reach thalweg which runs along the right descending bank.

Appalachian performed additional hydraulic analyses comparing an 88 cfs bypass flow release from Tainter Gate 6 to an 88 cfs bypass flow release from Obermeyer Gate 12. Separate model simulations

were run and the depth results from each were overlaid on Figure E.9.4. Purple shaded areas indicate the 88 cfs bypass flow release from Obermeyer Gate 12 resulted in greater depths. Green shaded areas indicate the 88 cfs bypass flow release from Tainter Gate 6 resulted in greater depths. As shown in Figure E.9.4, the flow release location only affects depths (and wetted area) in the immediate downstream area. Water depths in the majority of the bypass reach are not affected by the flow release location (areas shown in white in Figure E.9.4) and depths in the study area downstream from the bypass reach were also not affected by the flow release location. It is noted that bypass flow releases from Tainter Gate 6 cross over the rocky substrate between the two gates and maintain water surface elevations in the upper thalweg pool downstream from Obermeyer Gate 12. The same delta depth model results are provided in a zoomed in view of the bypass reach area immediately below the spillway structure on Figure E.9.5. Note the area depicted in white at the base of the spillway adjacent to the Byllesby Powerhouse is influenced by leakage from the Tainter gates, which was held constant in both of the 88 cfs bypass flow model simulations.

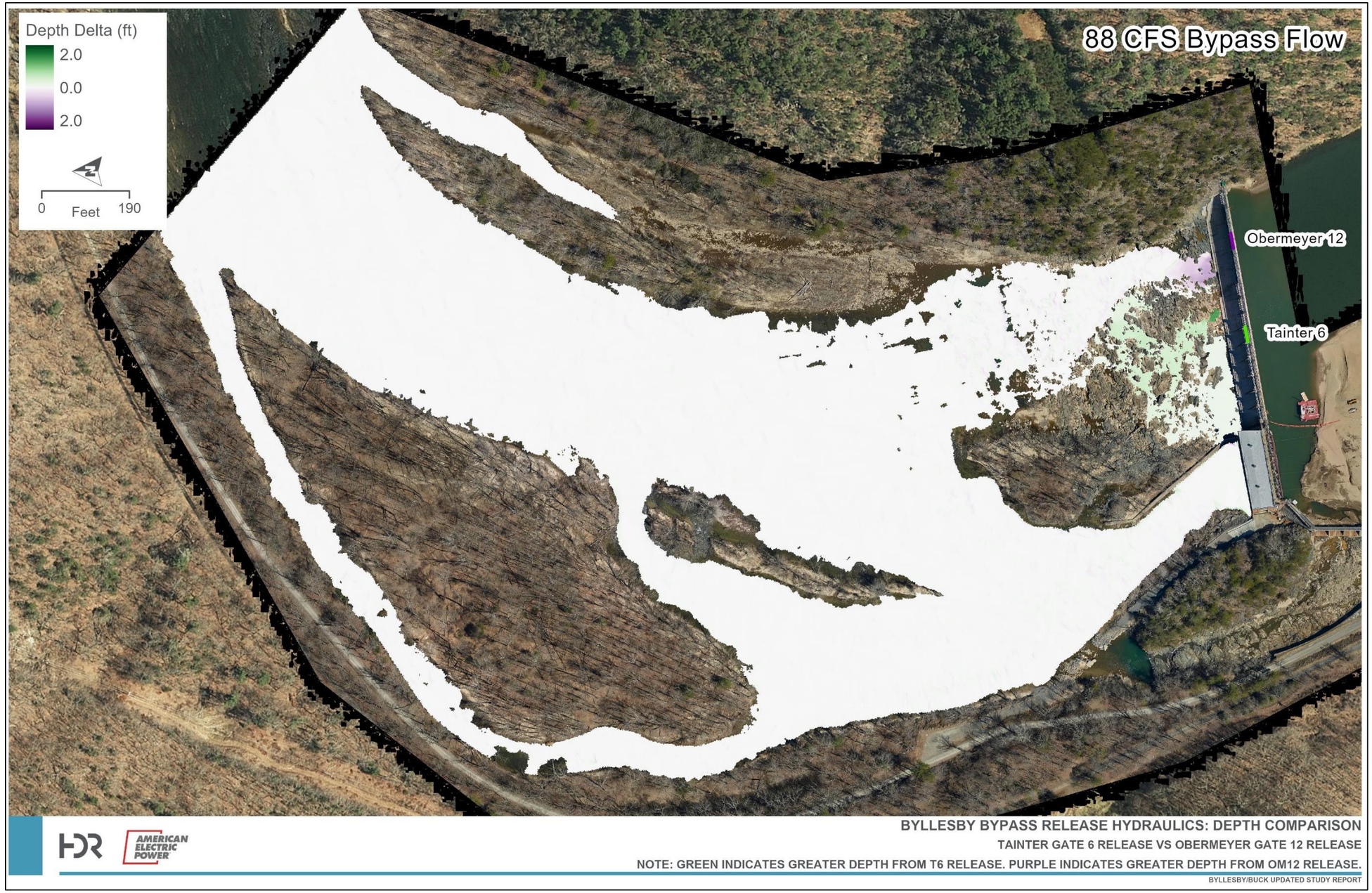


Figure E.9.4 Byllesby Bypass Reach Release Hydraulics – Depth Comparison

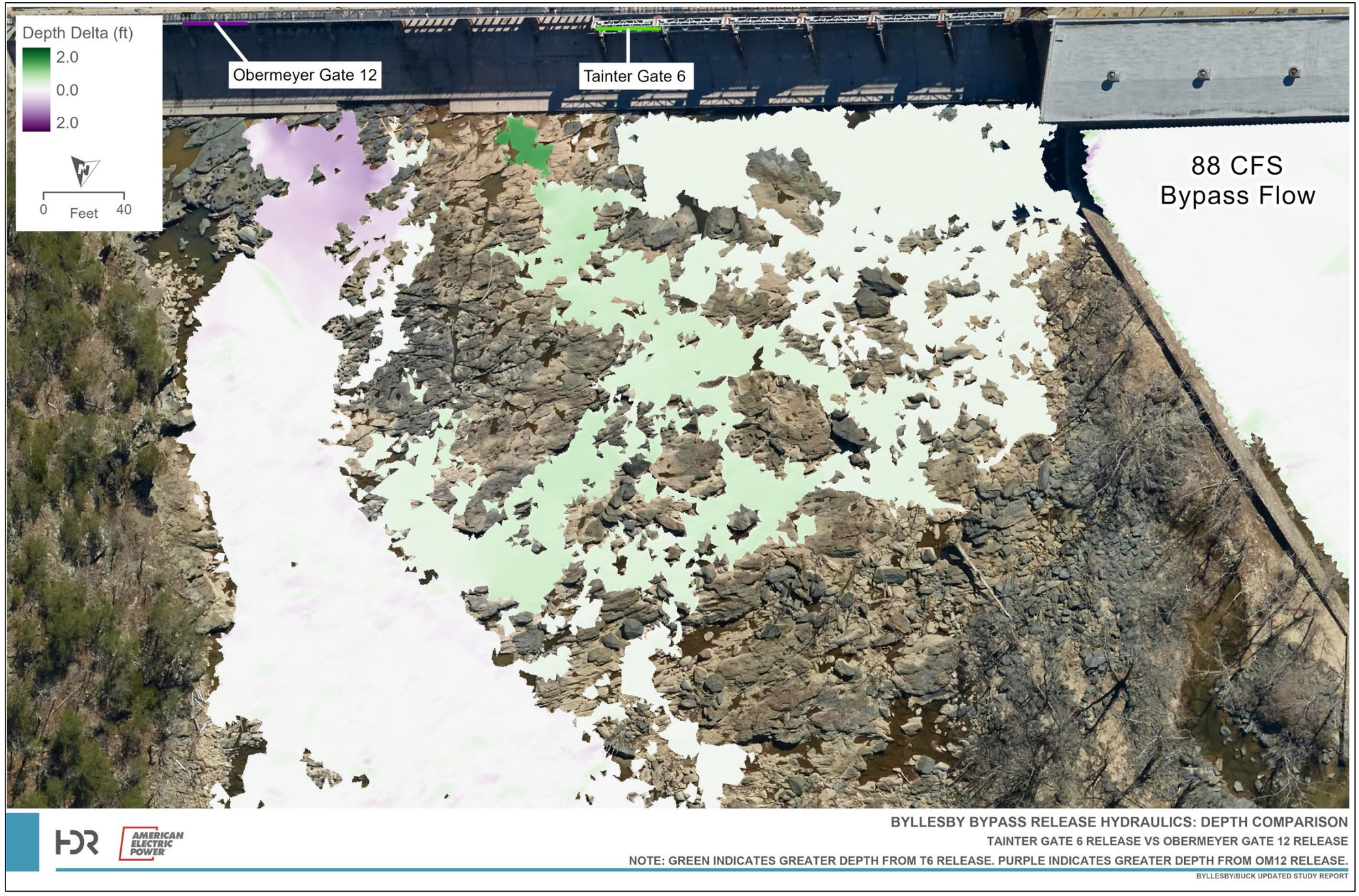


Figure E.9.5 Byllesby Bypass Reach Release Hydraulics – Depth Comparison Near the Spillway

E.9.2.2.3 Potential Need for Minimum Flows for Protection of Aquatic Resources (Buck)

In comments on the DLA (dated January 18, 2022), the USFWS and VDWR recommended releasing flows to the Buck bypass reach via Obermeyer Gate 10 versus Tainter Gate 1 because Obermeyer Gate 10 is closer to the thalweg which runs along the left descending bank of the bypass reach. The agencies also requested additional analysis and discussion related to potential fish stranding in the upper bypass reach side channel area which runs along the left descending bank immediately downstream from the main spillway flashboard sections.

Appalachian performed additional analyses to evaluate differences in hydraulic flow patterns and depths related to releasing flows from Tainter Gate 1 versus Obermeyer Gate 10. Tainter Gate 1 is located closest to the right descending bank of the bypass reach and is the primary gate used for flow releases into the bypass reach. Obermeyer Gate 10 is near the center of the main spillway structure and is the closest gate to the bypass reach left descending bank. Four bypass flow model scenarios were evaluated: 210 cfs, 354 cfs, 714 cfs, and 1,500 cfs. Separate model simulations were run for each of the two release points and the depth results from each were overlaid for comparison. This analysis was done for each of the four modeled bypass flows. Model results from the 1,500 cfs release scenario are shown on Figure E.9.6. Green shaded areas indicate areas that are deeper due to flow releases from Tainter Gate 1. Purple shaded areas indicate areas that are deeper due to flow releases from Obermeyer Gate 10. White shaded areas indicate no difference in water surface elevations due to the flow release location.

As shown on Figure E.9.6, the flow release location only affects depths (and wetted area) in the area immediately downstream from the flow release point. Depths in the majority of the bypass reach are not affected by the flow release location (areas shown in white). Model results indicate that flows released from either Tainter Gate 1 or Obermeyer Gate 10 generally follow the same flow path in the upper bypass reach running diagonally towards the apex of the outer bend in the bypass reach and then down the thalweg along the left descending bank. As a result, water surface elevations in the side channel area along the left descending bank immediately downstream from the flashboard sections are the same regardless of which gate the flow is released from.

The same delta depth model simulation results are provided for each of the four flows evaluated in a zoomed in view of the bypass reach area immediately below the spillway structure onFigure E.9.7. These results indicate that while there are localized hydraulic differences between flow release locations, these differences extend only approximately 700 feet downstream of the spillway at the highest flow release evaluated (i.e., 1,500 cfs).

Appalachian also evaluated the potential for fish stranding in the upper bypass reach pools immediately below the spillway along the left descending bank. Nine pools in this area (shown on Figure E.9.8) were analyzed by plotting pool water surface elevation versus bypass flow releases. Figure E.9.9 plots water surface elevation versus bypass flow for each of the nine pools. Also shown on Figure E.9.9 in blue text are the annual flow exceedance values for each gate opening. These exceedance values were determined using USGS gage 0316550 New River at Ivanhoe, VA and the period of record from 1996 to 2020. Note the powerhouse was assumed to be operating at full capacity (3,540 cfs discharge) for this analysis. Hydraulics at these nine pools are not affected by powerhouse flows.

Water surface elevations in Pool 9 (Figure E.9.8) are affected due to a backwater effect from a single gate opening (i.e., full gate opening of approximately 3,000 cfs depicted in Figure E.9.9) as the main flow path in the upper bypass reach intersects with the downstream end of Pool 9. When a single gate is open, ramping rates require hold points at 2 ft and 1 ft gate openings to allow time for water in the bypass reach to gradually recede. As a result, potential fish stranding in Pool 9 under single gate operations is minimized. The water surface elevations in Pools 8 and 7 are not affected by backwater from a single gate opening but begin to increase when a second gate is opened. Water surface elevations in Pool 6 are not affected until at least three spillway gates are opened and pools across the toe of the spillway (i.e., Pools 1 – 5) are not affected until five or more spillway gates are opened.

Based on annual flow exceedance probabilities, a single gate would be opened to some extent (either partially or fully) approximately 19.7 percent of the time. However, the probability of multiple gates opened at the same time is significantly lower. The probability of two gates opened at the same time is approximately 4.0 percent, which means the water surface elevations in Ponds 7 and 8 are not affected from bypass flow releases 96.0 percent of the time. The probability of three gates opened at the same time is approximately 1.7 percent, which means the water surface elevations in Pool 6 are not affected from bypass flow releases 98.3 percent of the time. The probability of five or more gates opened at the same time drops to less than 1 percent of the time, so water surface elevations in the pools located along the downstream toe of the spillway (i.e., below the flashboard sections), are rarely affected by bypass flow releases. As a result, the potential for fish stranding in this area is minimal and is mitigated by the current ramping rate requirements at the Buck Development.

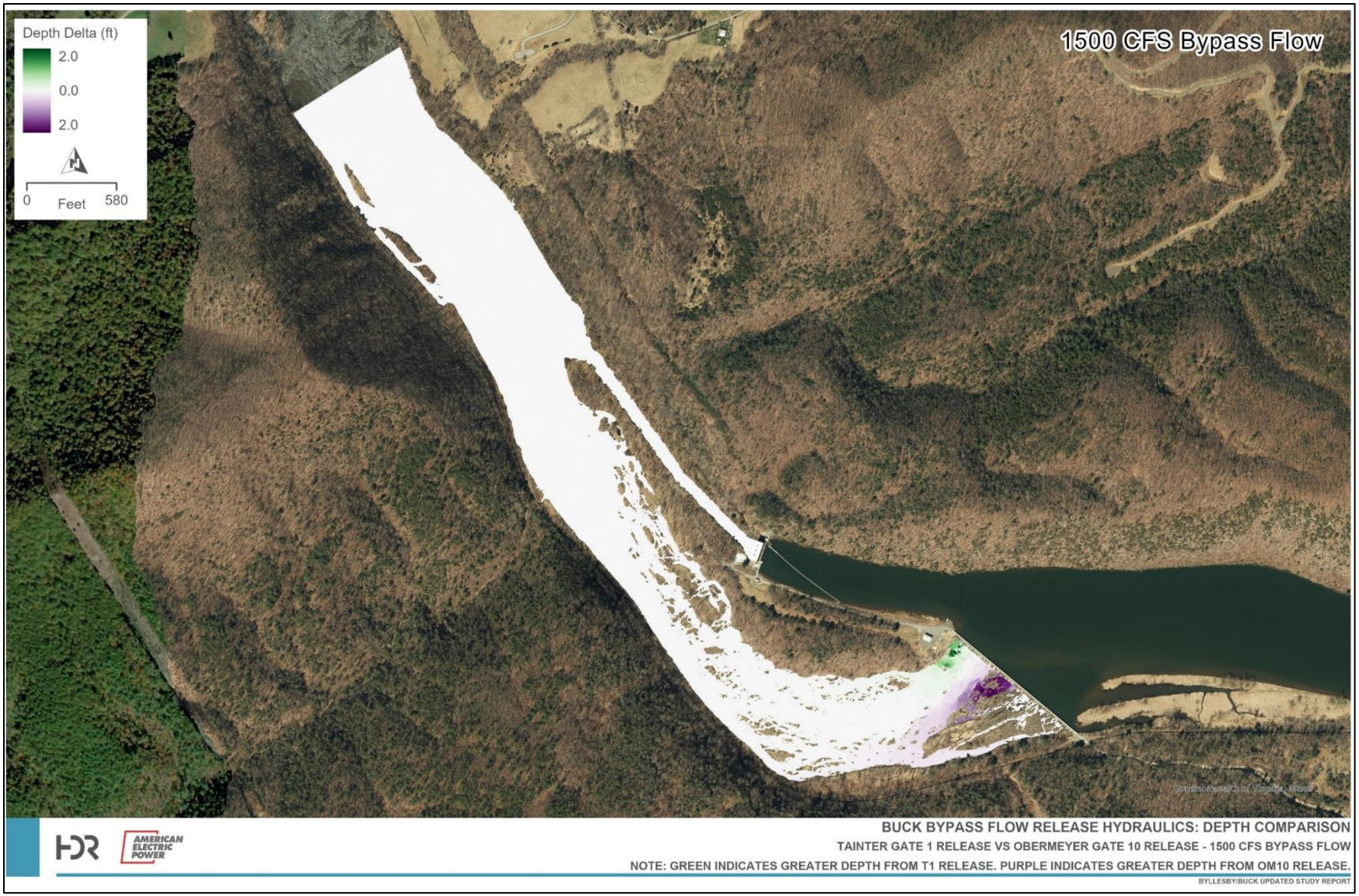


Figure E.9.6 Buck Bypass Reach Flow Release Hydraulics – Depth Comparison

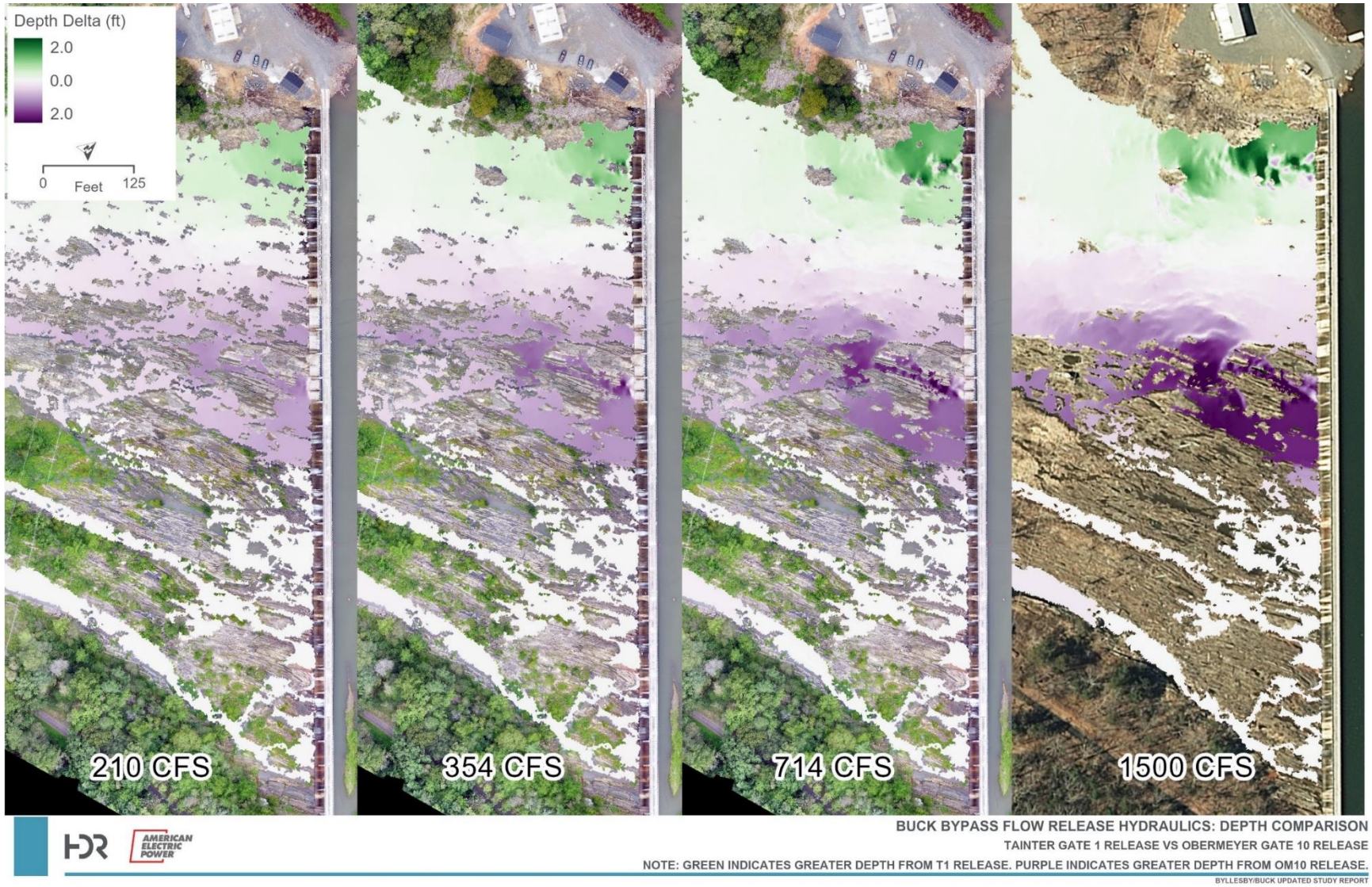


Figure E.9.7 Buck Bypass Reach Release Hydraulics – Depth Comparison Near the Spillway

Figure E.9.8. Buck Left Descending Bank Pool Identification

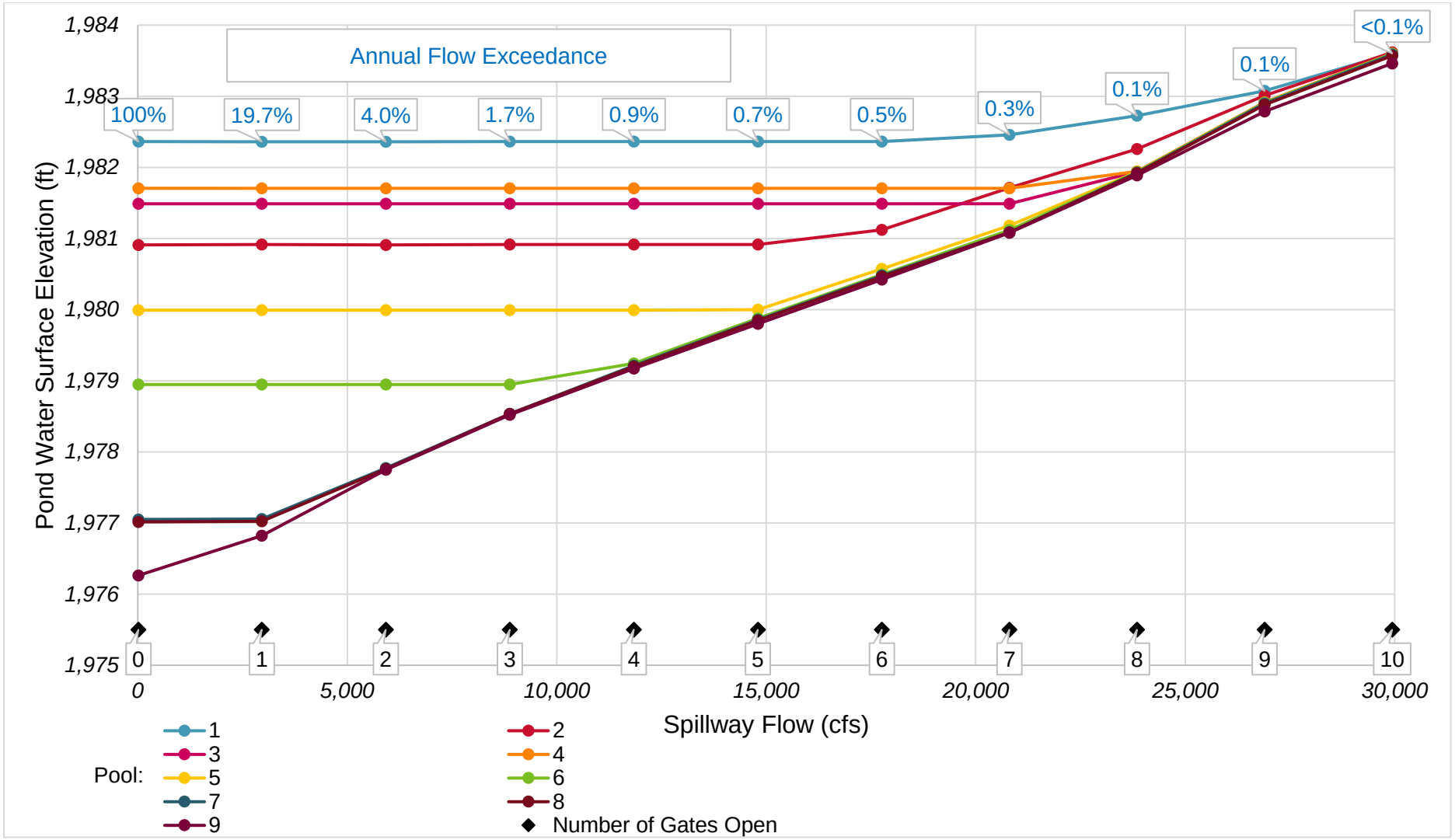


Figure E.9.9. Buck Left Descending Bank Pool Water Surface Elevations vs Spillway Flow with Annual Exceedance Probabilities

E.9.2.2.4 Effects of Continued Project Operation on Entrainment and Impingement of Resident Fishes

To date, the findings of the current study concur with the historical entrainment study (Appalachian 1991b) completed for the prior relicensing in that effects to the fish community in the Project vicinity are expected to be minimal. Most fish would not be excluded by the intake trashracks at the Byllesby and Buck intake structures; however, velocities in front of the intakes are comparable to normal flow conditions of the New River and would therefore likely be navigable by most juvenile and adult fish in the area. While the greatest opportunity for fish mortality at a facility is associated with potential contact with the turbine runner blades, injuries and mortalities can result from other mechanisms including extreme pressure changes, shear stress, water turbulence, cavitation, and grinding (Deng et al. 2005); however, the historical study (Appalachian 1991b) determined that these factors are minimal at the Project. Since no significant changes have occurred at the facility that would change these parameters since the last relicensing, injuries and mortalities caused by factors other than turbine strikes are expected to be negligible. Susceptibility to entrainment is variable depending on species and time period, however most target species and species groups have low entrainment potential for most of the year. Entrainment of early life stage fishes (eggs and larvae) is likely minimal given the life history characteristics of species in the vicinity of the Project.

E.9.2.2.5 Effects of Continued Project Operation on Species of Special Concern

New River Crayfish

The Spiny Stream Crayfish was collected upstream of Byllesby Dam, while Spiny Stream Crayfish and Conhoway Crayfish were both collected between the Byllesby and Buck dams, as well as downstream of Buck Dam. There were no crayfish captured at the two quantitative sites upstream of Byllesby Dam, while both species of crayfish were captured at both quantitative sites below Buck Dam, even though all four sites exhibited similar substrate, habitat composition, and physiochemical parameters. Conhoway Crayfish were observed under large boulders near the bank and in the channel, while the Spiny Stream Crayfish were concentrated within cobble substrates and near shore cover. Overall, the presence of these two relatively abundant native crayfish species and the absence of invasive crayfish species in the Project vicinity may indicate a healthy community.

Mussels

Existing relevant and reasonably available studies of mussels within the Project area were reviewed and compared to results of summer 2020 field surveys. In total, data from six other mussel surveys conducted within the Project area between 1997 and 2018 were compiled to form a more comprehensive understanding of the mussel community in the vicinity of Project operations. Six

species were observed within the Project area: purple wartyback, spike, pistolgrip, wavyrayed lampmussel, green floater, and pocketbook. A single live green floater was collected upstream of Byllesby Dam in 2018 (Stantec 2018a). Survey sites downstream of Buck Dam (downstream of the confluence of the tailrace and bypass channel) supported the highest density mussel habitats. Purple wartyback and pistolgrip were the most abundant species and mussel size data suggests that recent recruitment has occurred for these species. Results of 2020 field surveys are consistent with findings of historical surveys.

High quality mussel habitat within the Project area is limited and does not support a diverse or abundant mussel community. Therefore, continued operation of the Project is not anticipated to have an effect on the mussel community of the New River within the Project area.

Eastern Hellbender

Eastern hellbender have not been previously documented within the Project Boundary and none were collected incidentally during the fish and benthic macroinvertebrate studies performed at the Project in 2020 and 2021. No Eastern hellbender surveys were required by FERC's SPD or performed during the Project field studies in 2020 or 2021. In the RSP, Appalachian noted that due to challenges with implementing the currently acceptable survey methodology (i.e., surveys at night, requiring lifting of large boulders, safety concerns, and potential for specimen injury or damage to habitat), Appalachian has assumed that Eastern hellbender are likely present within the Project Boundary in lieu of performing a field study. In discussions at the PSP meeting and in comments filed on the PSP, VDWR, and USFWS were agreeable with this approach. While this species may occur in faster flowing sections within the general Project Boundary, the bypass reaches do not contain suitable habitat (i.e., absence of woody debris and logs) and therefore no effect of Project operations on this species is anticipated.

While Appalachian understands that this species may occur in faster flowing, well-oxygenated sections of the New River within the general Project vicinity, the Project bypass reaches do not contain suitable habitat for Eastern hellbender. The results of the Bypass Reach Flow and Aquatic Habitat Study (revised study report to be submitted as supplemental information by April 14, 2022) indicate that available substrates within the bypass reaches include bedrock, boulder, cobble, and woody debris/logs; however, the majority of the Byllesby bypass and the entire upper half of the Buck bypass reach are dominated by rocky outcrops, large boulders, and contiguous bedrock that are clean swept and provide no velocity shelters or spawning habitat. The boulders and bedrock in the upper Buck bypass reach are flat or vertical but positioned parallel to stream flow preventing the accumulation of sediments or other larger substrates that would provide habitat for Eastern hellbender. In the lower

half of the Buck bypass reach, the bedrock and large boulders are oriented more perpendicular to the flow and do provide some areas where velocity shelters could occur, resulting in some smaller substrate accumulation. However, the only portion of the downstream bypass reach that consistently remains fast flowing is along the left, downstream-facing bank in the thalweg of the channel. However, despite the continuous, swift flowing water in this portion of the reach, the substrates are suboptimal at best and covered in fine sediments and are not considered viable habitat for Eastern hellbender.

The conclusion that Eastern hellbender are unlikely to occur in the bypass reaches at the Project are supported by informal consultation with VDWR that Appalachian conducted in support of preparation of this FLA.[15] Appalachian's conclusions from this informal consultation are summarized as follows:

- The presence of potentially suitable habitat does not guarantee that Eastern hellbender is present.

- Aside from the presence of cool, well-oxygenated flowing water, the type and amount of substrate is the most significant factor for identifying potentially suitable habitats. These habitats would be indicated by the presence of large flat boulders, slab bedrock, or cobble substrates positioned so that they are partially embedded with the upturned side facing downstream so as to create a velocity shelter where finer-grained material (i.e., gravel/sand) can accumulate.

- Prey availability (e.g., crayfish, small fish, insects, and frogs) for production and survival is also important for habitat suitability.

- Dispersal for this species is not well documented, but Eastern hellbender tend to exhibit a small, local range and that likeliest source of dispersal may be through downstream immigration during high flow events.

- In the Project bypass reaches, the available instream flows, geology, flow paths, and available substrates do not provide suitable habitat for Eastern hellbender. Further, the dominant substrate in the bypass channels do not support the types and quantities of prey resources (e.g., crayfish, small fish, insects, and frogs) that would be needed to maintain production of Eastern hellbender in those areas.

[15] J.D. Kloepfer, personal communication, February 16, 2022

- The closest likely suitable habitat for Eastern hellbender occurs in the large riffle complexes located just downstream of the confluence of the Byllesby tailrace and bypass reach and just downstream of the confluence of the Buck tailrace and bypass reach. Results of multiple field studies completed at the Project in 2020 and 2021 indicate that under current operations, these riffle complexes support a diversity of aquatic organisms including fish, benthic macroinvertebrates, and mussels (see Sections E.9.2.1.2, E.9.2.1.4, and E.9.2.1.5).

Because Project bypass reaches do not provide viable suitable Eastern hellbender habitat, no effect of Project operations on Eastern hellbender is anticipated.

Dragonflies

Although larval dragonflies were collected during the field sampling efforts, no pygmy snaketail or moustached clubtail dragonfly larvae or adults were collected during the 2020-2021 Project macroinvertebrate study.

E.9.2.2.6 Adequacy of Ramping Rate to Prevent Fish Stranding (Buck Development)

Periodic or intermittent release of flows through the Tainter gates, Obermeyer crest gates, flashboards, or sluice gates creates the potential for fish stranding in pockets of water in the rough substrate of the bypass reaches. Flow releases over the main spillways into the bypass reaches are generally infrequent at the Project, though more common during the wet months of November-December and February-April, and necessary during plant outages. As previously noted, replacement of sections of wooden flashboards with inflatable Obermeyer crest gates at both developments is expected to reduce inadvertent flow into the bypass reach that may potentially attract and expose fish to stranding.

For times when flows are required to be released over the main spillway, ramping rates and associated procedures (i.e., incremental gate openings and closings) are in place for the Buck Development to mitigate, as feasible, fish stranding due to spillway gate operations. During the previous licensing, FERC noted that that the Buck bypass reach is characterized by exposed bedrock and that the Commission had no evidence that this reach provided any unique or outstanding characteristics of fish habitat relative to nearby reaches. Additionally, no minimum flows were proposed by Appalachian or recommended by resource agencies during the previous relicensing.

As a condition of the existing license, Appalachian conducted a ramping rate assessment in 1997 to assess the effectiveness of the ramping procedures for the protection of the fisheries downstream of the Buck spillway. Observations, including backpack electrofishing, of representative pools were conducted following three spill events during the period March through May 1997. The first assessment

(March 12, 1997) resulted in the collection of 185 fish representing 16 species. The majority of the fish appeared to be permanent residents of the larger pools in the bypass. These particular pools are maintained year-round by leakage through the flashboards and/or subsurface flow. A second assessment (March 18-19, 1997) resulted in the collection of 348 fish representing 20 species. Similar to the first assessment, almost all of the fish collected were likely full-time residents of the bypass reach. A few large Common Carp, White Suckers, and Northern Hogsuckers were identified and likely migrants. The third assessment (May 2-3, 1997) resulted in the collection of 201 fish representing 16 species. Species identified were similar to the first two assessments, but with an increased presence of larger fish such as Common Carp and Northern Hogsucker that were likely not resident to the bypass reach (Appalachian 1997).

The ramping rate assessment concluded that fish stranding is not a significant problem below the Buck spillway when the ramping procedures are followed in accordance with Article 406. The majority of the fish collected (85-90%) appeared to be permanent residents of the bypass area in pools or flowing-water areas fed by leakage through the flashboards, rain events, and possibly subsurface flow. Very few spring-migrating fish and almost no large game fish were observed in a stranded location following any of the three spill events. Additionally, in many areas of the bypass, particularly the area within 1,600 ft of the dam, leakage and other flows continue to provide an escape route to fish species when the gates are closed. Local observers also indicated that fish that moved into the area during spill events largely departed during the final period of spill at a 1.0-ft gate opening (Appalachian 1997). On March 27, 1998, FERC approved Appalachian's ramping rate assessment report, inclusive of and recommendations for Appalachian to continue to retain the ramping rate protocol assessed in the 1997 study. Additionally, as described above, Appalachian expects that continued operation of the Project with the inflatable Obermeyer crest gates installed at each dam will reduce instances of spills to the bypass reach that may not conform to the ramping rate required for the spillway gate operations.

To further protect the fishery and aquatic resources in the Buck bypass reach, in the section below Appalachian proposes a modification to the existing ramping rate requirements to add a 0.5-ft gate opening hold period to the existing requirements but shorten the hold periods to two hours each (instead of three hours). Stepping down from a 0.5-ft gate opening to a closed gate position would result in a smaller incremental change in water surface elevations along the main flow pathway in the upper bypass reach ranging from 1.0 – 1.5 ft versus the current 1.5 – 2.0 ft when going from a 1-ft gate opening to a closed position. This modification would result in a more gradual lowering of depths in the upper bypass reach to further minimize the potential for fish stranding, particularly in pool areas along the main flow pathway as well as the lower-most pool ("Pool 9" on Figure E.9.8) in the side channel area along the upper left descending bank of the bypass reach.

E.9.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

E.9.3.1 PM&E Measures Proposed by Licensee

As previously noted, for the protection of mussels, Appalachian will continue to consult with USFWS and VDWR in advance of reservoir drawdowns as required for periodic scheduled or unscheduled Project maintenance and conduct mussel salvage surveys as appropriate.

For the continued protection of fish and aquatic resources at the Project, Appalachian proposes the following PM&E measures for the new license term:

- For the protection of multiple New River resources, continue to operate the project in a run-of-river mode, maintaining the Byllesby reservoir between EL. 2,078.2 ft and 2,079.2 ft and the Buck reservoir between EL. 2,002.4 ft and 2,003.4 ft.

- Continue to provide a minimum flow of 360 cfs, or inflow to the Project, whichever is less, to the New River downstream of each powerhouse. (During powerhouse outages, the minimum flow will be passed through the spillways.)

- Implement a modified ramping rate for spillway gate operations at the Byllesby and Buck developments; whereby, following periods of spill when a spillway gate has been opened 2 ft or more, water will continue to be released into the bypass reach through a 2-ft-gate opening for at least 2 hours, then the gate opening will be reduced to 1.0 ft for 2 hours and then to 0.5 ft for 2 hours before closing the gate.

- Develop and implement a Bypass Reach Aquatic Resources Protection Plan in consultation with USFWS and VDWR and for FERC approval. The Bypass Reach Aquatic Resources Protection Plan is expected include provisions for the following:
    - Spillway gate and ramping rate procedures under various Project operation scenarios for the protection of aquatic habitat and resources.
    - Detailed identification of Buck spillway operating conditions that may result in a risk for stranding in isolated pool areas along the toe of the main Buck spillway and upper side channel area along the left descending bank.
    - Visual inspection of the isolated pool areas along the toe of the main Buck spillway and upper side channel area along the left descending bank after Project inflow events that require at least five gates to be opened and/or after flashboard failure

events. The purpose of the visual inspection would be to determine if fish have become stranded in these areas and to determine the best way to relocate stranded fish back to areas that are connected to the lower bypass reach under leakage flow conditions.

- Provisions for scheduling Project maintenance requiring powerhouse outage during times of the year to reduce potential adverse effects of disruption of powerhouse discharge.

No additional protection, minimization, or mitigation efforts are proposed by Appalachian for the protection of fishery and aquatic resources, as the results of studies presented in this FLA indicate that the New River within the Project Boundary continues to support a balanced and indigenous aquatic biological community characterized by a diversity of game and non-game fishes, and the presence of an abundant and diverse benthic macroinvertebrate community, including mussels and crayfish.

E.9.3.2 PM&E Measures Proposed by Others

The sections below provide a summary of preliminary PM&E recommendations made by USFWS and VDWR and Appalachian's response. Appalachian will provide additional information in response to comments received on the USR (see Appalachian letter to FERC dated February 14, 2022) in the revised Bypass Reach Flow and Aquatic Habitat Study Report and the revised Aquatic Resources Study Report that will be filed as supplemental information by April 14, 2022. Based on informal consultation discussions with the agencies since the USR Meeting, Appalachian also expects that USFWS and VDWR will provide refined PM&E recommendations in response to the FLA and revised study reports through the post-filing phase of this ILP.

E.9.3.2.1 Mussels

In comments filed on the DLA dated January 29, 2021, the USFWS stated that additional PM&E measures should be proposed in the FLA for the protection of mussels. USFWS further noted that the final Species Status Assessment Report for Green Floater and listing determination expected for release in 2022 could help shape additional conservation measures needed for the species. Fish host species required for the species to successfully reproduce should be considered and protected, especially with new research on possible host fish for green floater and differing reproductive strategies. Fish hosts for the state listed mussels Pistolgrip and Tennessee heelsplitter should also be considered for focus and protection measures. Minimization of turbine impacts to fish hosts should be included in the FLA.

Appalachian disagrees with the USFWS that additional PM&E measures are needed to protect fish species, including those identified as potential mussel glochidial hosts. Findings of the desktop entrainment study concur with the historical entrainment study completed for the prior relicensing in that effects to the fish community in the Project vicinity are expected to be minimal. Most larval fish and eggs would not be excluded by the intake trashracks at Byllesby and Buck intake structures; however, velocities in front of the intakes are comparable to normal flow conditions of the New River and would therefore likely be navigable by most juvenile and adult fish in the area. Entrainment of early life stage fishes (eggs and larvae) is likely minimal given the life history characteristics of species in the vicinity of the Project. Susceptibility to entrainment is variable depending on species and time period, however most target species and species groups have low entrainment potential for most of the year. Further, the low head design coupled with the spillway apron design indicate that fish that do pass through the turbines or over the spillway would exhibit relatively high survival.

E.9.3.2.2 Flows to the Bypass Reaches

Byllesby Development

In their comments filed on the DLA on December 30, 2021, the USFWS recommended that Appalachian prioritize excess flow releases through Obermeyer gates near the right descending bank in order to prioritize release of excess flow into the thalweg portion of the bypass reach. USFWS stated that release from this location would mimic natural flow conditions and reduce stranding potential in adjacent areas. As an alternative to these actions, the Service recommended considering an increase in the minimum flow to the bypass reach that will maintain pool connectivity.

In comments filed in response to the USR on January 18, 2022, the USFWS provided a preliminary minimum bypass reach flow recommendation for the Byllesby Development of 88 cfs (i.e., one of the four calibration flows presented in the USR). USFWS stated the intent of this flow recommendation is to prioritize spawning habitat for the endemic bigmouth chub and habitat for all life stages of the New River shiner. USFWS further stated that a minimum flow of 88 cfs represents 3.9 percent of the annual mean inflow to the Project and that they believe this recommended flow provides enough habitat benefits to justify the tradeoff in slightly reduced powerhouse generation flows to the areas beneath the powerhouse (i.e., tailrace, cross-over channel and side channel). According to USFWS, the results of the relicensing study indicate a significant increase in habitat suitability for the generic shallow-slow guild with coarse substrate (represented by the spawning life stage of the redbreast sunfish) in the lower Byllesby bypass reach, especially in the thalweg, under 88 cfs. USFWS acknowledged that they were provided sufficient opportunity to influence the list of species to be evaluated in this study, but that “a thorough evaluation of all possible benefits to aquatic organisms would be well beyond the practicable scope of the study.” As justification for a minimum flow recommendation of 88 cfs, USFWS

states that alternative, generic methodologies to the Bypass Reach Flow and Aquatic Habitat Study (e.g., the Nature Conservancy's Indicators of Hydrologic Alteration) support a minimum flow to the Byllesby bypass reach that is greater than the leakage flow observed during the study, which USFWS calculated to equate to approximately 0.5 percent of the annual mean inflow to the Project.

Appalachian notes that it is not operationally feasible to provide a stable minimum flow release through the Obermeyer gates, because releases through the Obermeyer gate sections pull from the top of the reservoir and will vary significantly with changes in the reservoir surface elevation.

The New River below the Byllesby Development already supports a healthy fishery. Appalachian does not believe that providing a continuous or seasonal minimum flow release at any location at Byllesby Dam will result in appreciable habitat gains for aquatic species of management interest to sufficiently justify the costs of implementing this measure (see discussion in Section E.15.3). Additional analysis supporting Appalachian's conclusion will be provided in the revised Bypass Reach Flow and Aquatic Habitat Study Report, which is planned for filing as supplemental information by April 14, 2022.

Buck Development

In their comments filed on the DLA on December 30, 2021, the USFWS recommended that Appalachian consider replacing flashboard gates near the left descending bank of the Buck bypass reach with Obermeyer gates in order to allow Appalachian to prioritize excess flow releases into the thalweg portion of the bypass reach. Both of these actions would mimic natural flow conditions and reduce stranding potential in adjacent areas. As an alternative to these actions, the Service recommended considering an increase in the minimum flow to the bypass reach that will maintain pool connectivity.

Appalachian does not agree with the USFWS's recommendation, because, as discussed in Section E.9.2.2.3, fish stranding appears to be an infrequent occurrence in the area of interest in the Buck bypass reach and it is not operationally feasible or beneficial to modify the Project to change spillway gate operations in the manner recommended by USFWS.

Appalachian modeled flow releases to the bypass reach from two different locations (i.e., Tainter Gate 1 and Obermeyer Gate 10) and determined that differences in depths and flow patterns were isolated to the area immediately downstream from the two flow release locations and did not affect depths or flow patterns along the main flow pathway in the upper bypass reach or in the side channel area along the left descending bank. Further, model results indicated that at least five spillway gates must be opened at the same time to affect water surface elevations in the isolated pools along the toe of the main spillway immediately below the flashboard sections. The exceedance probability for Project

inflows that would result in at least five spillway gates open is less than 1 percent of the time. Therefore, the potential for fish stranding in this far left channel is minimal and would only occur during extremely high Project inflow events and/or during flashboard failure events which would release flows into this far left channel area and potentially carry fish over the Buck spillway into the bypass channel or provide enough depth to allow fish to swim up into this area. With the recent installation of four new Obermeyer gates, the capacity of the spillway structure has increased by approximately 12,000 cfs, further reducing the likelihood of flashboard failures due to high Project inflow events.

Appalachian believes that due the length of the spillway, including the distance between the Obermeyer gate section and the flashboards closes to the left descending bank, and lack of readily available power supply and laydown area near the left abutment, it is not practical or cost-effective to replace flashboard sections in this area with Obermeyer gates. With respect to managing debris at and below the dam, it is also not desirable to significantly modify Project operations during high flows to prioritize spill to the left bank. Prioritizing flood releases to the left descending bank would be expected to increase incidents of stranding, given that it is not feasible to provide a minimum flow release for an extended period of time following flood operations over an Obermeyer gate. This is because releases through the Obermeyer gate sections pull from the top of the reservoir and will vary significantly with changes in the reservoir surface elevation.

In comments filed in response to the USR on January 18, 2022, the USFWS provided a preliminary minimum bypass reach flow recommendation for the Buck Development of 354 cfs (i.e., one of the four calibration flows presented in the USR). USFWS stated the habitat benefits of this (or a similar, modified seasonal) flow recommendation extend to the following: adult and spawning Bigmouth Chub, the endemic New River Shiner, the endemic Appalachia Darter (outside of its spawning season), and Walleye (fry, juvenile, and spawning stages).

While not yet a specific PM&E recommendation, in comments filed in response to the USR on January 18, 2022, VDWR stated that they agree with the USFW's evaluation of the interpretation of Buck bypass reach model results for the Walleye spawning stage in that the most suitable [walleye] habitat is provided under the highest model calibration flow release scenario (714 cfs). VDWR further stated that Walleye spawning requires attractant flows and suitable spawning substrate, and that creating suitable spawning conditions for the New River strain Walleye strain is a high priority for VDWR, as outlined in the New River Walleye Management Plan. VDWR added comments that the Buck bypass reach was formerly fully functioning riverine habitat that provided Walleye spawning habitat, so its potential importance to the New River Walleye population should be an important consideration in managing bypass reach flows.

Appalachian does not believe that providing a continuous or seasonal minimum flow release at any location at Buck Dam will result in habitat gains for aquatic species of management interest to sufficiently justify the costs of implementing this measure (see discussion in Section E.15.3.). Appalachian notes that it is not presently operationally feasible to provide a continuous stable minimum flow release through the Obermeyer gates, because releases through the Obermeyer gate sections pull from the top of the reservoir and will vary significantly with changes in the reservoir surface elevation. Nor is this type of continuous minimum flow release feasible through a Tainter gate, which was not designed to be opened indefinitely or at low opening heights. Operation of the spillway in this manner could accelerate deterioration of the gate structure or components. The New River below the Buck Development already supports a healthy fishery, and the species listed by the agencies as incrementally benefiting from habitat gains in the bypass reach are not habitat-limited in the New River or Project vicinity. Providing continuous minimum flow to the Buck bypass reach may also create an attraction by species to suboptimal habitat, and habitat that is subject to scour during periodic flood flow releases at the spillway. Additional analysis supporting Appalachian's conclusion will be provided in the revised Bypass Reach Flow and Aquatic Habitat Study Report, which is planned for filing as supplemental information by April 14, 2022.

E.9.3.2.3 Fish Entrainment

In their comments filed on the DLA on December 30, 2021, USFWS recommended that the Applicant consider more fish-friendly turbines (e.g., Natel Restoration Turbine; Voith) to replace Byllesby Units 1, 2 and 4, and Buck Units 1 and 3. USFWS noted that although the proposed new turbines (i.e., Mavel KV2650K5 Kaplan turbines, with 5 blades each, and a rotation speed of 189.47 rpm) would be less hazardous than the Francis turbines they will replace, they do not appear to be the best technology available for preventing a significant level of injuries and mortality to fish that pass through the powerhouses, based on the results of the Turbine Blade Strike Analyses conducted by Appalachian. Appalachian does not agree with the USFWS's recommendation and is not proposing to modify the upgrade proposal for the Project to utilize a different turbine technology. The proposed Kaplan turbines would improve prevention of significant injuries and mortality of entrained fish and represent what Appalachian believes to be the optimal design for the Project for balancing energy generation and cost. Appalachian expects that the Voith design (i.e., minimum gaps at hub and blade tips) would result in an installed cost of at least twice what is presently estimated for the proposed upgraded units. Appalachian does not believe that the Natel technology is technically viable or practical for the Project, as the size of the turbines for the Project powerhouses is outside of the published range from this manufacturer.

E.10 Wetlands, Riparian, and Littoral Habitat

E.10.1 Affected Environment

E.10.1.1 Overview

Wetland, riparian, and littoral habitats within the study area are associated with the near-shore areas of the impoundments. Wetlands are generally defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support vegetation typically adapted for life in saturate soil conditions. The USACE and VDEQ have jurisdiction over wetlands in Virginia.

The littoral zone, in the context of a large river system, is the habitat between about a half-meter of depth and the depth of light penetration (Wetzel 1975). The littoral width varies based on the geomorphology and rate of sedimentation of the stretch of river (Wetzel 1983).

Riparian habitats are areas that support vegetation found along waterways such as lakes, reservoirs, rivers, and streams. The boundary of the riparian area and the adjoining uplands is gradual and not always well defined. However, riparian areas differ from the uplands because of their high levels of soil moisture, frequency of flooding, ability to provide important ecosystem functions, and unique assemblage of plant and animal communities (Virginia State University 2000; Mitsch and Gosselink 2000). Riparian habitat in the Project area is dominated by hardwood forest. Small areas of open field or cleared areas are present along parts of the western and eastern shorelines of the New River, including electric transmission corridors in the vicinity of the Project.

E.10.1.2 Existing Data and Previous Studies

E.10.1.2.1 Wetlands, Riparian, and Littoral Zone

Wetland, riparian, and littoral habitats within the Project Boundary are associated with the margin and near-shore areas of the impoundments. The USFWS National Wetlands Inventory (NWI) data and digital orthophotography of the Project area identifies the vegetated wetlands within the Project Boundary as consisting of areas of aquatic beds in the impoundment, palustrine emergent wetlands along the edge of the river channel and palustrine forested wetlands along the upper New River (see Section E.10.2.1 for NWI wetlands and field verified wetlands identified as party of the study effort for the relicensing effort). Sediment deposition in the backwater areas of the project reservoirs has created sites suitable for wetland vegetation bordering both impoundments (Appalachian 1991a). Additional wetlands are also created by sediment deposition at other areas, such as a small area approximately 100 yards upstream of the gated spillway dam at the Buck Development. The Byllesby wetland (Figure

E.10.1) is an approximately 6-acre emergent wetland, created as mitigation for sediment removal conducted at the Project in 1997. This wetland is located approximately 500 ft upstream of the Byllesby Dam. Wetland vegetation at this location is at an elevation higher than the normal reservoir operating level.

Figure E.10.1. Representative Photograph of Byllesby Wetland (Photo from 2007)

The species composition of the approximately 6-acre wetland was documented through transect monitoring of this wetland from 2004 to 2007. The dominant species observed at this wetland in 2007 are listed in Table E.10-1. Species noted with an "*" were also noted as present (at the genus level) at wetlands within the larger Project Boundary during the 1990 survey conducted by Appalachian (Appalachian 1991a). Additional emergent wetland vegetation observed during the 1990 survey included water plantain (*Alisma* sp.), swamp milkweed (*Asclepia incarnata),* red willow dogwood *(Cornum amomum*), Joe-pye-weed (*Eupatorim* sp.), witch hazel (*Hamamelis virginia*), cardinal flower (*Lobelia cardinalis*), monkey flower (*Mimulus* sp.*)*, green cone flower (*Rudbeckia* sp.), black willow, cord grass (*Spartina* sp.), and vervain (*Verbena* sp.).

Table E.10-1. 2007 Byllesby Wetland Vegetation Survey Species List

Common Name	Scientific Name	Indicator Status[1]
False nettle (bog hemp)	*Boehmeria cylindrica*	FACW+
Rough (or American) barnyard grass	*Echinochloa muricata*	FACW+
Orange (or common or spotted) jewelweed or touch-me-not	*Impatiens capensis**	FACW
Common (or soft) rush	*Juncus effuses**	FACW+
Cut-grass	*Leersia oryzoides*	OBL
Reed canary grass	*Phalaris arundinacea*	FACW+
Dotted smartweed (or knotweed)	*Polygonum punctatum**	OBL
American (or arrowleaf) tearthumb	*Polygonum sagittatum**	OBL
Broadleaf arrowhead	*Sagittaria latifolia**	OBL
Woolgrass	*Scirpus cyperinus**	FACW+
Bur-reed	*Sparganium* spp.	OBL
Woolgrass	*Typha latifolia**	OBL
Wingstem	*Verbesina alternifolia*	FAC

[1] obligate wetland (OBL), facultative wetland (FACW), facultative (FAC).

The riparian zone serves as the primary interface between riverine and upland habitats, influencing both the primary productivity and food resources within the river. The majority of riparian habitat within the Project Boundary is located within the Deciduous Forest, Mixed Forest, and Developed, Low-Intensity cover types. Lands associated with the Byllesby Development includes silver maple, black willow, and sycamore with understory riparian herbaceous species (Appalachian 1991a). Littoral habitat is an important feature within aquatic systems, particularly for fish and other aquatic wildlife in the area. Refer to Section E.10.2.1 for details on littoral and riparian zones in the study area.

E.10.1.2.2 Invasive Plant Species

There are close to 100 invasive plant species in Virginia (VDCR 2014). Hydrilla (*Hydrilla verticillata*), curly-leaf pondweed (*Potamogeton crispus*), and brittle naiad (*Najas minor*) have been previously documented in the New River in Claytor Lake (Normandeau 2008). Hydrilla is a perennial herb that is found in a variety of aquatic environments. It spreads through dispersal of plant fragments. It grows aggressively and spreads through shallower areas forming thick mats in surface waters, which block sunlight to native plants below. This species has been shown to displace native vegetation and significantly alters the physical and chemical characteristics of waterbodies. In Virginia, it was first reported in 1982 in the Potomac River and is now present in waters throughout the state. Triploid

Grass Carp (*Ctenopharyngodon idella)* have been stocked in the upper New River by VDWR to control Hydrilla in Claytor Lake with great success (Weberg et al. 2015). An aquatic plant community study was conducted in 2012 on the reach of the upper New River between Buck Dam and the head of Claytor Lake to evaluate the success of the Grass Carp stockings. The reach was visually surveyed from canoe, utilizing a double-sided rake attached to a rope to monitor for plant presence in deeper pool sections. To gauge the occurrence and abundance of aquatic-plant species, a single 5-minute drift-net sample using a seine was done every 5 river kilometers. Drift samples were also collected by wading into the river at each sampling site. The study resulted in identification of 13 macrophyte species, including one Virginia-listed aquatic invasive plant, curly-leaf pondweed, discussed in further detail below. No hydrilla was observed in the 2012 survey (Weberg et al 2015).

Curly-leaf pondweed grows entirely as a submersed aquatic plant with no floating leaves. It can survive and grow at very low light levels and low water temperatures (USGS 2016). As a result, it often thrives in polluted waters with low light penetration. It can survive under the ice throughout the winter and exhibit rapid growth in the spring when water temperatures rise above 10°C. It can outcompete native species for light and space early in the growing season, which can reduce plant diversity and alter predator/prey relationships. Large infestations can impede water flow and cause stagnant water conditions (USGS 2016).

Brittle naiad is an annual submersed rooted or floating plant. It prefers stagnant or slow-moving waters such as ponds, lakes, reservoirs, and canals. It can grow in depths of up to four meters and is tolerant of turbidity and eutrophic conditions. It reproduces by fragmentation and by one-seeded fruits. It starts growing early in the season and blocks sunlight from native species, thereby inhibiting their growth. It can also form dense underwater meshes, which can produce unfavorable conditions for aquatic organisms (NOAA 2017).

E.10.1.2.3 Federally Protected Species

The riparian plant *Spiraea virginiana* (Virginia spiraea), which is federally listed as threatened, has potentially occurred upstream of the Byllesby Dam historically, however, there has been no documentation or verification of its presence or exact location. A detailed habitat assessment in the vicinity of the Project was conducted for Appalachian (ESI 2017a) in April 2017 and submitted to USFWS and VDCR in July 2017 as part of a habitat assessment for Virginia spiraea in support of the license amendment application for installation of the inflatable Obermeyer crest gates. The survey area was evaluated via a combination of desktop assessment, field-based habitat assessments, and presence/absence surveys within identified suitable habitat and encompassed approximately 12 miles along the New River between Fries Dam and the portion of the New River just downstream of Buck

Dam. The survey area also included tributaries along this span, where suitable Virginia spiraea habitat was identified. A total of 102 separate habitat patches were delineated within the survey area.

The majority (84) of the habitat patches delineated during the ESI (2017a) habitat assessment did not contain any habitat suitable to support Virginia spiraea. Ten patches were found to provide low-suitability habitat, and eight patches were found to provide moderate-suitability habitat. No instances of Virginia spiraea were observed in any of these potential suitable habitat patches.

E.10.1.2.4 Wetlands and Riparian Wildlife

Information on specific wildlife known to occur in wetland and riparian habitats in the Project vicinity is included in Appendix E (Terrestrial Resources Study Report) in Volume II of this FLA.

E.10.2 Environmental Analysis

E.10.2.1 Studies in Support of the Current Relicensing

In support of the current relicensing, Appalachian completed a Wetlands, Riparian, and Littoral Habitat Characterization Study in 2021. A summary of the methods and results of the Wetlands, Riparian, and Littoral Habitat Characterization Study is provided in this section and details are provided in Appendix E, Volume II of this FLA. The goal of the Wetlands, Riparian, and Littoral Habitat Characterization Study was to identify and characterize the existing wetlands, waterbodies, and riparian and littoral vegetative habitats (including emergent and submerged aquatic vegetation beds) in the study area. Specific study goals and objectives include the following:

- Perform a desktop characterization using the USFWS (2019a) NWI, the Wetland Condition Assessment Tool (WetCAT) (VDEQ 2021), and other resources such as GIS-based topographic maps, hydrography, aerial imagery, and soil surveys to identify and describe, approximate, and classify wetlands and waterbodies (i.e., streams, creeks, rivers) within the study area (including upland, littoral, and riparian zones);
- Perform a field verification survey to confirm the location, dominant vegetative community, and vegetation classification identified in the previous desktop survey;
- The field verification will include identification of littoral and instream vegetation in the study area to characterize the availability of littoral, submerged, and emergent vegetative habitat;
- Using the results of the desktop characterization and field verification, develop a GIS-based map identifying wetlands, waterbodies, and riparian, littoral, and instream vegetative community composition according to the Cowardin Classification System (Cowardin et al. 1979);

- Riparian communities will be classified according to the VDCR (2021) Natural Communities of Virginia of Ecological Groups and Community Types Third Approximation (Version 3.3); and
- Using the results of the desktop and field verification efforts, evaluate the potential for Project effects on wetlands, riparian, and littoral habitat in the study area.

E.10.2.2 Methods

E.10.2.2.1 Wetlands and Streams

The Wetlands, Riparian, and Littoral Habitat Characterization study was carried out as a desktop analysis followed by field verification of streams and wetlands within the study area. For the purposes of this study, the riparian zone was defined as terrestrial areas 100 feet from the shoreline (VDCR 2006) or to the study area boundary, whichever is closer. The littoral zone was defined as the shallow shoreline area of the New River from the stream bank down to the maximum depth of light penetration in the water column and also includes instream emergent and/or submerged aquatic vegetation beds. Information sources included the USFWS NWI (NWI 2019a), the VDEQ WetCAT (VDEQ 2021), USGS topographic maps and National Hydrography Dataset, elevation data, high-resolution orthoimagery, and Natural Resources Conservation soil surveys. WetCAT query results were used to score wetland types based on the habitat and water quality stressors associated with surrounding land use types; classifications include slightly stressed, somewhat stressed, somewhat severely stressed, and severely stressed. Data collected during the desktop survey were used to create preliminary habitat characterization maps that was used to facilitate the field verification efforts.

Potential streams and wetland areas not confirmed previously (i.e., through prior licensing studies or other sources) were field-verified by HDR Engineering, Inc (HDR) wetland scientists between July 20-22, 2021. A visual assessment and field evaluation of wetland hydrology, hydrophytic vegetation, and hydric soils was performed to identify wetlands. Wetland cover types were classified according to dominance by trees (palustrine forested), shrub species (palustrine scrub-shrub) herbaceous species (palustrine emergent), and rocky bottom (palustrine rocky bottom). Ordinary high water mark indicators including bed and banks, change in sediment texture, deposition, shelving, and change in vegetation were identified in the field to assess the presence of non-wetland waterbodies and streams. Wetland areas and streams identified in the desktop study were field-verified, but not formally delineated (i.e., no flagging or boundary marking).

E.10.2.2.2 Littoral Habitat

The four main categories of aquatic plants include algae, emergent aquatic vegetation, submerged aquatic vegetation, and floating plants. Transect-based surveys were performed to characterize the availability of littoral zone aquatic habitats within the study area. Seven transect lines were evaluated

in each of the Project reservoirs and four additional transect lines were evaluated in the tailrace and bypass portions downstream of the Byllesby and Buck dams. In the reservoirs, transects were oriented parallel to the shoreline in boat accessible areas, with transects distributed to represent both shorelines. In the tailrace and bypass reaches of the river, transects were oriented perpendicular to the shoreline to include littoral zones along the stream margins and potential instream shallows where emergent or submerged vegetation may occur.

Each transect line was 100 meters in length and 1.0-m^2 areas (i.e., quadrants) spaced equally along the transect line at 10-meter intervals were surveyed. For two of the eleven transects (littoral zones 10 and 11), four quadrants were sampled along the transect. The survey at each of the intervals consisted of a visual presence/absence assessment for emergent or visible submerged aquatic vegetation. A vegetation sampling throw rake was also deployed at each sample area on transect lines (when feasible) to capture any non-visible submerged aquatic vegetation. The location and scientific name of each vegetation sample were recorded during the survey.

E.10.2.2.3 Riparian Habitat

Data from the desktop review were used to perform the riparian habitat field verification. To facilitate the field verification of the preliminary vegetative cover maps, the riparian habitat within each vegetative community type was characterized by recording the dominant species of vegetation at three strata (tree, sapling/shrub, and herb). HDR biologists used relevant reference materials including regional field guides and plant identification mobile apps to identify plants to genus and species level.

E.10.2.3 Results

E.10.2.3.1 Wetlands

A total of 95.43 acres of wetlands were field verified July 20-22, 2021. There were 50.72 acres of palustrine emergent wetlands, 11.6 acres of palustrine scrub shrub, 15.37 acres of palustrine forested, and 17.74 of rock bottom wetlands. The USFWS NWI estimated approximately 9.8 acres of wetlands (freshwater forested/shrub and emergent). Table E.10-2 provides information of individual wetlands found in the study area. The VDEQ (2021) WetCAT results indicated that there were no stressed areas of wetlands in the study area.

A total of 15,608.42 linear feet of riverine features were field verified along with the wetlands. There were 514.9 linear feet of perennial stream habitat and 501 linear feet of intermittent stream habitat. Table E.10-3 provides information describing streams in the study area.

Wetland cover types were classified according to Cowardin et. al (1979) which included palustrine (emergent, scrub-shrub, forested, and rock bottom) and riverine systems. These wetland and waterbody features were verified in the field; representative photographs are included in Appendix D of Volume II of the FLA. Locations of wetlands are provided in Figure E.10.2, Figure E.10.3, and Figure E.10.4.

Palustrine emergent wetlands comprise the majority of the wetlands within the study area and occur primarily as fringe wetlands and floodplain wetlands along the shorelines of the New River and Crooked Creek, as well as on islands within the New River. The largest area of palustrine emergent wetland occurs upstream of the Byllesby Dam near the canoe portage take-out where herbaceous strata is dominant and includes Japanese stilt grass (*Microstegium viminium*), soft rush (*juncus effusus*), canary reed grass (*Phalaris arundinacea*), deer tongue grass (*Dichanthelium clandestinum*), cattails (*Typha sp*.), falsenettle (*Boehmeria cylindrica*), bulrush (*Scirpoides holoschoenus*), and woolgrass (*Scirpus cyperinus*).

Palustrine forested wetlands within the Study Area occur primarily on the higher floodplains and point bars of the New River. The dominant vegetation in these wetlands included American sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), red maple (*Acer rubrum*), black walnut (*Juglans nigra),* and silver maple (*Acer saccharinum*)*.* The majority of understory included Japanese stilt grass, reed canary grass (*Phalaris arundinacea*), falsenettle, highbush blackberry (*Rubus argutus*) and smart weed.

Palustrine scrub-shrub wetlands within the study area occur primarily in the floodplain of the New River at an elevation higher than most of the emergent wetlands but lower than the forested wetlands where frequent inundation could occur. Most of this cover type occurs adjacent to emergent wetlands. The shrub vegetation consisted of American sycamore, box elder, and silver maple. The herbaceous vegetation included canary reed, grass, deer tongue, falsenettle, and soft rush.

Palustrine rock bottom wetlands are seasonally flooded to intermittently exposed trees, shrubs, and herbaceous vegetation on boulder and cobble deposition bars, or less frequently bedrock exposures, on the shores and islands of high-gradient streams. In the study area, these occur primarily within the Byllesby and Buck bypass reaches. The dominant tree vegetation in these types of wetlands include American sycamore, alder (*Alnus* sp.), and willow (*Salix* sp.). The dominant herbaceous vegetation includes spike rush (*Eleocharis palustris*), cattails, asters, smart weed (*Persicaria pensylvanica*), and water willow (*Justicia americana*).

Riverine habitats in the study area include the New River and associated tributaries. The New River is a lower perennial riverine feature on the upstream and downstream limits of the study area. There are several perennial tributaries that flow into the New River including Chestnut Creek, Crooked Creek, Rocky Branch, Poor Branch, Big Branch, and Brush Creek along with eight unnamed tributaries. In general, these perennial riverine habitats included several areas of scour with dominant vegetation consisting of American sycamore, boxelder, cattails, and reed canary grass.

Table E.10-2. Field Verified Wetlands in Study Area

Wetland Number	Coordinates (decimal degrees)	Cowardin et al. (1979) Classification[1]	Estimated Acres
Wetland 1	36.759009 -80.960207	PEM	0.03
Wetland 2	36.759746 -80.960682	PEM	0.02
Wetland 3	36.761681 -80.955008	PEM	0.07
Wetland 4	36.763144 -80.954669	PEM	0.09
Wetland 5	36.764569 -80.956177	PFO	8.57
Wetland 6	36.768343 -80.955143	PEM	0.02
Wetland 7	36.770779 -80.944087	PSS	8.39
Wetland 7	36.770905 -80.943297	PEM	0.42
Wetland 8	36.782522 -80.933081	PEM	17.26
Wetland 9	36.785501 -80.934788	PEM	0.38
Wetland 10	36.785902 -80.93497	PEM	0.19
Wetland 11	36.785897 -80.935283	PEM	0.21
Wetland 12	36.789201 -80.93654	PFO	0.47
Wetland 13	36.790216 -80.934183	PEM	0.15
Wetland 14	36.793727 -80.928082	PEM	0.13
Wetland 15	36.805674 -80.929075	PEM	6.64
Wetland 15	36.805831 -80.926859	PSS	2.94

Wetland Number	Coordinates (decimal degrees)	Cowardin et al. (1979) Classification[1]	Estimated Acres
Wetland 16	36.805453 -80.933384	PRB	1.78
Wetland 17	36.805803 -80.935885	PRB	0.87
Wetland 18	36.804308 -80.937275	PRB	0.79
Wetland 19	36.805006 -80.938208	PRB	1.14
Wetland 20	36.807444 -80.94027	PRB	11.96
Wetland 21	36.807124 -80.935493	PEM	0.51
Wetland 22	36.817095 -80.946182	PEM	0.33
Wetland 23	36.815291 -80.945638	PEM	0.14
Wetland 24	36.81447 -80.943847	PFO	2.3
Wetland 25	36.813258 -80.942915	PFO	0.1
Wetland 26	36.81205 -80.942162	PFO	0.18
Wetland 27	36.811552 -80.94188	PFO	0.05
Wetland 28	36.810265 -80.940278	PFO	0.98
Wetland 29	36.802149 -80.916507	PSS	0.13
Wetland 30	36.793097 -80.921259	PEM	0.05
Wetland 31	36.792198 -80.925934	PEM	0.03
Wetland 32	36.7889 -80.932528	PRB	1.2
Wetland 33	36.789763 -80.932072	PFO	0.74
Wetland 34	36.776203 -80.930155	PEM	1.52
Wetland 35	36.774089 -80.925964	PEM	1.16
Wetland 36	36.771005 -80.921339	PEM	1.68
Wetland 37	36.769382 -80.918157	PEM	0.05

Wetland Number	Coordinates (decimal degrees)	Cowardin et al. (1979) Classification[1]	Estimated Acres
Wetland 38	36.770681 -80.91925	PEM	0.24
Wetland 39	36.772551 -80.920091	PEM	0.09
Wetland 40	36.769917 -80.917954	PEM	0.3
Wetland 41	36.770048 -80.921166	PEM	0.42
Wetland 42	36.772325 -80.92415	PEM	3.16
Wetland 43	36.774715 -80.928032	PEM	1.68
Wetland 44	36.774541 -80.933913	PEM	4.67
Wetland 45	36.772704 -80.93709	PEM	1.8
Wetland 46	36.77106 -80.936989	PSS	0.14
Wetland 47	36.766158 -80.949684	PEM	5.46
Wetland 48	36.766606 -80.951983	PFO	1.98
Wetland 49	36.758734 -80.956248	PEM	1.58
Wetland 50	36.757326 -80.960264	PEM	0.24
		Total	**95.43**

Table E.10-3. Field Verified Wetlands in Study Area

Stream Number	Coordinates (decimal degrees)	Cowardin et al. (1979) Classification[1]	Linear Feet
Stream 1	36.757351 -80.963421	R5UB	4.99
Stream 2	36.757903 -80.963086	R5UB	18.22
Stream 3	36.785697 -80.935238	R5UB	18.3
Stream 4	36.786761 -80.935575	R5UB	11.84
Stream 5	36.79022 -80.936482	R5UB	147.65

Stream Number	Coordinates (decimal degrees)	Cowardin et al. (1979) Classification[1]	Linear Feet
Stream 6	36.805405 -80.923981	R4SB	94.11
Stream 7	36.80526 -80.930796	R4SB	25.25
Stream 8 (Big Branch)	36.809067 -80.943427	R5UB	41.1
Stream 9	36.816282 -80.944068	R5UB	1201.65
Stream 10	36.811017 -80.941006	R4SB	381.97
Stream 11 (Poor Branch)	36.801904 -80.916201	R5UB	24.89
Stream 12 (Rocky Branch)	36.79676 -80.917398	R5UB	27.92
Stream 13	36.771979 -80.93728	R5UB	1428.64
Stream 14	36.764523 -80.956305	R5UB	670.85
Stream 15 (Brush Creek)	36.769003 -80.955318	R5UB	913.21
Stream 16 (Crooked Creek)	36.77046 -80.921317	R5UB	8561.46
Stream 17 (Chestnut Creek)	36.756648 -80.954166	R5UB	2036.37
		Total	**15,608.42**

[1]R4SB: Riverine, Intermittent, streambed.
R5UB: Riverine, Perennial, unconsolidated bottom.

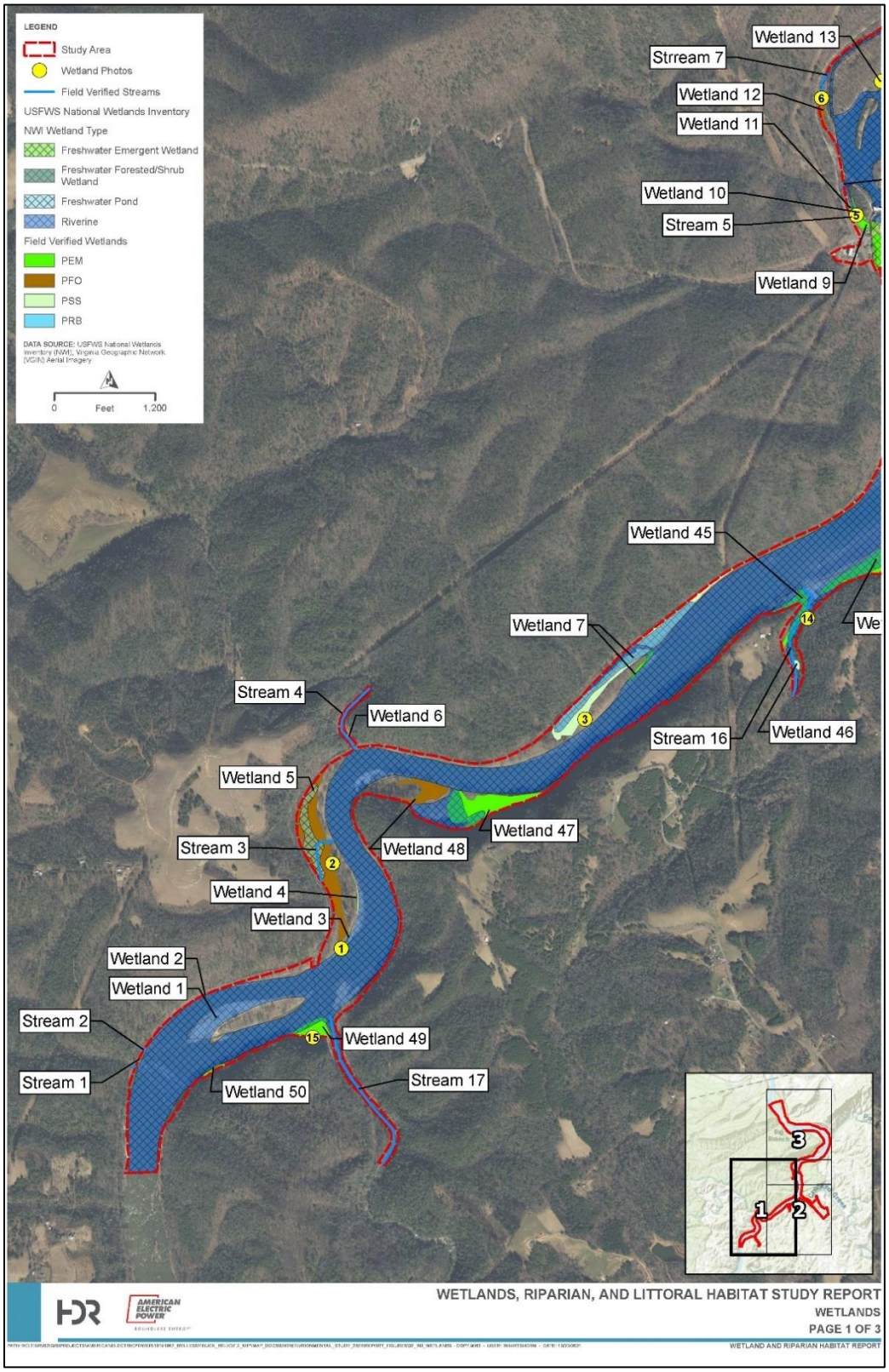


Figure E.10.2. Wetlands in the Vicinity of the Project (Map 1 of 3)

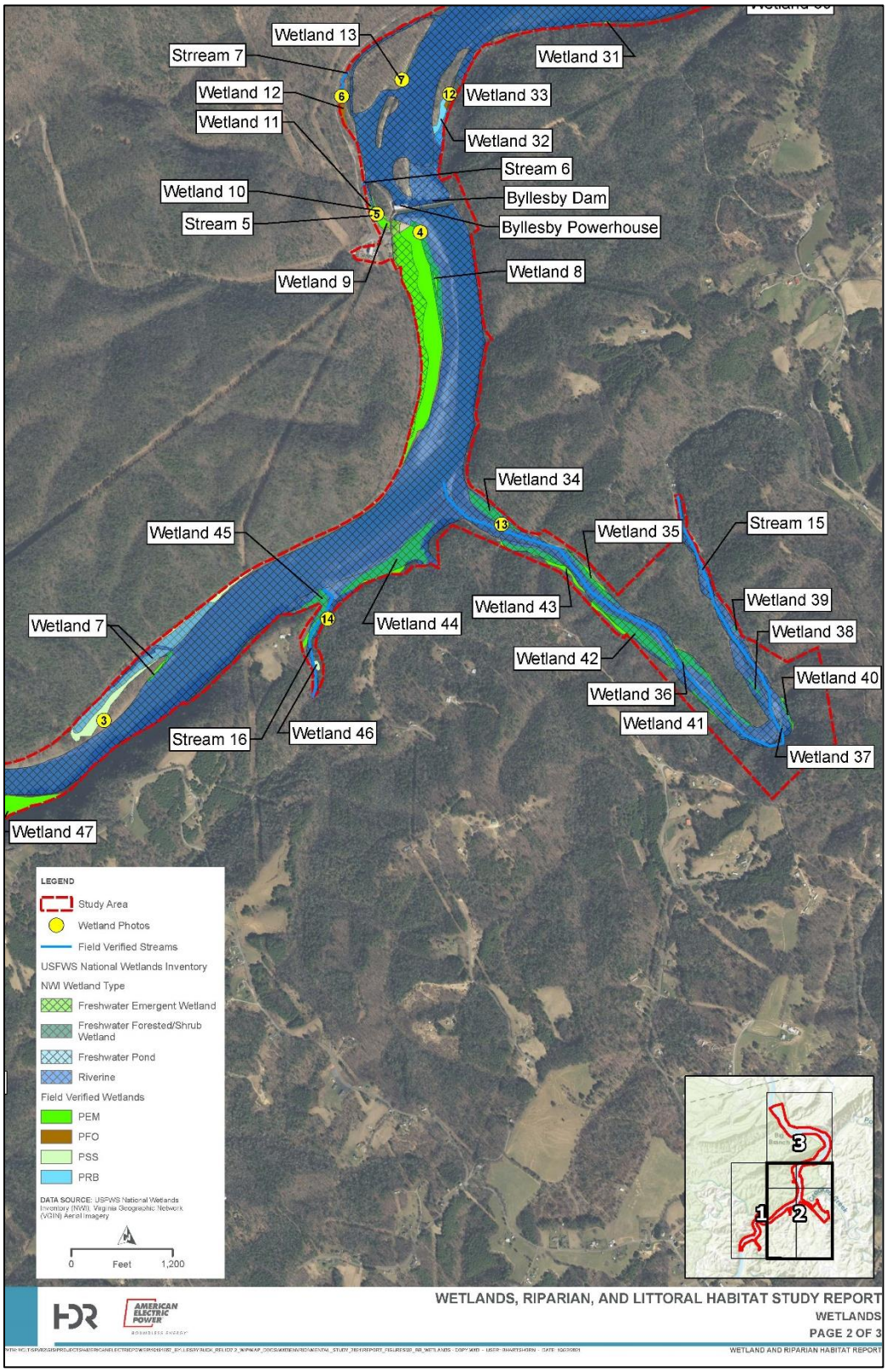


Figure E.10.3. NWI Wetlands in the Vicinity of the Project

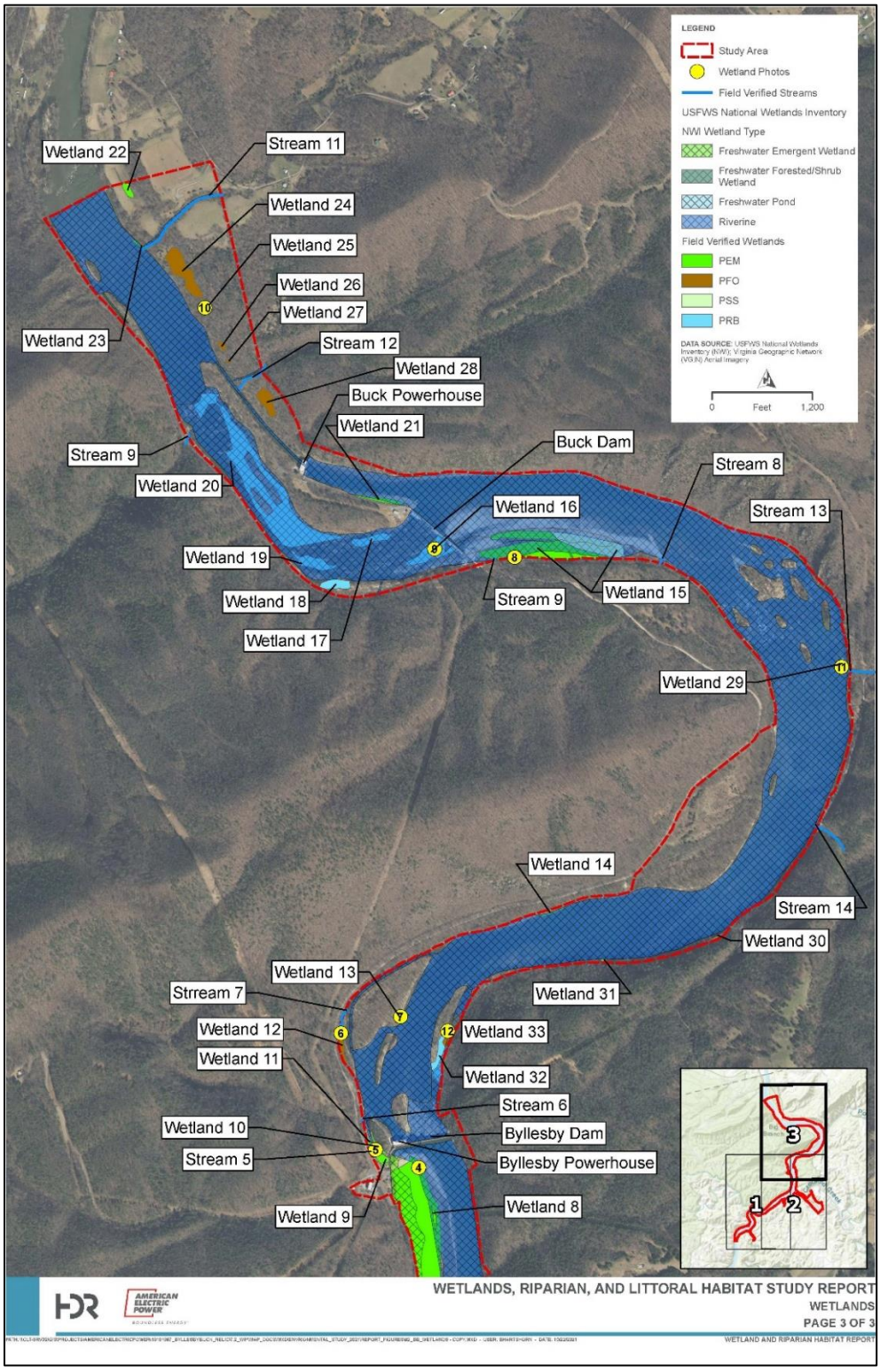


Figure E.10.4. NWI Wetlands in the Vicinity of the Project (Map 3 of 3)

E.10.2.3.2 Littoral Zone

The littoral zone contains seasonally flooded to intermittently exposed herbaceous vegetation along depositional bars on the shores of the reservoirs and within the rock exposures of the bypass reaches. Littoral zone vegetation included *Elodea Spp*, algae, curly pondweed (*Potamogeton crispis*), parrot's feather (*Myriophyllum aquaticum*), broad leaf pondweed (*Potamogeton natans*), smartweed (*Polygonum* sp.) spike rush, bulrush, rice cut grass, soft rush, water willow, shallow sedge (*Carex lurida*), Japanese honeysuckle (*Lonicera japonica*), goldenrod (*Solidago sp*.), Virginia creeper (*Parthenocissus quinquefolia*) and American sycamore. Curly pondweed is considered to be a non-native invasive species. Elodea was the most abundant submerged aquatic vegetation throughout the reach located close to the stream bank adjacent to wetlands. Although present throughout the reach, algae was dominant in the littoral zone upstream from the Byllesby Dam where water flow was slower. In the bypass reaches, Elodea and algae were the dominant aquatic plants. Littoral zone transect results, representative location maps, and photographs of habitat at littoral zone transects are provided in Appendix D, Volume II.

E.10.2.3.3 Riparian zone

The riparian area consists of approximately 177 acres and is mainly found along the shoreline, on islands, and within the bypass reach (Figure E.10.5). The riparian area varies in width from 5 to 520 feet wide. Dominant vegetation in the over story includes black walnut, black cherry (*Prunus serotina*), red maple, Northern red oak (*Quercus rubra*), Eastern red cedar (*Juniperus virginiana*), Virginia pine (*Pinus virginiana*), black willow (*Salix Nigra*), American sycamore, Sugar Maple (*Acer saccharum*), box elder, chestnut oak (*Quercus montana*), green ash (*Fraxinus pennsylvanica*), and white pine (*Pinus strobus*). The understory typically included blackberry *(Rubus argutus*), mountain laurel (*Kalmia latifolia*), and witch hazel (*Hamamelis sp.*). The herbaceous vegetation consisted of Christmas fern (*Polystichum acrostichoides*), mayapple (*Podophyllum peltatum*), wingstem (*Verbesina alternifolia*), bedstraw (*gallium aparine*), muscadine grape (*Vitis rotundifolia*), Virginia creeper (*Parthenocissus quinquefolia*), cinnamon fern (*Osmunda cinnamomea*) and poison ivy (*Toxicodendron radicans*). Japanese knotweed (*Reynoutria japonica*), multiflora rose (*Rosa multiflora*), oriental bittersweet (*Celastrus orbiculatus*), and Tree of Heaven (Ailanthus altissima) which are all considered a non-native invasive species are present in the riparian habitat. Documented occurrences of these non-native invasive species are noted in Appendix E of Volume II of the FLA (Terrestrial Resources Study Report).

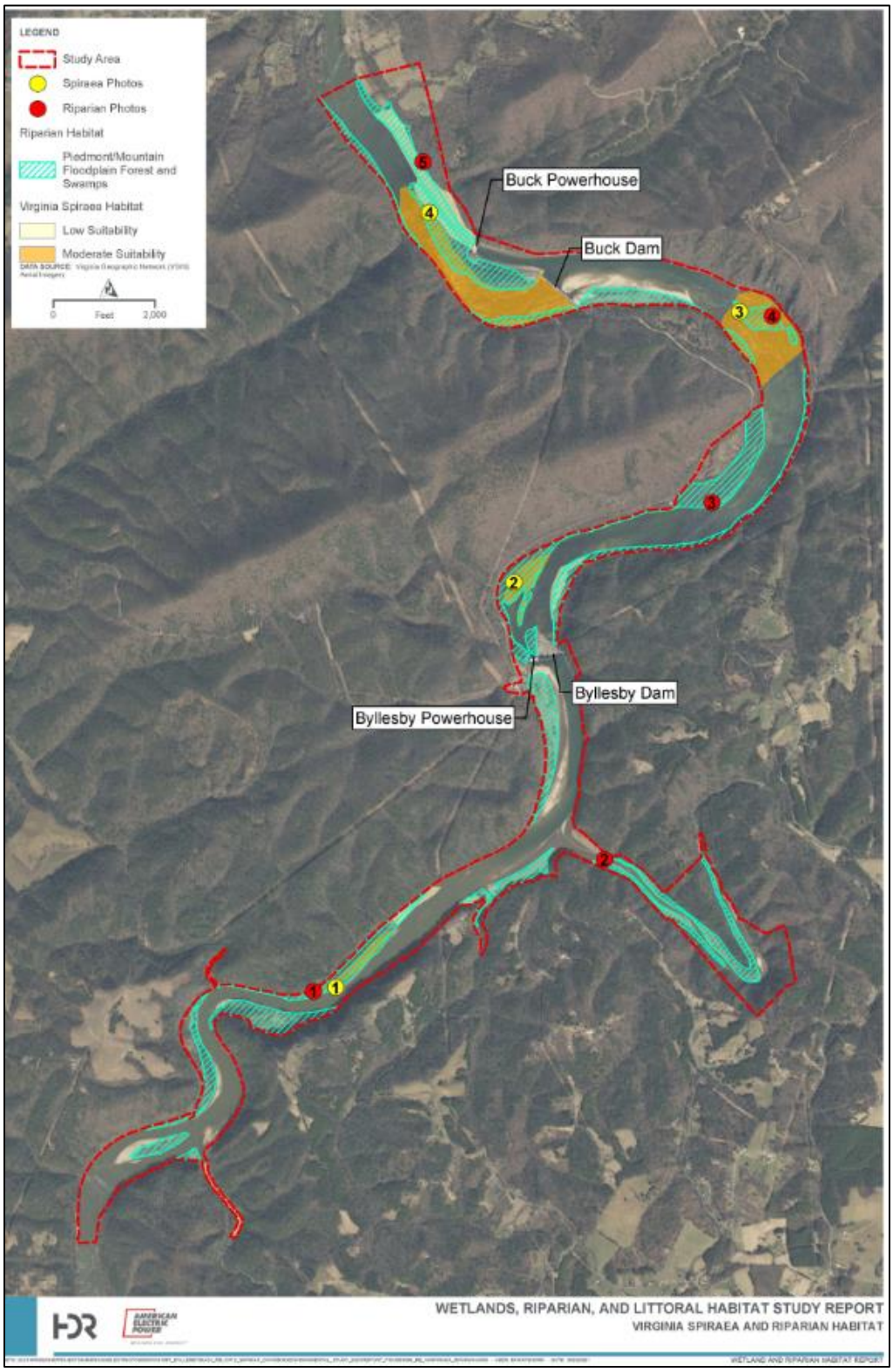


Figure E.10.5. Riparian Habitat and Potential Virginia Spiraea Locations

E.10.2.3.4 Virginia Spiraea Review

There were no observed occurrences of Virginia spiraea in areas identified in the ESI (2017a) survey. However, potentially suitable habitat was observed throughout the study area in rocky, low flow areas of streams, and on portions of bars and benches. Figure E.10.5 shows the location of potential Virginia spiraea habitat in the mapped riparian zones and provides a classification of low suitability or moderate suitability. Photographs of potential Virginia spiraea habitat are included in Appendix D. Additional information on Virginia spiraea is included in Section E.11.1.1.3.

The USFWS has shared with Appalachian that they are currently conducting a 5-year review under the ESA for seven northeastern species, including the Virginia spiraea (55 FR 24241), based on available scientific and commercial data. The completed review will be available in 2024 and will include updated information regarding the biology and life history of Virginia spiraea, historical and current population dynamics, habitat conditions and distribution, and conservation measures and threats.

E.10.2.3.5 Invasive Plant Species

The invasive plant species observed in the study area were Japanese knotweed, multiflora rose, oriental bittersweet, and Tree of Heaven. These species were located along the banks of the New River and several associated tributaries as well as within the floodplain. These results are reflective of the region-wide invasion of these invasive and non-native species in the eastern U.S.

E.10.2.4 Project Impacts on Wetlands, Riparian, and Littoral Habitat

In SD3, FERC staff identified the following resource issue to be evaluated in its NEPA document:

- Effects of continued project operation and maintenance, on riparian and wetland habitat, emergent and submerged aquatic vegetation beds, and associated wildlife.

The wetland types in the study area appeared to reflect the natural community expectations for this location. Periodic drawdowns of the impoundment for Project maintenance have the potential to temporarily dewater wetland, riparian, or littoral areas, though for short-duration drawdowns, soils are likely to remain saturated between inundation periods. Longer-term drawdowns could potentially cause soils in wetland areas to lose saturation, resulting in temporary loss of wetland vegetation. This potential Project impact has been previously studied at the Byllesby wetland. Following completion of maintenance activities at Byllesby Dam in 2005-2006 that required a drawdown of the impoundment by approximately 11 ft, Appalachian conducted monitoring of the plant community in an adjacent wetland that was created by deposition of dredged material in shallow water during 1997, pursuant to a VWP Permit. Monitoring of the plant community was performed each year from 2004 through 2007.

Despite the lower water levels during two growing seasons during this period, no appreciable change in the extent or composition of the wetland plant community occurred.

An additional short-term impact of a long-term reservoir drawdown could include temporary loss of ecological function of the wetlands by reducing the amount of habitat available for aquatic wildlife adapted for these environments. These species may be required to migrate to un-affected adjacent habitats temporarily during drawdown periods.

Sediment accumulation is known to be slowly occurring at locations within and around the impoundments, in some cases leading to the creation of new wetland areas. If such areas interfere with Project operations, there could be a need in the future to dredge such areas, such as was done during 1997 and 2014. Adverse effects of this activity would be addressed through the protections and mitigations required by approvals and permits to be issued by USACE and VDEQ and FERC standard license articles.

The Licensee does not anticipate that operation and maintenance of the Project over the new license term will have any long-term, unavoidable, adverse impacts on wetland, riparian, and littoral resources.

E.10.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Wetland, riparian, and littoral habitats at the Project are reflective of current Project operations. Appalachian proposes to maintain the run-of-river mode of operation for each development and existing measures and programs to protect wildlife habitat. Appalachian does not expect that operation of the Project as presently proposed over the term of the new license to adversely impact wetland, littoral, and riparian habitat, and notes that Appalachian's land rights, and FERC's jurisdiction over, such lands within the Project Boundary provide a level of additional regulatory protection for these resources.

While the existing WMP has provided a general means for qualitatively monitoring land development and general wetland, littoral, and riparian habitat conditions over the term of the existing license, Appalachian does not believe that the process has yielded meaningful information or been necessary to inform decisions or manage lands within the Project Boundary. Appalachian does not propose to continue the WMP during the term of the new license.

From discussions at the USR Meeting, Appalachian understands that USFWS is concerned about the potential impacts of periodic maintenance drawdowns of the Project reservoirs on wetlands and potential habitat for Virginia spiraea. Appalachian notes that this species has not been observed in the Project Boundary, including during past targeted surveys at the Project.

For the continued protection of wetland resources, Appalachian proposes to continue to operate the project in a run-of-river mode, maintaining the Byllesby reservoir between EL. 2,078.2 ft and 2,079.2 ft and the Buck reservoir between EL. 2,002.4 ft and 2,003.4 ft. No additional environmental PM&E measures are presently proposed by Appalachian for the protection or management of wetlands, riparian, and littoral habitat at the Project.

In comments filed on the DLA on December 22, 2021 and comments filed on the USR on January 18, 2022, VDWR recommended that the results of the Wetland, Riparian, and Littoral Habitat Study be used to develop a Wildlife or Wetlands Management Plan in consultation with VDWR to enhance Project wetlands for specific wildlife species, including ways to enhance some of the larger wetlands for waterfowl use. VDWR noted that maintaining wetland resources at the Project to benefit waterfowl and waterfowl hunters would also provide additional recreation enhancement not outlined in the Recreation Study. In comments filed in response to the USR dated January 18, 2022, USFWS provided support for continued consultation with VDWR in developing a Wetland Management Plan. USFWS also stated that impacts to wetland resources, including temporary reservoir drawdowns, should be documented and that persistence of wetland vegetation is only one component of wetland habitat.

Appalachian acknowledges that the wetland areas in the Project Boundary are important wildlife resources for waterfowl and fish and aquatic communities. Appalachian's ownership and control of lands in the Project Boundary, and the run-of-river operation of the Project, provide important protections for wetland, riparian, and littoral habitat within the Project Boundary. The results of the relicensing study do not support a conclusion that the Project operations are adversely affecting wetland, riparian, and littoral habitat at the Project to support PM&E measures for more active management by Appalachian of these resources.

E.11 Rare, Threatened, and Endangered Species

E.11.1 Affected Environment

E.11.1.1 Federally Listed Threatened, Endangered, and Candidate Species

A review of federally listed threatened, endangered, and candidate species using the USFWS IPaC online system was conducted on December 10, 2021 for both the Byllesby and Buck Project boundaries (USFWS 2021c). Based on the IPaC review, a total of four threatened, endangered, or candidate species have the potential to occur within the Project Boundary (Table E.11-1).

Table E.11-1. Federally Listed Species Potentially Occurring within the Project Boundary

Common Name	Scientific Name	Status	Byllesby Development	Buck Development
Indiana bat	*Myotis sodalis*	Endangered	X	X
Northern long-eared bat	*Myotis septentrionalis*	Threatened	X	X
Virginia spiraea	*Spiraea virginiana*	Threatened	X	
Monarch Butterfly	*Danaus plexippus*	Candidate	X	X

Source: USFWS 2021

Additionally, on November 21, 2018, the Candy Darter was listed as endangered under the Endangered Species Act with proposed designated critical habitat, effective December 21, 2018 (USFWS 2018a). Although, watersheds of five tributaries to the New River are listed as Candy Darter critical habitat, the nearest critical habitat to the Project is the Cripple Creek tributary, which confluences with the New River approximately five river miles downstream of Buck Dam. (See also discussion in Section E.9.1.5.1.)

The green floater was included in an April 2010 petition for listing of 404 southeastern aquatic species submitted to the USFWS by the Center for Biological Diversity and is currently under review for listing. The green floater is also currently listed as threatened in Virginia (VDWR 2021). The USFWS is expected to complete their evaluation and peer review process by the end of 2021, and a federal listing determination for the green floater would then follow (USFWS 2021b). A single live green floater was collected from the impoundment above Byllesby Dam during mussel salvage and relocation activities performed from April 30 to May 1, 2018 during a planned reservoir drawdown for the Obermeyer gate replacement at Byllesby Dam (Stantec 2018a). (See also discussion in Section E.9.1.5.2.)

E.11.1.1.1 Indiana Bat

Indiana bats are found over most of the eastern half of the United States (USFWS 2016). The Indiana bat is a relatively small, dark-brown bat. Although they only weigh around one-quarter of an ounce, they have a wingspan of 9 to 11 inches (USFWS 2016).

Indiana bats hibernate during winter in caves or occasionally in abandoned mines. They hibernate in cool, humid caves with stable temperatures under 10°C but above freezing. Very few caves are known to have these characteristics. After hibernation, Indiana bats migrate, often long distances, to their summer habitat in wooded areas where they roost under loose tree bark on dead or dying trees. They forage in or along the edges of forested areas (USFWS 2016). Migratory females may migrate up to 357 miles to form (summer) maternity colonies to bear and raise their young, with each giving birth to just a single pup (USFWS 2016). Both males and females return to hibernacula in late summer or early fall. Indiana bats mate during the fall before they enter hibernation, but fertilization is delayed until the spring after they emerge from the caves (USFWS 2007a).

Indiana bats are found over most of the eastern half of the United States. Critical habitat for this species designated by USFWS includes 11 caves and two abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia. During winter, Indiana bats are restricted to suitable underground hibernacula. The vast majority of these sites are caves located in karst areas of the east-central U.S.; however, Indiana bats also hibernate in other cave-like locations, including abandoned mines. No critical habitat is designated within the Project Boundary. Hellhole Cave in Pendleton County, West Virginia, northeast of the Project, is a Priority 1 (≥ 10,000 bats) hibernacula and is designated as critical habitat for the Indiana bat.

In summer, most reproductive Indiana bat females occupy roost sites under the exfoliating bark of dead trees that retain large, thick slabs of peeling bark. Primary roosts usually receive direct sunlight for more than half the day. Roost trees are typically within canopy gaps in a forest, in a fence line, or along a wooded edge. Habitats in which maternity roosts occur include riparian zones, bottomland and floodplain habitats, wooded wetlands, and upland communities. Indiana bats typically forage in semi-open to closed (open understory) forested habitats, forest edges, and riparian areas (USFWS 2007a). Habitat suitable for Indiana bat foraging and roosting is likely available within the Project Boundary.

Multiple biological opinions have been developed for the Indiana bat (USFWS 2017a). A draft recovery plan was issued for the Indiana bat in April 2007 (USFWS 2007a). No official status reports exist for the Indiana bat; however, the general status of this species, the associated listing, fact sheets, range maps, and other important information are available on the USFWS website.

E.11.1.1.2 Northern Long-Eared Bat

The northern long-eared bat is found across much of eastern and north-central United States and all Canadian provinces from the Atlantic Ocean west to the southern Yukon Territory and British Columbia (USFWS 2013). It is a medium-sized bat, measuring 3.0 to 3.7 inches, with a wingspan of 9 or 10

inches. Its fur color can be medium to dark brown on the back and tawny to pale brown on the underside. The bat is distinguished by its longer ears relative to other bats in the genus Myotis.

The northern long-eared bat spends winters hibernating in caves and mines, preferring hibernacula with very high humidity. During the summer months, the northern long-eared bat prefers to roost singly or in colonies underneath bark, in cavities, or in the crevices of live or dead trees (USFWS 2013; USFWS 2015b). Breeding begins in late summer or early fall when males swarm near hibernacula. After a delayed fertilization, pregnant females migrate to summer colonies where they roost and give birth to a single pup. Young bats start flying 18 to 21 days after birth, and adult northern long-eared bats can live up to 19 years (USFWS 2013). Northern long-eared bats emerge at dusk and fly through the understory of forested hillsides feeding on moths, flies, leafhoppers, caddisflies, and beetles. They also feed by gleaning motionless insects from vegetation and water (USFWS 2013).

The most severe and immediate threat to the northern long-eared bat is white-nose syndrome. As a result of this disease, numbers have declined by 99 percent in the northeast. Other significant sources of mortality include impacts to hibernacula from human disturbance. Loss or degradation of summer habitat as a result of highway or commercial development, timber management, surface mining, and wind facility construction and operation can also contribute to mortality (USFWS 2013). The spatial distribution for the northern long-eared bat extends from Montana and Wyoming in the west, south to eastern Texas, across the northern portions of Mississippi, Alabama, Georgia, and North Carolina, north to Maine, and across the Great Lakes. As this species overwinters in local or regional hibernacula, it does not migrate extensive distances and, therefore, does not have significant temporal distribution (USFWS 2013). No critical habitat has yet been determined or designated by USFWS for this species.

Multiple biological opinions have been developed for the northern long-eared bat (USFWS 2017b). No official status reports exist for the northern long-eared bat; however, the general status of this species, the associated listing, fact sheets, range maps, and other important information are available on the USFWS website. A recovery plan has not yet been developed for the northern long-eared bat.

E.11.1.1.3 Virginia Spiraea

Virginia spiraea is a perennial shrub with many branches growing in height from 3 to 10 ft. The plant produces flowers that are yellowish green to pale white. The shrub blooms from May through early July, but flower production is sparse and does not begin until after the first year of establishment. Virginia spiraea occurs along rivers and streams and relies on periodic disturbances, such as high-velocity scouring floods, which eliminate competition from trees and other woody vegetation. Virginia spiraea is a southern Appalachian species, with isolated populations found in the mountain regions of

Georgia, North Carolina, Tennessee, Kentucky, Virginia, Ohio, and West Virginia. Little population expansion has been reported for this species and temporal distribution is limited. No critical habitat has been designated by USFWS for this species.

Multiple biological opinions have been developed for Virginia spiraea. No official status reports exist for Virginia spiraea; however, the general status of this species, the associated listing, fact sheets, range maps, and other important information are available on the USFWS website. A draft recovery plan was issued for Virginia spiraea in November 1992 (USFWS 1992).

Following consultation with the USFWS in support of the non-capacity license amendment application for installation of the inflatable Obermeyer crest gates at both developments, a habitat suitability assessment and a presence/absence survey for Virginia spiraea was conducted by Appalachian in 2017. The geographic scope of this survey was from Fries Dam to the downstream extent of the Project Boundary for the Buck Development. No instances of Virginia spiraea were observed within any habitat patches identified as having at least low or moderate suitability for this species. The report of this survey was submitted to USFWS and USFS in July 2017. An additional rare plant field survey was completed by Appalachian in July 2017 in support of a non-Project related transmission project in the vicinity of Buck Dam Road (ESI 2017b). Prior to the survey, USFS provided a list of 56 designated sensitive species under the National Threatened, Endangered, and Sensitive Species Program that had the potential to occur in this area, including Virginia spiraea and the federally threatened small whorled pogonia (*Isotria medeoloides*). Neither presence nor suitable habitat for either species was observed in the survey area (Figure E.11.1).

Field work carried out as part of the Terrestrial Resources study for the current relicensing re-assessed all areas previously identified by ESI (2017a); there were no observed occurrences of Virginia spiraea in any of these areas. However, potentially suitable, albeit limited, habitat was observed throughout the study area in rocky, low flow areas of streams, and on portions of bars and benches. Figure E.10.5 shows the location of potential Virginia spiraea habitat in the mapped riparian zones and provides a classification of low suitability or moderate suitability. Photographs of potential Virginia spiraea habitat are included in Appendix E, Volume II of this FLA.

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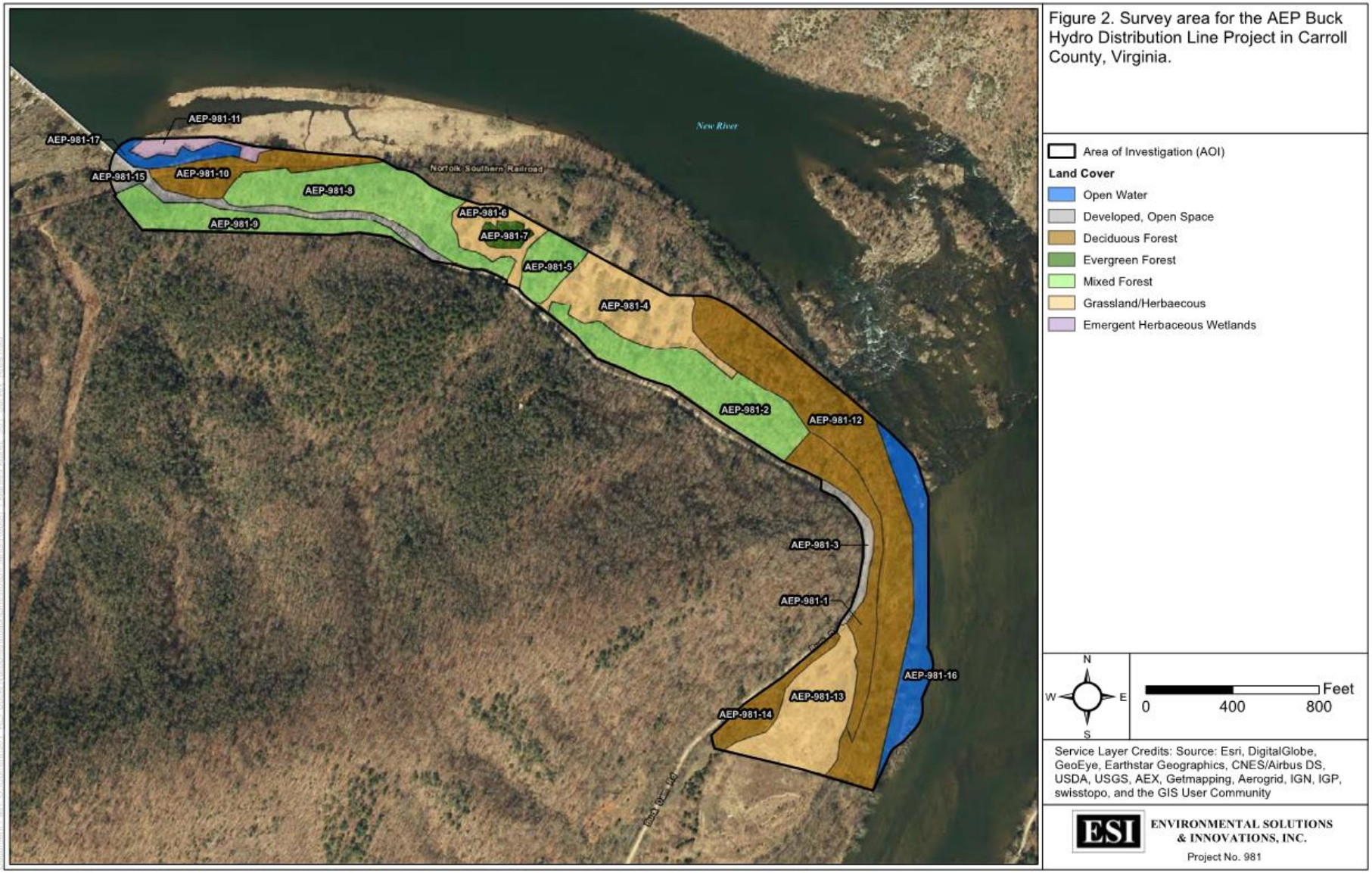

Figure E.11.1. Area Subject to Rare Plant Survey in July 2017 (ESI 2017b)

E.11.1.1.4 Monarch Butterfly

A recent (December 2021) review of the USFWS IPaC database indicates the monarch butterfly, which was listed as a candidate species in December of 2020, has potential to occur in the study area. In North America the eastern population of the monarch butterfly migrate north to the United States and Canada in March from the mountains of central Mexico. This species is typically found in open grass areas during the breeding season. Adult monarchs use a wide variety of flowering plants throughout migration and breeding. Important nectar sources during the spring migration typically include tickseeds (*Coreopsis* spp.), Viburnum spp., Phlox spp., and early blooming milkweeds. Important nectar sources during fall migration include goldenrods (*Solidago* spp.), asters (*Symphyotrichum* spp. and *Eurybia* spp.), gayfeathers (*Liatris* spp.), and coneflowers (*Echinacea* spp.). The optimal survey window for this species is August-December (USFWS 2019b).

A candidate species listing indicates that the USFWS has sufficient information on a species' biological status and threats to propose it as endangered or threatened, but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Candidate species receive no statutory protection under the Endangered Species Act.

E.11.1.2 State-listed Threatened, Endangered, and Candidate Species

Authorized by the 1979 Endangered Plant and Insect Species Act of the Code of Virginia, the Virginia Department of Agriculture and Consumer Services, VDWR, and VDCR cooperate to provide protection for Virginia's threatened and endangered species. The Virginia Department of Agriculture and Consumer Services is the regulatory authority for the conservation and preservation of threatened and endangered plant and insect species. The VDWR has legal authority for preservation of vertebrate and other invertebrate endangered and threatened species. The VDCR Division of Natural Heritage produces an inventory of the Virginia's natural resources and maintains a database of ecologically significant areas.

By letter dated September 23, 2017, the VDCR identified two species of concern within the Project vicinity, the moustached clubtail and the pygmy snaketail, and provided information on these species, summarized below.

In addition, a geographic search of the VDWR Fish and Wildlife Information Service was conducted for a three-mile radius from each Project dam and those species with a status concern for conservation are identified in Table E.11-2. Species lists between the two developments were the same, with the exception of the elktoe, which was only identified during the search for the Byllesby Development. In addition, a search using the VDGIF Little Brown Bat and Tri-colored Bat Winter Habitat and Roosts

Application indicated that both of the developments boundaries are outside of the 5.5-mile buffer zone of the closest known hibernaculum sites (VDGIF 2018b).

Table E.11-2. Rare Species with Historical Records at or within the Project Vicinity

Common Name	Scientific Name	Status*	Tier**
Amphibians			
Blue Ridge dusky salamander	*Desmognathus orestes*		IVc
Blue Ridge two-lined salamander	*Eurycea wilderae*		IIIa
Eastern hellbender	*Cryptobranchus alleganiensis alleganiensis*	CC	Ia
Green salamander	*Aneides aeneus*		IIb
Jefferson salamander	*Ambystoma jeffersonianum*		IVa
Mountain chorus frog	*Pseudacris brachyphona*		IIa
Yonahlossee salamander	*Plethodon yonahlossee*		IVc
Birds			
American black duck	*Anas rubripes*		IIa
American woodcock	*Scolopax minor*		IIa
Bank swallow	*Riparia riparia*		IIIc
Barn owl	*Tyto alba pratincola*		IIIa
Belted kingfisher	*Ceryle alcyon*		IIIb
Black-and-white warbler	*Mniotilta varia*		IVa
Black-billed cuckoo	*Coccyzus erythropthalmus*		IIb
Brown thrasher	*Toxostoma rufum*		IVa
Canada warbler	*Cardellina canadensis*		IVb
Cerulean warbler	*Setophaga cerulea*		IIa
Chimney swift	*Chaetura pelagica*		IVb
Eastern wood pewee	*Contopus virens*		IVb
Eastern kingbird	*Tyrannus tyrannus*		IVa
Eastern meadowlark	*Sturnella magna*		IVa
Eastern towhee	*Pipilo erythrophthalmus*		IVa
Eastern whip-poor-will	*Antrostomus vociferus*		IIIa
Field sparrow	*Spizella pusilla*		IVa
Golden eagle	*Aquila chrysaetos*		Ia
Golden-winged warbler	*Vermivora chrysoptera*		Ia
Grasshopper sparrow	*Ammodramus savannarum pratensis*		IVa
Gray catbird	*Dumetella carolinensis*		IVa
Green heron	*Butorides virescens*		IVb
Kentucky warbler	*Geothlypis formosa*		IIIa

Common Name	Scientific Name	Status*	Tier**
Loggerhead shrike	*Lanius ludovicianus*	ST	Ia
Migrant loggerhead shrike	*Lanius ludovicianus migrans*	ST	Ia
Northern rough-winged swallow	*Stelgidopteryx serripennis*		IVc
Northern saw-whet owl	*Aegolius acadicus*		Ic
Northern flicker	*Colaptes auratus*		IVb
Northern harrier	*Circus cyaneus*		IIIa
Peregrine falcon	*Falco peregrinus*	ST	Ia
Red crossbill	*Loxia curvirostra*		IIIc
Ruffed grouse	*Bonasa umbellus*		IIIa
Short-billed dowitcher	*Limnodromus griseus*		IVa
Swainson's warbler	*Limnothlypis swainsonii*		IIc
Wood thrush	*Hylocichla mustelina*		IVb
Yellow-billed cuckoo	*Coccyzus americanus*		IIIa
Yellow-breasted chat	*Icteria virens virens*		IVa
Crustaceans			
Longclaw crayfish	*Cambarus buntingi*		IIIa
Fish			
Appalachia Darter	*Percina gymnocephala*		IVc
Blackside Darter	*Percina maculata*		IVc
Brassy Jumprock	*Moxostoma sp*		IVc
Brook Trout	*Salvelinus fontinalis*		IVa
Candy Darter	*Etheostoma osburni*	FE[1]	Ib
Highback Chub	*Hybopsis hypsinotus*		IVc
Kanawha Darter	*Etheostoma kanawhae*		IIIc
Kanawha Minnow	*Phenacobius teretulus*		IIIc
Logperch	*Percina caprodes*		IVc
Longear Sunfish	*Lepomis megalotis*		IVb
New River Shiner	*Notropis scabriceps*		IVc
Redlip Shiner	*Notropis chiliticus*		IVc
Sauger	*Sander canadensis*		IIIb
Sharpnose Darter	*Percina oxyrhynchus*		IVc
Stonecat	*Noturus flavus*		IVc
Tonguetied Minnow	*Exoglossum laurae*		IVc
Insects			
Diana fritillary	*Speyeria diana*		IVc

Common Name	Scientific Name	Status*	Tier**
Monarch butterfly	*Danaus plexippus*		IIIa
Mottled duskywing butterfly	*Erynnis martialis*		IIIc
Moustached clubtail	*Gomphus adelphus*		IVc
Pygmy snaketail	*Ophiogomphus howei*		IIc
Regal fritillary	*Speyeria idalia idalia*		Ia
Mammals			
Appalachian cottontail	*Sylvilagus obscurus*		IVa
Eastern red bat	*Lasiurus borealis borealis*		IVa
Eastern small-footed bat	*Myotis leibii*		Ia
Eastern spotted skunk	*Spilogale putorius putorius*		IVc
Hoary bat	*Lasiurus cinereus cinereus*		IVa
Little brown bat	*Myotis lucifugus lucifugus*	SE	Ia
Long-tailed shrew	*Sorex dispar dispar*		IVc
Northern long-eared bat	*Myotis septentrionalis*	FTST	Ia
Northern bobwhite	*Colinus virginianus*		IIIa
Silver-haired bat	*Lasionycteris noctivagans*		IVa
Tri-colored bat	*Perimyotis subflavus*	SE	Ia
Mussels			
Elktoe	*Alasmidonta marginata*		IIc
Green floater	*Lasmigona subviridis*	ST	IIa
Pistolgrip	*Quadrula verrucosa*	ST	IIIb
Pocketbook mussel	*Lampsilis ovata*		IVa
Tennessee heelsplitter	*Lasmigona holstonia*	SE	IIa
Reptiles			
Bog turtle	*Clemmys muhlenbergii*	FTSE	Ia
Common ribbonsnake	*Thamnophis sauritus sauritus*		IVa
Eastern hog-nosed snake	*Heterodon platirhinos*		IVc
Queen snake	*Regina septemvittata*		IVa
Snapping turtle	*Chelydra serpentina*		IVb
Timber rattlesnake	*Crotalus horridus*	CC	IVa
Woodland box turtle	*Terrapene carolina carolina*		IIIa
Snails			
Seep mudalia snail	*Leptoxis dilatata*		IVc

[1] The Candy Darter was listed as endangered by the USFWS on November 21, 2018 (effective December 21, 2018) (USFWS 2018a).

*FE=Federal Endangered; FT=Federal Threatened; SE=State Endangered; ST=State Threatened;
FP=Federal Proposed; C=Federal Candidate; CC=Collection Concern.
Virginia Wildlife Action Plan Tier Ranking:
**I=VA Wildlife Action Plan - Tier I - Critical Conservation Need.
II=VA Wildlife Action Plan - Tier II - Very High Conservation Need.
III=VA Wildlife Action Plan - Tier III - High Conservation Need.
IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need.
Virginia Wildlife Action Plan Conservation Opportunity Ranking:
a - On the ground management strategies/actions exist and can be feasibly implemented.
b - On the ground actions or research needs have been identified but cannot feasibly be implemented at this time.
c - No on-the-ground actions or research needs have been identified, or all identified conservation opportunities have been exhausted.

E.11.1.2.1 Odonates

The moustached clubtail dragonfly inhabits mostly rapid, clear, rocky streams and rivers and occasionally the exposed shorelines of lakes. This species is found in southeastern Canada and the northeastern portion of the United States where its range extends southward along the Appalachian Mountains, but rarely reaches into North Carolina and Georgia. In Virginia, this species is known to occur from areas of the New River, specifically Grayson, Carroll, and Wythe counties, but it has also historically occurred in August and Bath Counties.

The pygmy snaketail dragonfly is found from northeast Maine, west to Wisconsin, and south to Virginia and Kentucky. It is found in big, clear rivers with high water quality and stable flow over coarse cobbles and periodic rapids. The larvae overwinter and take flight late April to early June. The nymph of this species occurs in fast-flowing water in sand and gravel substrates (USFWS 2015c).

Adult dragonflies are predators that typically forage in clearings with scattered trees and shrubs near the parent river. They feed on mosquitoes and other smaller flying insects. Dragonflies lay their eggs on emergent vegetation or debris along the water's edge. The larvae (nymphs) are aquatic and generally inhabit sand and gravel substrate. Nymphs are particularly vulnerable to shoreline disturbances. They are also sensitive to alterations in poor water quality, thermal fluctuations, and changes in aquatic habitat.

Five study reaches ranging from upstream to downstream of the Fries Project were surveyed for dragonfly larvae in 2016-2017 (Carey et al. 2017). At least 17 species representing 4 families were identified in all reaches except Reach 3 (bypass). Moustached clubtail was found at the upstream reach and tailwater reach, but not within the Fries Project reservoir or bypass reach. Pygmy snaketail was found in the tailwater reach and downstream reach. The Allegheny river cruiser, spine-crowned clubtail and green-faced clubtail were also identified within the Fries Project area.

No moustached clubtail or pygmy snaketail specimens were collected within the Project Boundary during the 2020-2021 macroinvertebrate sampling efforts. Based on available habitat and substrates, neither of these dragonfly species are expected to occur within the Byllesby or Buck bypass channels. As such, continued operation of the Project is not expected to impact populations of moustached clubtail or pygmy snaketail.

E.11.1.2.2 Mussels

As shown in Table E.11-2, five species of freshwater mussels considered rare in the state of Virginia have been historically documented in the Project vicinity. The VDCR also indicated that the New River has been designated by the VDWR as "Threatened and Endangered Species Waters" for the pistolgrip and recommended further coordination with the VDWR to ensure compliance with the Virginia ESA.

E.11.1.2.3 Herpetofauna

In preliminary consultation with VDWR about potential Project impacts or information needs, the potential for habitat and/or occurrences of Eastern hellbender was raised. The Eastern hellbender is listed as a federal species of concern. In Virginia, the Eastern hellbender is listed as a species of special concern and as a Tier II species in the Virginia Wildlife Action Plan. Eastern hellbender is a large, stout-bodied, fully aquatic salamander that occupies portions of New York, Pennsylvania, Ohio, Indiana, West Virginia, Kentucky, Tennessee, Alabama, Georgia, North Carolina, and Virginia. In Virginia, Eastern hellbenders are found in the mainstem and tributaries of the New River drainage and in the Clinch, Powell, and Holston River tributaries of the upper Tennessee River. Eastern hellbenders are somewhat cryptic, stout-bodied, fully-aquatic salamanders found in clear, fast-flowing, well-oxygenated streams and rivers. Eastern hellbenders utilize stream bottoms with many large, unembedded and flat boulders, cobble, and gravel substrates, along with logs and woody debris (VDGIF 2017d; USFWS 2018c). Successful reproduction and survival for this species depends on the availability of abundant prey (predominantly crayfish, but also small fish, insects, and frogs) and large, flat slab rocks that are partially embedded to create a downstream facing opening that creates a velocity barrier that results in nest and shelter habitat (USFWS 2018). The most recent Eastern hellbender encounters in the upper New River[16] occurred in 2018 in the New River near the North Carolina border, with one specimen each collected above and below the Fries Project dam (Carey et al 2017; FERC 2020).

[16] Upper New River segment extends from the Bluestone Dam near Hinton, West Virginia, to the headwaters of the New River's north and south forks in northwestern North Carolina near Blowing Rock.

Table E.11-2 indicates the potential for the bog turtle (*Clemmys [Glyptemys] muhlenbergii*) to occur near the Project. The bog turtle is listed as threatened wherever found, except for Georgia, South Carolina, North Carolina, Tennessee, and Virginia (USFWS 2018b); however, the bog turtle's status in Virginia is "Similarity of Appearance (Threatened)". Species listed for Similarity of Appearance are not subject to Section 7 consultation by the USFWS (USFWS 2018d). This species has unique habitat requirements; bog turtles typically occur in headwater areas where they inhabit shallow, spring-fed habitats (fens, sphagnum bogs, swamps, marshy meadows, and pastures characterized by soft, muddy bottoms) characterized by clear, cool, slow-flowing water, high humidity, and an open canopy (USFWS 2015c). Results from the 2021 Terrestrial Resources study and Wetlands study, as well as a desktop review of known bog turtle sites and nearby field observations by Carey et al. (2017) stating there are no populations upstream of Project with similar wetland habitats, indicate it is unlikely that this species is present in the vicinity of the Project. Additionally, habitat and individual species surveys for the bog turtle were not required part of the FERC-approved study plan and the bog turtle was not included on a recent (December 2021) IPaC report for the Project vicinity.

E.11.2 Environmental Analysis

In SD3, FERC staff identified the following resource issue to be evaluated in its NEPA document:

- Effects of continued project operation and maintenance on the federally listed Indiana bat, northern long-eared bat, bog turtle, candy darter, and Virginia spiraea.

Wildlife and riparian habitats and species in the vicinity of the Project are reflective of current Project operations. Appalachian proposes to maintain the run-of-river mode of operation for each development and existing measures and programs to protect wildlife habitat. Appalachian does not expect that operation of the Project as presently proposed over the term of the new license to affect habitat for RTE species.

As noted above, suitable foraging and potential roosting habitat for bats, including the species listed above, is likely common in the Project area, which supports a range of upland, riparian, wetland, and open water habitats. The upland forested habitats used by these species are not affected by normal or proposed Project operations. While habitat with low or moderate suitability for Virginia spiraea has been identified at the Project, the species is not known to occur based on recent survey in these previously identified areas.

There are no current plans for improvements or activities at the Project that would require the clearing of trees that may provide habitat for roosting or maternity colonies for Indiana bat and northern long-eared bat. Ongoing land and facility maintenance performed by Appalachian, including vegetation

management, maintenance of project structures, and recreational facility maintenance has the potential to affect terrestrial and riparian or littoral habitats for RTE species. Appalachian expects that future activities at the Project will need to be conducted in accordance with prevailing guidelines of Appalachian and the USFWS.

With respect to state-listed aquatic species, periodic drawdown of the Project impoundments has the potential to have short-term impacts on littoral and near-shore habitat. Water level fluctuations in the bypass reaches have the potential to limit habitat and habitat connectivity. As previously discussed, the existing ramping rate provides a level of protection against stranding of fish in the Buck bypass reach. During the term of the new license, these issues are expected to be mitigated by completion of installation of the Obermeyer gates, which will allow for better control of water levels and more stable water levels. Operation of the dams with the new gates is expected to reduce the risk of deviations from the allowable 1.0-ft reservoir operating band, and to reduce the frequencies of inadvertent spills to the bypass reaches and of reservoir drawdowns required to repair/replace flashboards damaged by high flow events. Additionally, Appalachian notes that due to existing topographic and substrate conditions, the existing bypass reaches are not expected to provide habitat for the aquatic species described in the section above.

Refer to Section E.9.2.2 for additional discussion of Project impacts on sensitive mussels and other aquatic species.

E.11.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Because normal Project operations do not and are not expected to adversely affect listed species, no PM&E measures specific to the protection of federally listed rare, threatened, endangered, or state-listed species are presently proposed by Appalachian.

Pending the outcome of the USFWS listing decision for green floater or other candidate species, Appalachian anticipates that future species surveys or other protection measures (e.g., mussel salvage survey during reservoir drawdowns for Project maintenance) may be requested and will continue to be performed in consultation with USFWS and VDWR when regulatory approvals are needed for activities that have the potential to adversely impact mussels where they are known to be present at the Project.

In comments filed on the DLA on December 30, 2021, the USFWS recommended as a PM&E measure, appropriate time of year restrictions for any tree cutting associated with transmission right of way (ROW) maintenance, to avoid adverse effects to federally listed bats, as well as to migratory

birds during the nesting season. USFWS noted that most of the approximate 2-mile-long right of way occurs through suitable summer (forest) roosting habitat for Indiana bat and northern long-eared bat. Given the terrain of the existing ROW and dangerous winter conditions for maintenance activities in this corridor, Appalachian does not believe that a seasonal broad ban on vegetation management (including tree trimming) is practical for the Project, including the transmission ROW. Appalachian proposes to consult with USFWS and VDWR prior to tree clearing (i.e., trunk removal) for any ROW expansion that may be required or proposed over the new license term.

E.12 Terrestrial Resources

E.12.1 Affected Environment

E.12.1.1 Existing Data and Previous Studies

E.12.1.1.1 Botanical Resources

Most of the land adjacent to the Project is steep and forested. Forest cover in the vicinity of the Project is of the oak-chestnut type, although there are many bare rock exposures in the rugged terrain. There is also a noteworthy percentage of pine and other types, such as hickory, hemlock, maple, ash, birch, rhododendron, locust, and basswood. The west side of the project is bounded by the Jefferson National Forest, and the east side consists of similarly forested terrain (Appalachian 1991a). According to the environmental assessment prepared by FERC for the existing license (FERC 1994), upland forests in the vicinity of the Project are characterized by silver maple (*Acer saccharinum*), black willow (*Salix nigra*), and American sycamore (*Platanus occidentalis*) as the primary species.

E.12.1.1.2 Invasive Terrestrial Plant Species

The VDCR (2017a) maintains a list of over 100 invasive plant species found within the State and includes species that pose a threat to Virginia's forests, marshes, wetlands, and waterways. These species are ranked based on the level of threat they present to natural communities and species. Invasive aquatic plants are known to exist in the New River, including hydrilla (*Hydrilla verticillata*), curly-leaf pondweed (*Potamogeton crispus*), and brittle naiad (*Naja minor*) (see section E.10.1.2.2) for descirptions. An aquatic plant community study performed in 2012 between Buck Dam and upper Claytor Lake identified 13 macrophyte species, including curly-leaf pondweed (Weberg et al. 2015). Terrestrial invasive plant species including Chinese lespedeza (*Lespedeza cuneata*), mutilfora rose (*Rosa multiflora*), and Japanese stiltgrass (*Microstegium vimineum*) have been documented in the study area in previous studies (ESI 2017b).

E.12.1.1.3 Wildlife

The study area supports many small mammals, avifauna, reptiles, and amphibians. Over 511 animal species (including both terrestrial and aquatic species) were identified as potentially occurring within a 3.0-mile radius of the Project per a geographic search on the VDWR Wildlife Information Service (VDGIF 2021). Of these 511 species, 342 were terrestrial species.

E.12.1.1.4 Mammals

Mammals, including commercially and recreationally important wildlife species, that occur within the Project area include white-tailed deer (*Odocileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), and gray fox (*Urocyon cinereoargenteus*) (VDGIF 2017a). Other species also known to occur within the general Project area include the Eastern chipmunk (*Tamias striatus*), red squirrel (*Tamiasciurus hudsonicus*), Eastern gray squirrel (*Sciurus carolinensis*), longtail weasel (*Mustela frenata*), common mink (*Neovison vison*), American beaver (*Castor canadensis*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), woodchuck (*Marmota monax*), muskrat (*Ondatra zibethicus*), meadow vole (*Microtus pennsylvanicus*), deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), and Northern short-tail shrew (*Blarina brevicauda*) (VDGIF 2017a).

E.12.1.1.5 Avifauna

Birds such as the Northern cardinal (*Cardinalis cardinalis*), American crow (*Corvus brachyrhynchos*), mourning dove (*Zenaida macroura*), pileated woodpecker (*Dryocopus pileatus*), and wood duck (*Aix sponsa*) are some of the many birds known to occur in the Project area (VDGIF 2017a), along with commercially and recreationally important species such as eastern turkey (*Meleagris gallopavo*), ruffed grouse (*Bonasa umbellus*), and various waterfowl species.

E.12.1.1.6 Protected Species

Habitat for several federal protected species including Indiana bat (*Myotis sodalist*), northern long-eared bat (*Myotis septentrionalis*), and Virginia spirea (*Spiraea virginiana*) are located within the study area. A recent (2021) review of the USFWS IPaC databased indicated the monarch butterfly (*Danaus plexippus*), which was listed as a candidate species in December of 2020, has potential to occur in the study area. A candidate species listing indicates that the USFWS has sufficient information on a species' biological status and threats to propose it as endangered or threatened, but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Candidate species receive no statutory protection under the Endangered Species Act.

Bald eagle (*Haliaeetus leucocephalus*) nesting and roosting habitat occurs in the vicinity of the Project. The bald eagle was removed from the Federal Endangered Species List on August 8, 2007 and is no longer protected under the ESA; however, bald eagles are protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. In association with agency consultation for the recent non-capacity amendment application for installation of the Obermeyer crest gates, searches for bald eagles and/or their nests were completed in the Project vicinity in April and July 2017 on behalf of Appalachian. A single bald eagle was observed on the first day along the west bank of the New River, approximately 1.4 miles upstream of the State Road 606 Bridge. The report presenting these findings was submitted to USFWS and VDCR in July 2017. On the second day, approximately 0.2 miles from this location, two bald eagles were observed perching on rocks in the river (one bald eagle was determined to be likely the same as that observed the previous day). A single juvenile bald eagle was observed fishing approximately 0.4 mile south of Byllesby Dam during the searches conducted in July 2017; this individual flew to a roost in a tree on the riverbank upon successfully catching a fish. No calls were heard, nor nests observed during any of these observations in 2017.

An aerial transect helicopter survey for nesting bald eagles was conducted for Appalachian in the vicinity of the Project in March 2021 by ESI in support of the AEP Byllesby-Ivanhoe 88-kV Transmission Line Retirement Project (ESI 2021). The survey area included approximately 2.5 miles of line crossing the Jefferson National Forest and approximately 1.6 miles on private lands immediately adjacent to the Jefferson National Forest, comprising 90.7 miles of flight across the survey area using standard survey design guidance set forth by the USFWS National Bald Eagle Management Guidelines. One active bald eagle nest (36.803860° -80.938881°; ID BAEA01) was observed in the survey area on the New River; the nest is approximately 0.52 miles from the transmission line corridor and approximately 0.27 miles south of the Buck Dam. An unoccupied nest was identified along the New River approximately 1.1 mile north of Buck Dam at the top of a transmission tower; however, after several fly-by attempts over two days, no birds were observed attending and the nest could potentially be an osprey nest. A third smaller stick nest was observed 2.4 river miles upstream of Byllesby Dam; however, it is not consistent with a bald eagle nest. Additionally, three individual eagles were observed within the survey area over two survey events. One was perched proximate the New River 0.7 miles northwest of the nest BAEA01, one adult eagle (female) was observed incubating at BAEA01, and a third immature bald eagle was observed hunting along the New River 0.4 miles east of the Survey Area (ESI 2021).

As noted above, Virginia spirea, is historically reported by the USFWS upstream of Byllesby Dam; however, there is no documentation or verification of any historically presence or exact location. ESI

(2017b) performed a habitat assessment in 2017 for this species within the Project Boundary and no individual species were observed within the identified suitable habitats for Virginia spirea.

E.12.1.1.7 Reptiles and Amphibians

A variety of reptiles and amphibians have been known to occur in the general Project vicinity. Common species may include the snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys picta*), eastern garter snake (*Thamnophis sirtalis*), red-spotted newt (*Notophthalmus viridescens*), American toad (*Anaxyrus americanus*), spring peeper (*Pseudacris crucifer)*, green frog (*Lithobates clamitans*), American bullfrog (*Lithobates catesbeianus*), pickerel frog (*Lithobates palustris*), and wood frog (*Lithobates sylvaticus*) (VDGIF 2017a). Based on comments filed with FERC by VDWR on the PAD for the Fries Project (VDGIF letter dated November 19, 2015), additional herpetofauna that may occur in the Project area includes two amphibians—the Blue Ridge dusky salamander (*Desmognathus orestes*) and Yonahlossee salamander (*Plethodon yonahlossee*), and four additional reptiles—woodland box turtle (*Terrapene carolina carolina*), eastern hog-nosed snake *(Heterodon platirhinos*), queen snake (*Regina septemvittata*), and common ribbonsnake (*Thamnophis sauritus sauritus)*. VDWR also noted the potential for occurrence of the Eastern hellbender *(Cryptobranchus alleganiensis alleganiensis).*

E.12.2 Environmental Analysis

E.12.2.1 Studies in Support of the Current Relicensing

In support of the current relicensing, Appalachian completed a Terrestrial Resources Study in 2021. A summary of the methods and results of the Terrestrial Resources Study is included in this section and details are provided in Appendix E, Volume II of this FLA. Specific objectives of the Terrestrial Resources Study are included below:

- Perform a desktop characterization of the upland vegetation types within the study area boundary utilizing the Nature Conservancy's Guide to the Freshwater and Terrestrial Habitats of the Northeast (Virginia Geographic Subset) (TNC 2018a) and Terrestrial Habitat Map (TNC 2018b), and classify plant communities according to the VDCR Natural Communities of Virginia Classification of Ecological Groups and Community Types (VDCR 2021a) in the field;
- Perform a characterization of the upland habitat types in relation to wildlife species that are known to inhabit or that were directly observed during the field visit; and
- Develop a map of the vegetative community within the upland portions of the study area, identifying general location and community type. The map will also identify the location of any invasive terrestrial species identified in the study area based on the literature review or observed during the field verification efforts.

E.12.2.1.1 Methods

The study area for the Terrestrial Resources Study includes the upland vegetative communities on each bank of the upper New River and lowermost tributary segments of Crooked Creek and Chestnut Creek and extends 3.4 miles upstream of Byllesby Dam and 1.15 miles downstream of Buck Dam, including 2.7 miles of the New River in between the two dams. The study area is located in the easternmost portion of the Mt. Rogers National Recreation area and the New River Trail State Park is also situated within the study area along the western streambank. The Terrestrial Resources Study was performed initially as a desktop analysis followed by a field verification to confirm locations and boundaries of upland terrestrial habitat types within the study area. A high-level characterization of the upland vegetation communities within the study area boundary was completed using high-resolution orthoimagery and other online databases including the TNC Terrestrial Habitat Map (TNC 2018b) and Virginia Natural Heritage Data Explorer (VDCR 2021b). The Virginia Invasive Plant Species List (VDCR 2014) was used to rank the level of threat to forests and other natural communities and native species.

The onsite terrestrial surveys were conducted from May 26 through May 28, 2021. Applicable reference materials were using during the field assessments including regional field guides and plant identification mobile apps to identify plants to genus and species level. The dominant species of upland vegetation, and any invasive species observations, were noted within each community type. The location of invasive species observed during the field verification were georeferenced and photographed using the ArcGIS Collector mobile app. Finalized cover type maps depicting plant community classifications and locations of invasive species were generated along with a summary list of the upland vegetative plant species documented during the field verification effort. During the field verification activities, observations of avifauna, mammals, or observations of their tracks and scat were recorded. A summary list of the wildlife species or signs of their presence were compiled along with the general vegetative community where the observation occurred.

E.12.2.1.2 Results

A summary of the terrestrial habitats within the study area and a base map depicting these major upland vegetation cover types present within the study area are included in Appendix E, Volume II of this FLA (Terrestrial Resources Study Report). This base map was used to verify and characterize terrestrial communities that best represent ecological groups described in accordance with VDCR (2021a). Terrestrial habitats varied throughout the study area and best professional judgement was used to categorize identified habitats into ecological groups and community types described in VDCR (2021a). Four upland communities were mapped within the study area: 1) Acidic Cove Forests, 2)

Montane Mixed Oak and Oak Hickory Forests, 3) Mountain/Piedmont Basic Woodlands, 4) Piedmont/Mountain Floodplain Forests and Swamps. The boundaries were consistent with similar habitat classification descriptions that are depicted on the TNC Terrestrial Habitat Map (TNC 2018b). Photographs of terrestrial habitats are located in Appendix E. The most prevalent natural community was Piedmont/Mountain Floodplain Forests and Swamps, encompassing 227 acres. Table E.12-1 provides a summary of ecological groups and community types mapped within the study area and

Table E.12-1. Groups and Community Types Observed During 2021 Surveys

VDCR Ecological Group and Community Type	Acres within Study Area	Percent within Study Area
Acidic Cove Forests	8.85	2.22
Montane Mixed Oak and Oak Hickory Forests	51.38	12.80
Open Areas	32.82	8.17
Mountain/Piedmont Basic Woodlands	80.52	20.06
Piedmont/Mountain Floodplain Forests and Swamps	227.77	56.75

According to VDGIF (2021), a total of 511 animal species (including terrestrial and aquatic species) are known or likely to occur within a 3-mile radius of the study area (Attachment 3 of Appendix E). Of these 511 species, 342 are terrestrial species, 127 are aquatic species, and 42 are semi-aquatic species. Table E.12-2 lists wildlife species directly observed or signs of their presence evident during the field visit and corresponding community type in which each species was observed. Five herpetofauna, 13 bird species, and 10 mammal species were observed during the field surveys. Several bald eagle nests are located in the vicinity of the Project and two were observed within the study area (ESI 2021). Bald eagle nests are indicated on Figure E.12.1.

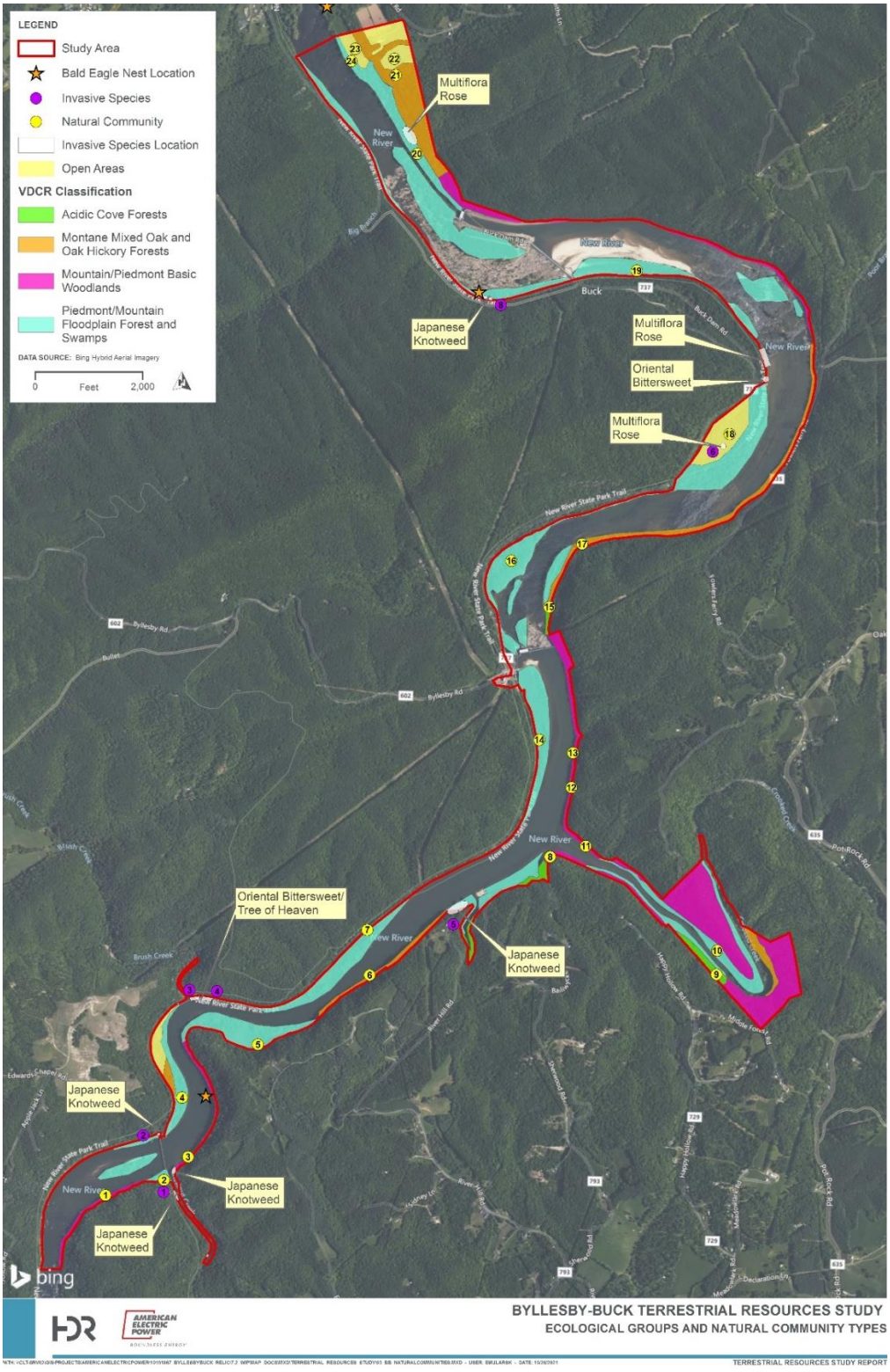

Figure E.12.1. Ecological Groups, Natural Communities, and Invasive Species Locations

Table E.12-2. Terrestrial Wildlife Species Observed During 2021 Surveys

Scientific Name	Common Name	Community Type
HERPETOFAUNA		
Chelydra serpentina	Common snapping turtle	Piedmont/Mountain Floodplain Forest & Swamps
Pantherophis alleghaniensis	Eastern ratsnake	Piedmont/Mountain Floodplain Forest & Swamps
Pantherophis guttatus	Red cornsnake	Piedmont/Mountain Floodplain Forest & Swamps
Pseudacris crucifer	Spring peeper	Piedmont/Mountain Floodplain Forest & Swamps
Thamnophis sirtalis	Eastern gartersnake	Montane Mixed Oak and Oak Hickory Forests
BIRDS		
Agelaius phoeniceus	Red-winged blackbird	Piedmont/Mountain Floodplain Forest & Swamps
Aix sponsa	Wood duck	Piedmont/Mountain Floodplain Forest & Swamps
Branta canadensis	Canada goose	Piedmont/Mountain Floodplain Forest & Swamps
Butoe jamaicensis	Red-tailed hawk	Open Areas
Cathartes aura	Turkey vulture	Open Areas
Cardinalis cardinalis	Northern cardinal	Piedmont/Mountain Floodplain Forest & Swamps
Colinus virginianus	Northern bobwhite	Open Areas
Dumetella carolinensis	Gray catbird	Mountain/Piedmont Basic Woodlands
Haliaeetus leucocephalus	Bald eagle	Piedmont/Mountain Floodplain Forest & Swamps
Meleagris gallopavo	Eastern wild turkey	Piedmont/Mountain Floodplain Forest & Swamps Mountain/Piedmont Basic Woodlands
Spizella pusilla	Field sparrow	Open Areas
Pandion haliaetus	Osprey	Piedmont/Mountain Floodplain Forest & Swamps
Zenaida macroura carolinensis	Mourning dove	Open Areas
MAMMALS		
Canis latrans	Coyote	Open Areas
Castor canadensis	Beaver	Piedmont/Mountain Floodplain Forest & Swamps
Lontra canadensis	North American river otter	Piedmont/Mountain Floodplain Forest & Swamps
Sylvilagus floridanus mallurus	Eastern cottontail	Open Areas
Odocoileus virginianus	White-tailed deer	All Communities
Ondatra zibethicus	Common muskrat	Piedmont/Mountain Floodplain Forest & Swamps
Sciurus niger vulpinus	Eastern fox squirrel	Piedmont/Mountain Floodplain Forest & Swamps
Sciurus carolinensis pennsylvanicus	Northern gray squirrel	Montane Mixed Oak and Oak Hickory Forests Mountain/Piedmont Basic Woodlands
Tamias striatus	Common eastern Chipmunk	Piedmont/Mountain Floodplain Forest & Swamps
Ursus americanus	Black bear	Mountain/Piedmont Basic Woodlands

The presence of several species on VDCR's Virginia Invasive Species Plant List (VDCR 2014) were identified throughout the study area. Many invasive species were noticed at low densities scattered throughout the study area and not feasible to map each individual location. Significant infestations of Japanese knotweed (most abundant), oriental bittersweet, and mutliflora rose were noticed primarily in riparian areas along the reservoirs were mapped in the field and are highlighted on Figure E.12.1. Photographs of invasive species are provided in Appendix E (Terrestrial Resources Study Report).

E.12.2.2 Project Impacts on Terrestrial Resources

In SD3, FERC staff identified the following environmental issues to be addressed in their NEPA document:

- Effects of continued project operation and maintenance on upland wildlife habitat and associated wildlife such as bald eagles.

There is limited terrestrial land within the Project Boundary and no potential issues related to wildlife and botanical resources have been identified. The Project has been in operation for over 100 years, and the existing terrestrial environment has developed in response to the current and proposed Project operations.

Resource agencies and other stakeholders have not identified any potential Project-related impacts to wildlife resources within the Project area. The occurrence and distribution of wildlife resources in the Project area is generally unrelated to Project operations, and Project operations have little potential to impact wildlife resources within and bordering the Project. Short-term minimal effects from normal maintenance, temporary construction activities, and ongoing operations may temporarily impact some generalist terrestrial wildlife species, but such species would be expected to move to adjacent habitat, returning once activities are complete. No significant impacts to wildlife or botanical resources at the Project are known to be occurring or expected to occur during the term of the new license.

Effects of continued project operation on upland wildlife is limited as there is very little terrestrial uplands within the Project Vicinity. Bald eagle nesting and roosting habitat occurs in the vicinity of the Project. Continued normal Project operations are not expected to affect this species. Activities that require clearing of significant trees (e.g., development of new recreation areas) or construction that could disturb breeding, should any be required to implement the terms of the new license or for other Project-related purposes over the new license term, have the potential to affect bald eagles. The National Bald Eagle Management Guidelines developed and maintained by the USFWS (2007b) provide guidance specifically for construction or development activities.

Appalachian conducts vegetation management activities on an as-needed basis using mostly mechanical vegetation removal techniques (e.g., mowing). The degree of impact resulting from this vegetation management is minor relative to other land uses that occur in the region (e.g., agricultural practices). The effects of these routine vegetation management activities are very minor in nature, and continued operation of the Project is not expected to have an adverse impact on terrestrial resources.

Surveys for protected bat species have not been conducted as part of this relicensing effort since proposed improvement plans and Project activities are not expected to involve clearing of trees in upland forested communities that provide habitat for roosting or maternity colonies for these species.

The Licensee does not anticipate that operation and maintenance of the Project over the new license term will have any long-term, unavoidable, adverse impacts on terrestrial resources.

E.12.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Appalachian proposes to continue to operate the Project in the existing run-of-river mode for the protection of multiple resources. Appalachian also proposes to conduct Project maintenance and new license implementation activities, as applicable, over the new license term in accordance with the USFWS's prevailing eagle management guidance and regulations.

While the existing WMP has provided a general means for qualitatively monitoring land development and general terrestrial and shoreline habitat conditions over the term of the existing license, Appalachian does not believe that the process has yielded meaningful information or been necessary to inform decisions or manage limited lands within the Project Boundary. Appalachian does not propose to continue the WMP, as presently constructed, during the term of the new license.

No other PM&E measures for general terrestrial resources have yet been recommended by resource agencies or other stakeholders.

E.13 Recreation and Aesthetics

E.13.1 Affected Environment

E.13.1.1.1 Recreational Resources in Vicinity of the Project

The New River is a major recreational resource in southwest Virginia. A majority of the land to the west of the Project is owned by USFS and consists of the George Washington and Jefferson National Forest. Additional outdoor recreation activities are available along the river, including the New River Trail State Park, which extends along the west shore of the Project, along the right-of-way for the former Norfolk & Western railroad. The New River Trail State Park allows recreationists to hike, horseback ride, and bicycle along the river. Of particular note along the New River in southwest Virginia is the historical Shot Tower State Park, Claytor Lake in Pulaski County, and Claytor State Park adjoining Claytor Lake providing campgrounds, cottages, a marina, and hiking trails (VDGIF 2017e).

As the New River flows through mountain scenery, craggy rock cliffs, and gorges, it provides opportunities for whitewater boating, with several major Class I-III rapids, as well as an abundance of flatwater for motor-boaters and canoeists (VDGIF 2017e). Class I, II, and III rapids (for normal flows) are present from Fries to the Byllesby reservoir for whitewater boating. Class II and III rapids (for normal flows) are present below the Buck Development (American Whitewater 2017).

Fishing in the New River is popular, as the river supports populations of just about every major freshwater game fish in Virginia, including Smallmouth Bass, Spotted Bass, Largemouth Bass, Rock Bass, Striped Bass, White Bass, hybrid striped bass, Muskellunge, Walleye, Black Crappie, Channel Catfish, Flathead Catfish, Yellow Perch, Redbreast Sunfish, and Bluegill (VDGIF 2017e).

There are no formal camping facilities within, near, or adjacent to the Project Boundary. A campground (the Thompson Campground[17]) was formerly maintained by USFS above the New River Trail upstream between Byllesby and Buck Dams but has since closed.

There are no National Scenic Byways in the immediate vicinity of the Project. The Blue Ridge Parkway is located approximately 30 miles south of the Project.

[17] The Thompson Campground located between Byllesby and Buck Dams was frequently mentioned in the Recreation Study online survey comments. The VDCR has explained that previous efforts (1990s and as recently as two years ago with an attempt to reach terms of a 99-year lease) by the VDCR to acquire the land from USFS were unsuccessful. The campground is located entirely outside of the Project Boundary and not on lands owned or controlled by Appalachian.

National Trails System and Wilderness Areas

The George Washington and Jefferson National Forest abuts the Project to the east and west. The George Washington and Jefferson National Forest contains nearly 1.8 million acres of public lands, representing one of the largest blocks of public land in the eastern United States. The Forest contains approximately 1,646,328 acres in Virginia, 123,384 acres in West Virginia, and 961 acres in Kentucky. Developed recreation opportunities are offered at over 200 sites in the Forest, resulting in nearly 3 million annual recreation visits. These opportunities vary from minimally developed sites such as ten-unit picnic areas with vault toilets and hand pumps, small scenic overlooks, and small non-fee campgrounds, to highly developed recreation complexes providing swimming beaches, camping spurs with utility hookups, warm showers, and flush toilets (USFS undated a).

The George Washington and Jefferson National Forest has approximately 2,100 miles of trails open to one or more non-motorized uses (hiking, horse-riding, and/or mountain biking). The Appalachian National Scenic Trail extends more than 325 miles across the Forest. The Appalachian Trail is located approximately 40 miles west of the Project (the “old” or original Appalachian trail crossed the western shore of the New River near the Byllesby Development, where the New River Trail State Park is now located [McNeely 2017]). In addition, there are 12 National Recreation Trails in the Forest totaling 143 miles (USFS undated a).

Along with National Trails Systems, there are 23 designated Wilderness Areas totaling approximately 140,000 acres within the George Washington and Jefferson National Forest. These designated Wilderness Areas provide primitive types of recreation. There are also 32 special-interest areas in the Forest emphasizing dispersed recreation opportunities (USFS undated a).

Regionally or Nationally Significant Recreation Areas and Recreational Attractions in the Vicinity of the Project

- **Mount Rogers National Recreation Area** (within the George Washington and Jefferson National Forest) - The Mount Rogers National Recreation Area is a United States National Recreation Area located in southwestern Virginia in Grayson County, approximately 15 miles west of the Project. The Mount Rogers National Recreation Area manages National Forest land near Mount Rogers within the George Washington and Jefferson National Forest. Activities in the Mount Rogers National Recreation Area include camping, picnicking, sight-seeing, bird watching, trout fishing, hunting, biking, bicycling, horseback riding, cross-country skiing, and swimming (USFS undated b).

- **Shot Tower Historic State Park** - The Shot Tower Historic State Park is approximately 10 miles downstream of the Project and is managed as part of the New River State Park. The Shot Tower was constructed over 200 years ago to make ammunition for the firearms of early

settlers and overlooks the New River. There is a parking lot, interpretive signs providing details of the park and visitors may ascend the tower (VDCR 2017).

- **Crooked Creek Wildlife Management Area** - The Crooked Creek Wildlife Management Area is located approximately 10 miles southeast of the Project. The 1,796-acre park includes forested and open land and encompasses portions of both Brooked Creek and the East Fork of Crooked Creek. Recreational opportunities include hunting, trapping, primitive camping, trout fishing, hiking, horseback riding, and birding (VDGIF 2017e).

- **New River Trail State Park** - The New River Trail State Park is an approximately 1,668-acre state park located in Carroll, Grayson, Pulaski, and Wythe counties. The park parallels the New River for approximately 39 miles. The New River Trail is a 57-mile linear park that follows an abandoned railroad right-of-way and is primarily used for hiking, biking, and horseback riding. The park's Foster Falls area offers guided horseback trips; canoe and bike rentals; boat launches; gift shops; and a horse arena. Fishing is also a popular activity off of the New River Trail State Park. Boat ramps are available at Allisonia, Foster Falls, and Austinville.

E.13.1.1.2 Project and Non-Project Recreation Facilities

The Project is accessible by a remote secondary road and is located in a rural setting. The lands on both sides of the Project are steep, but there are some flat parcels along the New River suitable for recreation. The New River Trail State Park extends along the western shore of the Project, which is typically used for hiking, walking, biking and horseback riding. Most of the land to the west of the Project is owned by the USFS and consists of the George Washington and Jefferson National Forest. Recreation activities at the Project mostly consist of fishing, biking, hiking, and small craft boating.

In association with the previous relicensing effort, Appalachian, the VDWR and the VDCR entered into a Memorandum of Understanding signed on June 7, 1994 to provide public recreational access to various points along the New River (Appalachian 1994a). As documented in the existing Recreation Plan (Appalachian 1994b) required by Article 411 of the existing license, the Project supports five FERC-approved ("Project") public recreation facilities owned by Appalachian (Table E.13-1, Figure E.13.1). Two of these Project-related recreation facilities are solely operated by Appalachian and the remaining three sites are operated by VDCR or VDWR under the Memorandum of Understanding and corresponding lease agreements.

Additional ("Non-Project") public recreation facilities or informal access areas exist within the Study Area. Project and Non-Project recreation facilities and access areas within the Study Area that were identified as areas of interest by relicensing participants during the study planning phase of the ILP are also listed and shown on Table E.13-1 and Figure E.13.1. Appalachian's land ownership as requested during the USR meeting and comments on the DLA is shown in Figure E.13.2.

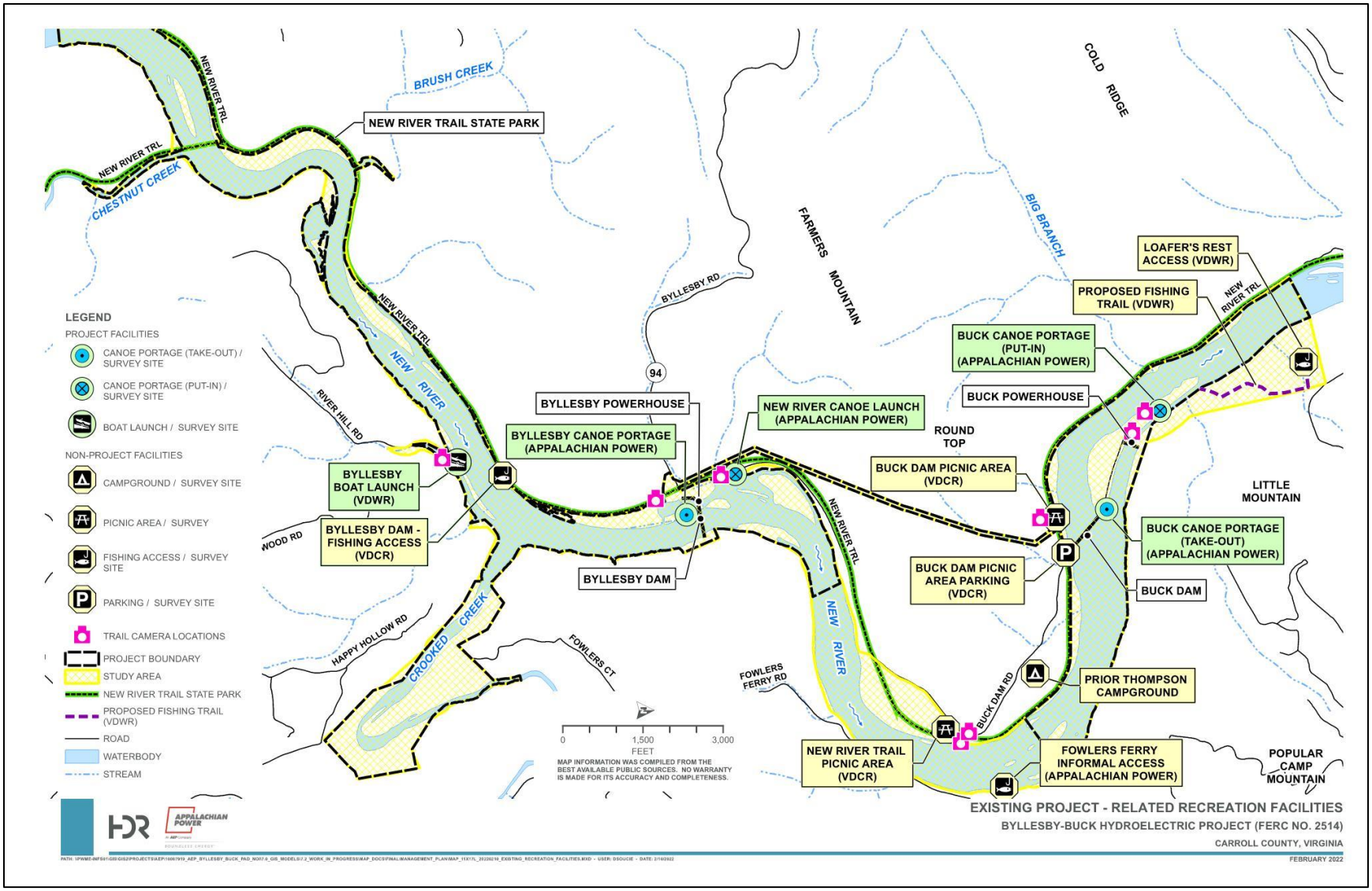

Figure E.13.1. Recreational Facilities at the Byllesby-Buck Project

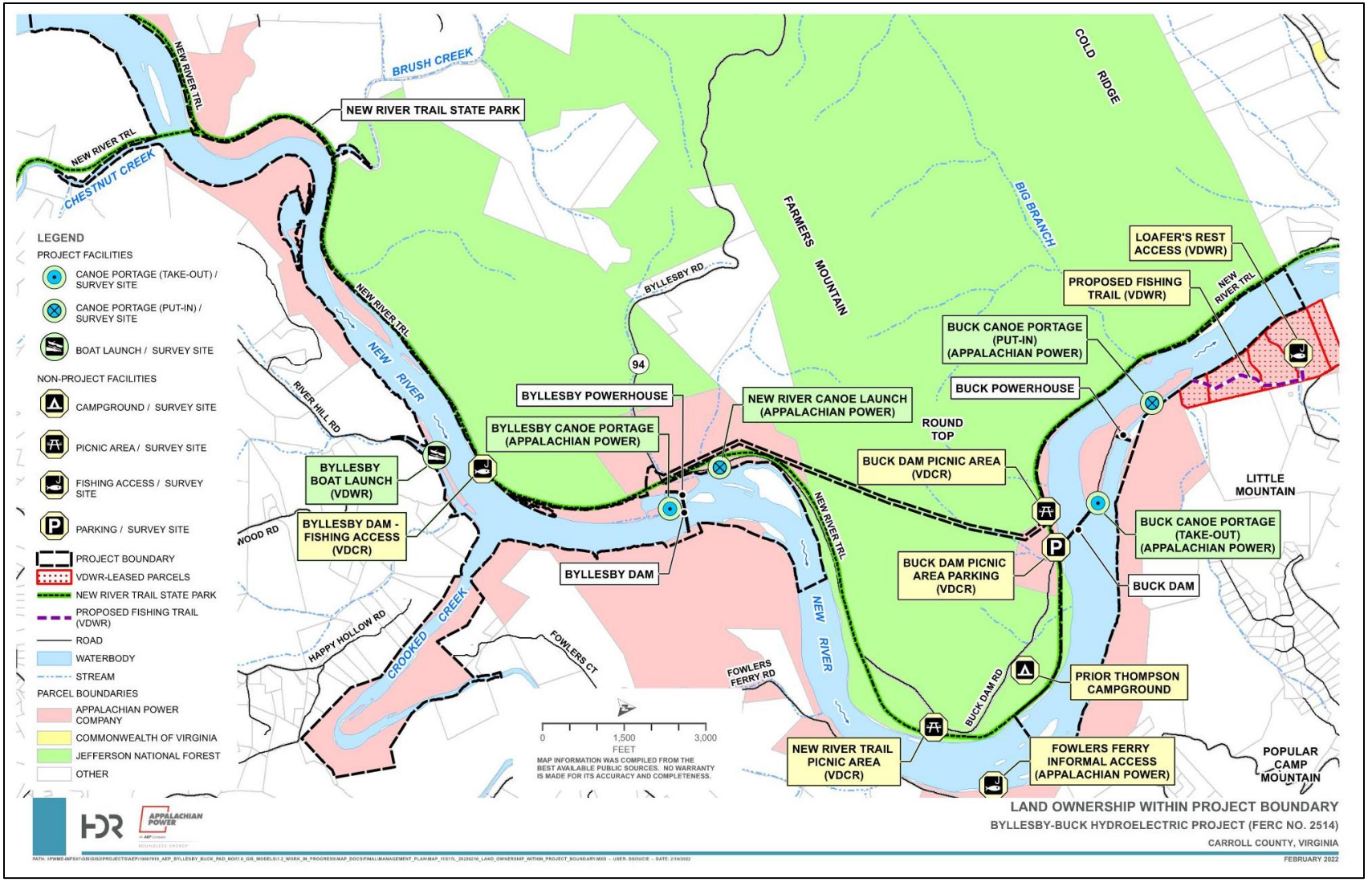

Figure E.13.2. Land Ownership in the Vicinity of the Project Boundary

Table E.13-1.Existing Recreation Facilities at Byllesby-Buck Project

Recreation Facility	Project or Non-Project Facility	Owner/Operator	Amenities	Relationship to Project Boundary
Byllesby Development				
Byllesby Boat Launch	Project Facility	Leased to and Operated by VDWR	Provides single-lane boat concrete boat launch with gravel parking area.	Within Project Boundary
Byllesby Canoe Portage	Project Facility	Owned and operated by Appalachian	Provides approximate 1,500-foot (ft) portage trail. Site consists of a hand-carry canoe take-out and an information trailhead kiosk for the New River Trail State Park.	Within Project Boundary
New River Canoe Launch	Project Facility	Owned and operated by Appalachian	Provides small, gravel parking area with short trail leading to a hand-carry boat launch (also serves as put-in for the Byllesby Canoe Portage).	Adjacent to Project Boundary
VDCR Fishing Site	Project Facility	Leased to and Operated by VDCR	Provides a stone embankment cleared for bank fishing and reservoir viewing. Approximately ¾ mile upstream of the Byllesby Dam on the western shore.	Adjacent to Project Boundary
Buck Development				
Buck Dam Canoe Portage	Project Facility	Owned and operated by Appalachian	Provides crushed stone hand-carry take out and a hand-carry put in.	Within Project Boundary
Buck Dam Picnic Area	Non-Project Facility	Owned and operated by VDCR	Provides gravel parking for vehicles, information kiosk, and access to New River Trail. Also provides a picnic area with picnic table, trash can, portable restroom facility, and a hitching post for equestrian trail users.	Adjacent to Project Boundary
New River Trail Picnic Area	Non-Project Facility	Owned and operated by VDCR	Provides upper and lower recreation areas that include benches, picnic tables, bike rack, trash can, grill, and informal angling access to the Buck reservoir.	Adjacent to Project Boundary
Loafer's Rest	Non-Project Facility	Leased to and Operated by VDWR	Provides a parking area and walking trail to access the New River. Stakeholders are interested in angler access from the Loafers Rest recreation area to the tailrace of Buck Dam.	Adjacent to Project Boundary
Other				
Fowlers Ferry	Non-Project Facility	Land is owned by Appalachian	No formal recreation activities. Informal activities include picnicking, camping, ATV, fishing, wading, and canoe/kayaking	Outside of Project Boundary

Of the facilities and areas evaluated through the Recreation Study, Appalachian believes that the Non-Project Loafer's Rest Area represents the best opportunity to provide additional and enhanced recreational access to the New River in the vicinity of the Project. Loafer's Rest Portage Put-In is operated by VDWR and leased from Appalachian but is outside of the FERC Project Boundary. It currently consists of a road, parking lot (12 spaces), a dove hunting field, a switchback trail, and faded signage. The launch put-in is located on natural riverbank. Additionally, the put-in is relatively far from the existing parking lot, requiring users to carry their boats a long distance. Enhancements to this area identified in consultation with recreation stakeholders and proposed by Appalachian in this FLA are described in Section E.13.3.2 and the draft Recreation Management Plan (Appendix H).

E.13.1.1.3 Aesthetics and Land Use

The Byllesby and Buck developments are located in rural settings along the New River. Neither development is visible from any bridges, roads, or other public transport ways, other than the New River Trail State Park, which runs along the north and west boundaries of the Project, and State Route 737, which parallels the river between Byllesby and Buck. Development along the Project reservoirs and downstream is extremely limited, resulting in riverbanks dominated by mature tree growth. The riverbanks and stream bottoms are composed of rock outcroppings that contribute to the rugged landscape of the New River in the Project area (Appalachian 1991a).

E.13.2 Environmental Analysis

E.13.2.1 Studies in Support of the Current Relicensing

In support of the current relicensing, the Licensee has completed the Recreation Study in accordance with the RSP and the Commission's SPD to support evaluation of the need and potential for enhancement to existing recreation facilities or for additional recreational facilities to support the current and future demand for public recreation in the Study Area.

The Project and Non-Project recreation facilities and opportunities were evaluated by Appalachian in accordance with the results of the Recreation Study. A summary of the methods and results of the Recreation Study is included in this section and details are provided in Appendix G, Volume II of this FLA. The goal of this study was to determine the need for enhancement to existing recreation facilities, or additional recreational facilities, to support the current and future demand for public recreation in the Project area. The primary objectives of the Recreation Study were as follows:

- Gather information on the condition of the existing Project-related public recreation facilities to identify any need for improvement;
- Characterize current recreational use of the Study Area;

- Assess future demand for public recreation at the Project;
- Solicit comments from stakeholders on potential enhancements or new facilities; and
- Analyze effects of continued Project operation on Project-related recreation facilities.

In support of the Recreation Study, Appalachian and their consultants implemented a range of data collection techniques, including a Recreation Facility Inventory and Condition Assessment, a virtual meeting and in-person site visit with stakeholders, a recreation visitor use online survey, and collection of visitor counts and site usage characterization through trail camera installations. Data gathered from these methods collectively illustrate general trends of the Project, which are described in detail in the Recreation Study Report filed as Appendix G, Volume II of this FLA and summarized below.

E.13.2.1.1 Recreation Facility Inventory and Condition Assessment

Appalachian's sub-consultant (LPDA) conducted a Recreation Facility Inventory and Condition Assessment of seven sites, five of which are FERC-approved Project facilities. LPDA recorded the following information for each recreational facility including:

- A description of the type and location of existing recreation facilities;
- The type of recreation provided (boat access, angler access, picnicking, etc.);
- Length and footing materials of any trails;
- Existing facilities, signage, and sanitation;
- The type of vehicular access and parking (if any);
- Suitability of facilities to provide recreational opportunities and access for persons with disabilities (i.e., compliance with current Americans with Disabilities Act (ADA) standards for accessible design); and
- Photographic documentation of recreation facilities and GPS location.

Additionally, a qualitative assessment of the condition of the recreation facilities was performed using a Facility Inventory and Condition Assessment Form.

LPDA observed several common themes among the recreation facilities including lack of ADA accessibility, aging though functional furnishings, informally developed amenities, incomplete signage, and deferred maintenance. LPDA noted that the Project is set in scenic, natural surroundings and the historic dams provide cultural interest. LPDA recommended there is a high potential for increasing recreation value of the sites, both by improving the existing conditions and by developing related amenities.

E.13.2.1.2 Site Visit with Stakeholders to Discuss Existing and Future Recreational Opportunities

Appalachian convened a site visit with key relicensing stakeholders to discuss existing and future recreational opportunities at the Project on October 28, 2020. Prior to the site visit, Appalachian held a virtual meeting on October 21, 2020 with involved stakeholders to share preliminary results of the Recreation Study.

In 2021, Appalachian conducted additional consultation with VDWR to evaluate potential Project and Non-Project recreation facility improvements to be included as part of Appalachian's licensing proposal, as follows:

- Site visit to the VDWR Loafer's Rest recreation facility with VDWR, Appalachian, and Appalachian's consultants on March 24, 2021.
- Conference call with VDWR, Appalachian, and Appalachian's consultants for the Recreation Study on June 29, 2021 to discuss priorities for potential Project and Non-Project recreation facility improvements and to introduce preliminary concepts for development of the VDWR Loafer's Rest recreation facility.

E.13.2.1.3 Recreation Visitor Use Online Survey

HDR developed an online survey drawing from general concepts and guidance from the National Visitor Use Monitoring Handbook (USFS 2007) as well as from other FERC-approved relicensing studies for recreation visitor use surveys. The online survey provided a method for existing and potential recreation visitors to the study area to respond and provide feedback on recreation opportunities and Project and Non-Project facilities at the Project. The online survey was administered through the Project's relicensing website and offered respondents the opportunity to provide survey responses electronically from April through November 2020.

A high-level summary of all the recreation facility user responses is provided below:

- Eighty-four percent of the responses came from four recreation facilities: Byllesby Boat Launch (VDWR), Buck Dam Canoe Portage, New River Canoe Launch, and New River Trail Picnic Area, indicating these sites were the most frequently utilized by online survey participants.
- Forty-two percent of the survey respondents traveled from three nearby zip code areas, with 92 percent considering themselves to be regular visitors to the recreation facility (considered at least 3 or more times a year) and staying at the Project an average length of 5 hours per trip. Eighty-three percent of respondents did not stay overnight at the Project.
- Males made up 74 percent of the respondents, 49 percent were in their thirties and forties.

- Facility usage followed traditional seasonal recreation patterns with May, June, and July being the peak months.

- Fishing and canoe/kayaking were the most popular activities at the Project documented in the online survey.

- Visitors rated recreational facilities on the following metrics: accessibility, parking, crowding, safety, condition, availability, and overall experience. The sliding scale rating system indicated that visitors generally found the individual metrics and general overall experience "acceptable". The only metric that was not rated highest in the acceptable category was the available facilities, which was rated neutral.

E.13.2.1.4 Recreational Use Documentation

Appalachian documented usage of the recreational areas of interest through the installation of trail cameras. Eight trail cameras were installed on October 15 and 16, 2019 and were removed on November 5, 2020. During the trail camera component of the study, HDR downloaded data from the cameras on eight different occasions, capturing thousands of photos.

Review of the trail camera data indicates that the Project is well-used during the spring to fall months, which is attributed largely to the easy access along the entire left bank via the New River Trail. While some of the recreation facilities were used for their intended use, some were used differently than predicted, as further discussed below. Additionally, it was concluded that parking areas at the Project are sufficiently large enough to meet the current demand during a typical and peak recreation day.

Project Facilities Trail Camera Assessment

The Project facilities most frequented by users are the Byllesby Boat Launch and the Byllesby Canoe Portage parking lot. These two Project facilities provide a range of recreation opportunities including boating, canoeing, fishing, walking, biking, and hiking. The Byllesby Boat Launch has the easiest boat access to the New River within the Project Boundary. Fishing is also popular along the shoreline at this facility.

The Byllesby Canoe Portage parking area was largely used to access the New River Trail (including biking, hiking, and walking and dog walking) rather than the intended use for loading and unloading kayaks and canoes. The New River Canoe Launch was used as intended (canoe/kayak put-in), but more frequently used for bank fishing or relaxing along the sandy shore. This facility was not as popular as the Byllesby Boat Launch and the Byllesby Canoe Portage but generally had a consistent amount of foot traffic, especially during the warmer days.

Finally, Buck Dam Canoe Put-In was assessed by the trail camera and found to be seldomly used but when it was, it was used as a put-in or for bank fishing. Stakeholders noted during the October 28, 2020 site visit that users cross the Buck bypass to Mountain Island[18] to gain angler access around the immediate area.

Non-Project Facilities Trail Camera Assessment

Just upstream of the Buck Dam Canoe Put-In, HDR used a time lapse camera to record activity on the right bank of the tailrace. This area is referred to for purposes of this study as Buck Dam – Fishing Access which is accessed from the VDWR's Loafers Rest Non-Project facility. The general area of the Buck Dam – Fishing Access was understood by Appalachian to be of interest to the stakeholders as a fishing spot during the development of the RSP; however the camera in this area recorded approximately two users during the entire survey window. At the October 28, 2020 site visit with the stakeholders, the VDWR noted that there is a No Trespassing sign (public access is prohibited proximate to the powerhouses and dams due to public safety and security concerns) and users are aware of this and avoid the area. Prior to the installation of the No Trespassing sign, this site was suggested to be popular for angler access. More discussion of this facility is provided in the attached Recreation Management Plan (Appendix H, Volume II).

The New River Trail Picnic Area is a Non-Project facility maintained and operated by the VDCR. The upper and lower access provides a wide range of recreational opportunities including picnicking, horseback riding, biking, walking (and dog walking), relaxing, grilling, fishing, observing wildlife and more. This area is accessed directly from the New River Trail and recorded consistent usage throughout the survey window, especially from spring to fall.

The final Non-Project recreation facility assessed with the trail cameras was the Buck Dam Picnic Area. This facility is just downstream of the New River Trail Picnic Area and is also on the New River Trail, therefore, the use was very similar and generally included picnicking, hiking, biking, horseback riding and walking (and dog-walking). This area has direct access from the New River Trail and saw consistent usage throughout the survey window especially from spring to fall.

[18] The Buck Dam Canoe Put-In is located on Mountain Island which is an island between the Buck powerhouse and the bypass.

E.13.2.2 Project Impacts on Recreation and Aesthetics

In SD3, FERC identified the following environmental issues to be addressed in FERC's NEPA document:

- Effects of continued project operation and maintenance on recreation, land use, and aesthetics within the project area.
- Adequacy of existing recreational facilities and public access to the Project (such as fishing in the tailraces) to meet current and future recreational demand.

Aesthetically, the powerhouses at both developments, as well as the primary spillways, have retained the same look since construction was completed in 1912. The powerhouses are both of brick construction with tall, slightly recessed window bays and simple corbelled cornices. The overall appearance is typical of industrial architecture of the time. Facilities related to both developments are well maintained, as are the surrounding grounds. The overall effect is an aesthetically pleasant visual experience for an industrial-oriented facility (Appalachian 1991a).

The Recreation Study captured consistent recreation usage at most of the Project and Non-Project facilities, with usage peaking on the weekends, holidays, and warmer months, as anticipated. In general, the recreation facilities experienced similar types of recreational activities and consistent recreational usage over the study period, especially from May through October. The results of the Recreation Study, as summarized in the sections above, indicate the following:

- The Project is set in scenic, natural surroundings and the historic dams provide cultural interest.
- Many recreation areas at or near the Project contain aging though functional furnishings.
- Visitors would benefit from additional public safety and directional signage.
- Existing sites with highest usage during the study period were the Byllesby Boat Launch, Buck Dam Canoe Portage, New River Canoe Launch, and New River Trail Picnic Area. Fishing and canoe/kayaking were the most popular activities documented from online surveys of visitors.
- Most visitors are local to the region.
- Facility usage followed traditional seasonal recreation patterns with May, June, and July being the peak months.
- The Project facilities most frequented by users based on trail camera observations in 2020 are the Byllesby Boat Launch (leased to and operated by VDWR) and the Byllesby Canoe Portage parking lot. These two Project facilities provide access to a range of recreation opportunities including boating, canoeing, fishing, walking, biking, and hiking. The Byllesby Boat Launch has the easiest boat access to the New River within the Project Boundary. Fishing is also popular along the shoreline at this facility.

- The Byllesby Canoe Portage parking lot was typically used to access the New River Trail (for biking, hiking, walking, and dog walking) rather than the expected use (i.e., loading and unloading kayaks and canoes).
- The New River Canoe Launch was used as intended (canoe/kayak put-in), but more frequently used for bank fishing or relaxing along the sandy shore.
- The Buck Dam Canoe Portage was seldomly used; when it was accessed it was used as a put-in as well as for bank fishing. The put-in is only accessible by water or by crossing the Buck bypass on foot. Stakeholders noted during the October 28, 2020 site visit that users cross the Buck bypass to Mountain Island19 to gain angler access further downstream of the put-in.
- The New River Trail Picnic Area is maintained and operated by the Virginia Department of Conservation and Recreation (VDCR). The upper and lower areas provides a wide range of recreational opportunities including picnicking, horseback riding, biking, walking (and dog walking), grilling, fishing, observing wildlife, and more.
- Usage at the Buck Dam Picnic Area, just downstream of the New River Trail Picnic Area on the New River Trail, was similar to the New River Trail Picnic Area and generally included picnicking, hiking, biking, horseback riding, and walking (and dog-walking). These areas have direct access from the New River Trail and receive consistent use, especially from spring to fall.
- The area below the Buck powerhouse on river right (as viewed looking downstream) known locally as Loafer's Rest was identified during the Recreation Study by the majority of stakeholders as an area where they considered improvements would be most beneficial, specifically for improvements to parking and portaging at the existing put-in and connectivity to fishing access to the Buck tailrace.

The Licensee does not anticipate that operation and maintenance of the Project over the new license term will have any unavoidable, adverse impacts on recreational resources, land use, or aesthetics. Short-term impacts of Project operations on recreation are primarily limited to temporary closure of reservoir boat access facilities if the reservoir(s) have to be drawn down for maintenance or an emergency condition. Appalachian has established procedures with VDWR and local recreational stakeholders for consultation and coordination of such events.

The PM&E measures in place at and proposed for the Project below will benefit recreational resources, land use, and aesthetics.

[19] The Buck Dam Canoe Portage is located on Mountain Island (or Buck Island) which is an island between the Buck powerhouse and the bypass (**Error! Reference source not found.**).

E.13.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Appalachian distributed a draft Recreation Management Plan, including provisions for specific recreation enhancements, to recreation stakeholders on January 26, 2022 for a 30-day review period. The RMP provides documentation of the existing Project facilities, historical agreements with agencies for operation and maintenance of facilities within the Project Boundary (if and as applicable), and proposed enhancement measures for the new license term, as summarized the sections below.

To date, Appalachian has received comments on the draft RMP from VDWR (February 24, 2022) and USFWS (February 24, 2022). These comments are presently under review by Appalachian (copies of these comments are included in the RMP). Appalachian plans to continue consultation with the RMP stakeholders following the filing of the FLA, with the intent of finalizing the RMP and filing a Final Recreation Management Plan with FERC as supplemental information to support Appalachian's relicensing proposal. Additional design details for specific improvements will be developed post-license issuance, according to the procedures and schedules established by the RMP. The draft RMP, and the comments received to date by Appalachian, is provided as Appendix H of Volume II.

E.13.3.1 Enhancements to Project Recreation Facilities Proposed by Licensee

The following proposed structures and enhancements are located on property that is under the control of Appalachian and within the Project Boundary. Appalachian will retain the ability to operate and maintain Project recreation facilities in the event VDWR or VDCR would terminate the lease or operating agreement. The enhancements listed below reflect those included in the draft RMP and may be refined in the final RMP.

- Byllesby Boat Launch (Project Facility): pave gravel parking lot with asphalt; install solar-power dusk to dawn light near main sign at entrance; design and install sign identifying the area and associating it with the FERC license, project number, and licensee; and additional signage installations by Appalachian and/or VDWR as described in the Recreation Management Plan.

- Byllesby Dam Fishing Access (Project Facility): replace bench; replace/refurbish fire ring and grill; design and install sign identifying the area and associating it with the FERC license, project number, and licensee; and additional signage installations by Appalachian and/or VDWR as described in the Recreation Management Plan.

- Byllesby Canoe Portage (Take-Out) (Project Facility): replace/refurbish existing FERC project and directional signage; install additional sign(s) providing emergency contact information for AEP or county emergency management.

- New River Canoe Launch (Put-In) (Project Facility): design and install sign identifying the area and associating it with the FERC license, project number, and licensee; replace/refurbish existing facility identification signage.

- Buck Canoe Portage (Take-Out and Put-In) (Project Facility): re-grade, add slide, and relocate put-in slightly downstream; design and install sign identifying the area and associating it with the FERC license, project number, and licensee; replace/refurbish existing facility identification and directional signage. Final plans for this site will be developed in consultation with VDWR and provided to FERC for review and approval prior to construction pursuant to the Recreation Management Plan.

E.13.3.2 Enhancements to Non-Project Recreation Facilities Proposed by Licensee

Through the Recreation Study performed for the relicensing, two primary improvements in the vicinity of the Loafer's Rest Area were identified by stakeholders: 1) vehicle access closer to the New River and 2) a new fishing access point and trail to the Buck tailrace. Additional improvements identified by VDWR included improvements to the Loafer's Rest put-in, emergency vehicle access, hardening the water access for emergency boat launching by VDWR, and updated signage.

Through site visits and stakeholder consultation conducted for the Recreation Study, an existing farm trail and utility right-of-way were identified as having the potential to provide access from the Loafer's Rest area to the lower portion of the Buck tailrace for bank fishing. The existing trail would also need sufficient improvements. Additionally, to provide access directly to the tailrace, a short trail spur would need to be developed from the existing farm trail. The bank along the Buck tailrace is wide enough to provide adequate room for anglers, therefore no additional improvements along the bank are proposed at this time. The generally undeveloped area of the trails and bank fishing access are also leased by Appalachian to VDWR and located outside of the Project Boundary.

Appalachian proposes to design and construct these improvements for VDWR, and VDWR would then operate and maintain the Loafer's Rest Area and Fishing Trail (Non-Project facility) for the duration of the lease. Appalachian sub-contracted with Land Planning Design Associates (LPDA) to develop conceptual plans and order of magnitude estimates of probable cost for the potential improvements. These conceptual plans, which have not yet been field verified and are subject to refinement through the design process, are provided in Appendix D. Appalachian will coordinate with VDWR and other

applicable agencies to complete necessary permitting and other regulatory approvals, including wetland/waterbody delineation, any necessary resource surveys or identification of time of year restrictions for certain activities, and cultural resources consultation, prior to commencement of construction

Appalachian will coordinate with USFWS, VDEQ, VDWR, Virginia Department of Historic Resources and other applicable agencies to complete necessary permitting and other regulatory approvals, including wetland/waterbody delineation, any necessary resource surveys or identification of time of year restrictions for certain activities, and cultural resources consultation, prior to commencement of any construction in support of the recreation improvements.

E.14 Historic and Archaeological Resources

E.14.1 Affected Environment

In considering a new license for the Project, FERC has the lead responsibility for compliance with applicable federal laws, regulations, and policies pertaining to historic properties, including the NHPA, as amended.[20] Section 106 of the NHPA (Section 106)[21] requires federal agencies to take into account the effects of their undertakings on historic properties and to afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.

The Section 106 process (defined at 36 CFR Part 800) is intended to accommodate historic preservation concerns with the needs of federal undertakings through a process of consultation with agency officials, the State Historic Preservation Officer (SHPO), federally recognized Indian Tribes, and other parties with a potential interest in an undertaking's effects on historic properties. The goals of the Section 106 process are to:

- Identify historic properties that may be affected (directly and/or indirectly) by an undertaking;
- Assess the effects of an undertaking on historic properties; and
- Seek ways to avoid, minimize, or mitigate adverse effects on historic properties through consultation.

Historic properties are defined in 36 CFR Part 800 as any pre-contact or historic period district, site, building, structure, or individual object listed in or eligible for inclusion in the NRHP. This term includes artifacts, records, and remains that are related to and located within historic properties, as well as properties of traditional religious and cultural importance (often referred to as "traditional cultural properties") that meet the NRHP criteria.

The Secretary of the Interior has established the criteria for evaluating properties for inclusion in the National Register (36 CFR Part 60). In accordance with the criteria, properties are eligible if they are significant in American history, architecture, archaeology, engineering, or culture. The quality of significance present in historic properties that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

- Are associated with events that have made a significant contribution to the broad patterns of our history; or
- Are associated with the lives of persons significant in our history; or

[20] 54 USC §300101 et seq.
[21] 54 USC §306108

- Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant or distinguishable entity whose components may lack individual distinction; or
- Have yielded or may be likely to yield information important in prehistory or history.

E.14.1.1 Area of Potential Effects

An area of potential effect (APE) is defined as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. The Commission has not yet defined an APE for the Project. In the context of the relicensing process, FERC generally defines the APE as follows: "The APE includes all lands within the Project Boundary. The APE also includes any lands outside the Project Boundary where cultural resources may be affected by Project-related activities that are conducted in accordance with the FERC license."

Because the Project Boundary encompasses all lands that are necessary for Project purposes, all Project-related operations, potential enhancement measures, and routine maintenance activities associated with the implementation of a license issued by the Commission are expected to take place within the Project Boundary. The proposed APE is consistent with the potential scope of Project effects and the manner in which the Commission has defined the APEs for similar hydroelectric relicensing projects in the region.

E.14.1.2 Existing Discovery Measures

Articles 409 and 410 of the existing license for the Project includes measures to protect and manage historic properties:

> Article 409. The licensee shall consult with the Virginia SHPO and develop and implement a cultural resources management plan to avoid and mitigate any impacts to the historical integrity of the project dams, spillways, and powerhouses, and the Byllesby caretaker's house and transformer house, from routine maintenance and repair work conducted during project operation.
>
> Article 410. If archeological or historic sites are discovered during project operation, the licensee shall: (1) consult with the Virginia SHPO; (2) prepare a cultural resources management plan and a schedule to evaluate the significance of the sites and to avoid or mitigate any impacts to any sites found eligible for inclusion in the National Register of Historic Places; (3) base the plan on the recommendations of the SHPO and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation; (4) file the plan

for Commission approval, together with the written comments of the SHPO on the plan; and (5) take the necessary steps to protect the discovered sites from further impact until notified by the Commission that all of these requirements have been satisfied. The Commission may require cultural resources survey and changes to the cultural resources management plan based on the filings. The licensee shall not implement a cultural resources management plan or begin any land-clearing or land-disturbing activities in the vicinity of any discovered sites until informed by the Commission that the requirements of this article have been fulfilled.

Under Article 409 of the current license, in 1996, Appalachian filed for FERC approval a Cultural Resource Management Plan to avoid effects that may result from maintenance or repair work at the Byllesby-Buck Project (Appalachian 2019a).

E.14.1.3 Identification of Archaeological and Historic Resources

E.14.1.3.1 Previous Cultural Resources Studies

A Phase 1A Archaeological Investigation was conducted by Appalachian for the previous relicensing (Louis Berger & Associates, Inc. 1991). As summarized in the Phase 1A report, only one archaeological site, approximately 0.75 miles downstream of the Buck powerhouse on the east bank of the New River, has been previously recorded in the vicinity of the Project. Additional sites have been recorded within lands managed by the USFS and in the vicinity of the Project.

At the Byllesby development, the potential for prehistoric archaeological sites is limited due to past disturbances, including Project construction. At the Buck Development, the potential for prehistoric archaeological sites is also limited, particularly in the area adjacent to the powerhouse which has been previously disturbed by construction and maintenance activities. With respect to “Mountain Island” (in the middle of the channel, starting at and extending downstream of the Buck dam), the potential for intact cultural deposits on the eastern end of Mountain Island is low due to dam construction and past disturbances, though the remaining portion of Mountain Island was determined to be moderate due to its undisturbed nature and higher elevation areas that may have offered prehistoric populations well-drained areas for occupation.

In support of developing the 1991 license application and other relicensing efforts, a comprehensive cultural resource evaluation of 19 hydroelectric power generating facilities of Virginia was conducted by Louis Berger & Associates, Inc. for Appalachian (Louis Berger & Associates 1991). Based on this assessment and investigations performed for the previous relicensing, the Byllesby-Buck (New River) spillways, dams, and powerhouses have been determined to meet National Register Criteria for Evaluation as set forth in 36 CFR §60.4, a finding with which the Virginia SHPO and FERC have previously concurred.

E.14.2 Environmental Analysis

E.14.2.1 Studies in Support of Current Project Relicensing

Concurrent with the January 7, 2019 PAD and NOI required by the ILP, Appalachian requested designation as the Commission non-federal representative for carrying out informal consultation pursuant to Section 106. The Commission granted Appalachian's request by notice dated March 8, 2019. Pursuant to 36 CFR §800.4(a)(1), in a letter dated September 1, 2020, Appalachian consulted with the Advisory Council on Historic Preservation, the U.S. National Park Service, Bureau of Indian Affairs, Virginia Department of Historic Resources/State Historic Preservation Office (VDHR/SHPO), the Cherokee Nation, the Catawba Indian Nation, the Delaware Nation, the Pamunkey Indian Tribe, the Eastern Band of Cherokee Indians, and the Archaeological Society of Virginia, requesting concurrence on determining the APE for the Project defined as all lands necessary for Project operations.

In August 2020, Appalachian's sub-consultant [Terracon Consultants, Inc. (Terracon)] reviewed the Virginia Cultural Resource Information System (V-CRIS) to identify previously recorded cultural resources within a 0.5-mile radius of the Study Area. On September 10, 2020, Terracon staff traveled to the VDHR office in Richmond, VA to gather additional information otherwise unavailable in V-CRIS.

Detailed study results are included in the Cultural Resources Study Report in Volume V of this FLA, which is filed as CUI \\ Privileged. The Cultural Resources Study Report was transmitted on September 13, 2021 to the SHPO and consulting Tribes for their review and concurrence with the report's recommendations.

E.14.2.1.1 Archaeological and Geomorphological Survey

Background research performed by Terracon indicated three previously recorded archaeological sites are within the Project Boundary: 44CA3, 44CA33, and 44CA121. Sites 44CA3 and 44CA121 are U.S. Army Corps of Engineers sluices that were cut into the shoals of the New River in late nineteenth century. Site 44CA33 was recorded as being a prehistoric open-air site but was never professionally investigated. The National Register of Historic Places (NRHP) eligibility of these three sites had not been assessed.

From October 19 to 22, 2020, Terracon conducted an archaeological assessment of portions of the Project APE. Areas south of Byllesby were accessed by boat, while areas north of Byllesby were accessed by land where possible. The riverbank and islands between Byllesby and Buck were generally not observed due to accessibility and safety concerns with rapidly flowing water and shoals. Terracon attempted to re-locate archaeological sites, although neither was observed during the field

work, possibly due to high water levels. Archaeological and geomorphological investigations of the Project found that most of the APE is either steeply sloped or deeply buried in historic alluvium. In addition, there was very little erosion or other Project related effects in any portions of the APE.

Nine different portions of the Project area considered to have the highest potential for containing archaeological resources were examined using shovel testing. In addition, Terracon tried to relocate the three previously recorded sites, 44CA3, 44CA33, and 44CA121 (Figures 1 and 2; Table 1). As a result of the survey, only site 44CA33 was identified. This temporally non-diagnostic lithic scatter is recommended as being ineligible for inclusion in the NRHP. Sites 44CA3 and 44CA121 could not be relocated, possibly because the water level was too high. In addition to the archaeological investigations, geomorphological investigations were conducted by Seramur & Associates from October 26–28, 2020, and again on April 20, 2021. Twenty hand auger borings were placed in the same nine areas where archaeological investigations took place. Based on the geomorphological analysis, only the area near site 44CA33 had the potential to contain buried archaeological deposits. Currently, this area is not being affected by Project operations, including erosion. The other eight areas did not have suitable landforms for containing undisturbed archaeological resources.

E.14.2.1.2 Architectural Survey

In addition to the archaeological sites listed above, there are three aboveground resources identified within the Project Boundary—the Buck Hydroelectric Facility (017-0022); the Byllesby Hydroelectric Facility (017-5154); and the Norfolk and Western Railway Cripple Creek Extension (077-5068). The Byllesby and Buck facilities were determined to be eligible for the NRHP (Berger 1990), as was the Norfolk and Western Railway. None of these historic resources are currently being affected by Project operations. The three above-ground historic resources are eligible for inclusion in the National Register of Historic NRHP and were revisited during the field work. All three remain eligible for listing in the NRHP.

E.14.2.2 Project Impacts on Historic and Archaeological Resources

In SD3, FERC staff identified the following environmental issues to be addressed in their NEPA document:

- Effects of project operation and maintenance on historic properties and archeological resources that are included in, eligible for listing in, or potentially eligible for inclusion in the National Register of Historic Places.
- Effects of project operation and maintenance on any previously unidentified historic or archeological resources or traditional cultural properties that may be eligible for inclusion in the National Register of Historic Places.

Based on the initial background research and site investigations, and the fact that none of the properties eligible for listing in the NRHP are being impacted, Terracon concluded that no historic properties are currently being affected by continued Project operations. However, Terracon recommended if new construction or significant ground disturbance occurs in areas that have the potential to contain archaeological resources (including areas with an unknown potential), additional archaeological investigations may be warranted and consultation with the SHPO would be necessary. Similarly, if there are any substantial changes to either the Byllesby or Buck facilities, consultation with the SHPO and other consulting parties would be required.

A summary listing of Cultural Resources within the APE is provided in the table below.

Table E.14-1.Cultural Resources within the APE

Resource ID	Description	NRHP Eligibility	Management Recommendation
44CA3	Late 19th century sluice	Not Relocated	No Effect
44CA33	Prehistoric lithic scatter	Not Eligible	None
44CA121	Late 19th century sluice	Not Relocated	No Effect
017-0022	Buck Hydroelectric Facility	Eligible	No Effect
017-5154	Byllesby Hydroelectric Facility	Eligible	No Effect
077-5068	Norfolk and Western Railway Cripple Creek Extension	Eligible	No Effect

Although no significant archaeological resources are being affected by the Project, the investigations performed for this relicensing did identify one area within the APE that has the potential for containing intact archaeological sites. This approximately 47.5-acre area includes a terrace located on the east bank of the river at the north end of the Project where archaeological site 44CA33 was found. Based on the archaeological and geomorphological studies, this is the only area within the Project that has the potential to contain intact archaeological resources. Although the area is not currently being affected by the Project, nor will continued operations of the Project affect the area through erosion or other mechanisms, Terracon recommended that a Phase I intensive archaeological survey take place if any ground disturbing activities were to occur in this area.

Appalachian is not currently proposing modifications to Project operations or Project-related land-clearing or land-disturbing development activities within the APE that would result in an impact to any historic properties. The continued operation of the Project as proposed by Appalachian and subject to the continued protections of an updated cultural resources management plan as described below is not expected to have any unavoidable adverse effects on historic or archaeological resources.

E.14.3 Protection, Mitigation, and Enhancement Measures Proposed by the Applicant, Resource Agencies, and/or Other Consulting Parties

Appalachian has developed a draft HPMP to establish procedures and guidelines for the management of historic properties found within the Area of Potential Effects over the new license term. Through consultation with the SHPO and consulting tribes on the HPMP, Appalachian will develop management measures to avoid, minimize, or mitigate adverse effects on existing and yet-to-be-identified historic and archaeological resources, including any unanticipated discoveries of archaeological material or human remains, over the term of the new license issued for the Project. The measures provided in the HPMP will direct the Licensee's management of NRHP-eligible historic properties within the Project's APE. Specifically, the HPMP:

- Establishes a process for identifying the nature and significance of historic properties that may be affected by project maintenance and operation, proposed improvements to Project facilities, and/or public access;
- Establishes a decision-making process for considering potential effects on historic properties;
- Defines goals for the preservation of historic properties;
- Establishes guidelines for routine maintenance and operation activities as they relate to historic properties; and
- Establishes procedures for consulting with the VDHR, which serves as the SHPO for the State of Virginia and the interested public concerning the potential effects of the Project on historic properties.

The draft HPMP for the Project is included in Volume V (CUI // Privileged) and is also being distributed under separate cover to the SHPO and consulting tribes for their review and comment.

E.15 Economic Analysis

This section of Exhibit E presents the estimated annual value of developmental resources associated with the Project under the current license, the cost of operating and maintaining the Project under the existing license, the cost of each PM&E measure proposed by Appalachian and stakeholders, and the reduction in the value of the developmental resources of the Project attributed to proposed PM&E measures.

E.15.1 Current Annual Value of the Developmental Resource

Appalachian operates the Project for the purposes of electrical power generation. In operating the Project, Appalachian also ensures dam safety, meets the requirements of the existing license, and

implements required PM&E measures to provide for the protection of aquatic resources, water quality, and public recreation facilities and opportunities.

Consistent with the Commission's approach to economic analysis, the value of the Project's power benefits are determined by estimating the cost of obtaining the same amount of energy and capacity using likely alternative resources available in the region. This analysis is based on current costs and does not consider future escalation of fuel prices in valuing the Projects' power benefits.

Appalachian sells all of the electricity generated at the Project into PJM Interconnection[22] (PJM). Based on average 2021 revenue for the Project of $34.44/MWh and generation in 2021 of 73,233 MWh, in 2021 the value of Project power was $2,522,242.

E.15.2 Current Annual Cost of Operations, Maintenance, Repairs, and Administration of the Project

Based on average operations and maintenance costs for the period 2017-2021, the estimated annual cost for the Byllesby-Buck Project is presented in Table E.15-1.

Table E.15-1. Niagara Project Operating Cost for 2021

Description	Cost
Annual operation, maintenance, expenses, fees, insurance, overhead	$978,154
Annual depreciation	$1,692,326
Local, state, and federal taxes	$83,920
Total	**$2,754,400**

E.15.3 Estimated Annual Costs of Proposed Resource Protection, Mitigation, and Enhancement Measures

Appalachian has proposed a number of measures for the protection, mitigation, and enhancement of environmental resources associated with the Project. The proposed environmental enhancements will not require any new lands or water rights for which Appalachian does not already have ownership or rights. The estimated capital and annual costs of PM&E measures proposed by Appalachian at the Project are presented in Table E.15-2.

[22] The PJM Interconnection is a regional transmission organization that coordinates the movement of electricity in all or parts of 13 Mid-Atlantic and Midwestern states plus the District of Columbia.

Table E.15-2. Preliminary Cost Estimate of Resource PM&E Measures Proposed by Appalachian at the Byllesby-Buck Project

Item	Capital Cost (2022 Dollars)	Incremental Operations & Maintenance or Annual Cost (2022 Dollars)
Continue to operate the Project in a run-of-river mode.	-	-
Continue funding of the USGS New River at Galax and Ivanhoe gages.	-	$25,400
Continue to provide a minimum flow of 360 cfs, or inflow through the Project, whichever is less, to the New River downstream of each powerhouse.	-	-
Implement proposed modified ramping rate for spillway gate operations at the Buck development.	$5,000	-
Develop and implement a Bypass Reach Aquatic Resources Protection Plan in consultation with USFWS and VDWR and for FERC approval.	$50,000	$10,000
Conduct Project maintenance and new license implementation activities, as applicable, in accordance the USFWS's prevailing eagle management guidance and regulations.	$10,000	$5,000
Finalize and implement Recreation Management Plan in consultation with Project stakeholders, including provisions for improvements to existing Project facilities (Byllesby Boat Launch, Byllesby Dam Fishing Access, Byllesby Canoe Portage (Take-Out), New River Canoe Launch (Put-In), and Buck Canoe Portage (Take-Out and Put-In) and construction of the Non-Project Loafer's Rest Area and Fishing Trail.	$515,000	$25,000
Finalize in consultation with consulting parties (Tribes, SHPO, and FERC) the draft Historic Properties Management Plan.	$5,000	$1,500
Total	**$585,000**	**$66,900**

E.15.4 Resource Protection, Mitigation, and Enhancement Measures Proposed by Others

Appalachian has received preliminary requests for PM&E measures by agencies and other relicensing stakeholders, primarily through comments filed on the DLA. These requests are presented in Table ES-1 in the Executive Summary. Appalachian expects that resource agencies and Project stakeholders may also revise or make additional requests in response to the FLA, and that supplemental information provided by Appalachian after the FLA (i.e., the revised Bypass Reach Flow and Aquatic Habitat and Aquatic Resources Study Reports, which Appalachian plans to file with FERC by April 14, 2022) may serve to refine Appalachian's proposals. The estimated capital and annual costs of PM&E measures of common and feasible (given the limits of Appalachian's land ownership)

PM&E measures proposed by others at the Project to date and that are not presently proposed by the Licensee are presented in Table E.15-3.

Table E.15-3. Preliminary Cost Estimate of Resource PM&E Measures Proposed by Others at the Byllesby-Buck Project

Item	Requested by	Capital Cost (2022 Dollars)	Incremental Operations & Maintenance or Annual Cost (2022 Dollars)
Implement minimum bypass flows of 88 cfs at Byllesby and approximately 360 cfs at Buck	USFWS	Unknown[a]	$396,300
Develop Wetland Management Plan in consultation with VDWR	VDWR, USFWS	Unknown	Unknown
Consider more fish-friendly turbines (e.g., Natel Restoration Turbine; Voith) to replace Byllesby Units 1, 2 and 4, and Buck Units 1 and 3.	USFWS	Unknown	Unknown
Additional measures to minimize turbine impacts to fish	USFWS	Unknown	Unknown
Total		**$Unknown**	**$396,300+**

[a] Capital costs for the recommended minimum flows have not been evaluated by Appalachian. Appalachian has not identified operationally feasible options for providing continuous minimum flows at the recommended release locations.

Implementation of the minimum bypass flows preliminarily recommended by USFWS (88 cfs at Byllesby and approximately 360 cfs at Buck, continuously) would result in a significant reduction of generation by the Project. Appalachian used a proprietary operations model to analyze energy generation at the Project under the existing (as-licensed) base case and the minimum bypass flows recommended by USFWS. A minimum bypass flow of 88 cfs at the Byllesby Development would result in a reduction of average annual generation of approximately 4.1 percent, or 3,064 MWh (70,811 MWh compared to 73,875 MWh base case). A minimum bypass flow of approximately 360 cfs at the Buck Development would result in a reduction of average annual generation of approximately 16.9%, or 8,442 MWh (41,559 MWh compared to 50,001 MWh base case). The total reduction in generation for the Project with the preliminary minimum bypass flow recommendations is 9.3 percent, or 11,506 MWh (112,370 MWh compared to 123,876 MWh base case). Based on average 2021 revenue for the Project of $34.44/MWh, the annual reduction in Project value that would result from the minimum bypass flow recommendations is $396,267.

E.15.5 Reduction in the Annual Value of the Developmental Resource

Appalachian is not presently proposing any PM&E measures or operational modifications at the Project that would cause a decrease in annual generation or decrease in the value of project power.

Based on the annual value of power presented in Section E.15.1, the PM&E measures proposed by others to date would result in reduction in the annual value of power generated at the Project by an additional (approximately) $396,300 (excluding any additional capital costs). This reduction is the result of the reduced generation that would result from providing the preliminary minimum bypass reach flow recommendations of USFWS.

E.16 Consistency with Comprehensive Plans

Section 10(a)(2) of the Federal Power Act (16 USC §803(a)(2)(A) requires the Commission to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by a project.

Appalachian has no plans to modify existing Project facilities or operations in a manner that would impact existing comprehensive waterway plans on the New River. The proposed turbine upgrades proposed herein would result in an increase in annual energy generation at the project but require no significant changes in Project operations. The Project facilities and operations described in this license application are compatible with the comprehensive waterway plans for the New River as defined in Section 10(a)(1) of the Federal Power Act. The comprehensive plan which affects the Project is the Virginia Department of Conservation and Recreation (VDCR) 2018 Virginia Outdoors Plan (VDCR 2018), which presents a recreational needs assessment and identifies recreational priorities for the Commonwealth.

In accordance with 18 CFR §5.6(d)(4)(III and IV), HDR, on behalf of Appalachian, has reviewed the April 2021 FERC List of Comprehensive Plans applicable to Virginia and adopted by FERC under Section 10(a)(2)(A) of the Federal Power Act, 16 USC §803(a)(2)(A). Of the 62 comprehensive plans relevant to Virginia, four are considered applicable to the Project.

These potentially relevant comprehensive plans, listed by state, are presented in Table H.6-1. Based on a review of these comprehensive plans, current and proposed operations of Project facilities have been determined to be consistent with these plans.

Table E.16-1. List of Qualifying Federal and State Comprehensive Plans Potentially Relevant to the Project

Comprehensive Plan
U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American waterfowl management plan. Department of the Interior. Environment Canada. May 1986.
U.S. Fish and Wildlife Service. n.d. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.
Virginia Department of Conservation and Recreation. The 2018 Virginia Outdoors Plan (SCORP). Richmond, Virginia.
Virginia State Water Control Board. 1986. Minimum instream flow study – final report. Annadale, Virginia. February 1986.
National Park Service. The Nationwide Rivers Inventory. Department of the Interior, Washington, D.C. 1993.
U.S. Forest Service. 1978. Mount Rogers National Recreation Area final management plan. Department of Agriculture. Roanoke, Virginia.
U.S. Forest Service. 2004. Revised Land and Resource Management Plan for the Jefferson National Forest. Management Bulletin R8-MB 115A. Department of Agriculture. Roanoke, Virginia.
U.S. Forest Service. 1993. George Washington National Forest revised land and resource management plan. Department of Agriculture, Harrisonburg, Virginia.
Virginia Department of Game and Inland Fisheries. Upper New River Walleye Management Plan, 2017 to 2022. Blacksburg, Virginia.
Virginia Department of Environmental Quality. 2015. Commonwealth of Virginia State Water Resources Plan. Richmond, Virginia. October 2015.
Virginia Department of Game and Inland Fisheries. 2015. Virginia's 2015 Wildlife Action Plan. Henrico, Virginia. September 1, 2015.

In addition to the FERC List of Comprehensive Plans, the VDCR identified three additional Comprehensive Plans or guidance documents that are also applicable to the Project:

- VDCR Division of Planning and Recreational Resources. Virginia Scenic Rivers Program. Richmond, Virginia.
- VDCR Division of Planning and Recreational Resources. Trails, Greenways, and Blueways. Richmond, Virginia.
- VDCR Division of Planning and Recreational Resources. Virginia State Park Master Planning and State Park Design and Construction. Richmond, Virginia.

E.17 Consultation Documentation

Through the pre-filing consultation stage of the ILP, Appalachian consulted with Federal, state, interstate and local resource agencies, Indian tribes, non-governmental organizations, and unaffiliated

members of the public. A summary and copies of formal consultation correspondence is provided in Appendix I (Volume II of this FLA).

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