Shoreline Stability Assessment Study Report

Niagara Hydroelectric Project (FERC No. 2466)

December 6, 2021

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Prepared for:

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1 Project Introduction and Background

Appalachian Power Company (Appalachian or Licensee), a unit of American Electric Power (AEP) is the Licensee, owner, and operator of the 2.4-megawatt (MW) run-of-river Niagara Hydroelectric Project (Project) (Project No. 2466), located on the Roanoke River (River Mile 355) in Roanoke County, Virginia.

The Project is currently licensed by the Federal Energy Regulatory Commission (FERC or Commission) 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 subsequent 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.

In accordance with 18 CFR §5.11 of the Commission's regulations, Appalachian developed a Revised Study Plan (RSP) for the Project that was filed with the Commission and made available to stakeholders on November 6, 2019. The Commission issued the Study Plan Determination (SPD) on December 6, 2019.

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 11, 2021. Appalachian conducted a virtual ISR Meeting on January 21, 2021 and filed the ISR Meeting summary with the Commission on February 5, 2021. Stakeholders provided written comments in response to Appalachian's filing of the ISR meeting summary, which are addressed in this Updated Study Report (USR) along with study methods and results.

Appalachian has conducted studies in accordance with 18 CFR §5.15, as provided in the RSP and as subsequently modified by FERC. This USR describes the methods and results of the Shoreline Stability Assessment conducted in support of preparing an application for new license for the Project.

2 Study Goals and Objectives

The goals and objectives of the Shoreline Stability Assessment are to:

- Survey the Project'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) (Rosgen 2001; 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.

3 Study Area

The study area for the Shoreline Stability Assessment Study includes the study area shown on Figure 1, including the reservoir shoreline along segments of the Roanoke River and Tinker Creek, bypass reach, and tailrace area downstream of the Niagara powerhouse

4 Background and Existing Information

Existing relevant and reasonably available information regarding geology and soils in the Project vicinity as well as description of the river basin is presented in Section 5.2 of the Pre-Application Document (PAD) (Appalachian 2019). The topography bordering the reservoir is relatively steep in areas, especially along the southern bank. The steeper slopes transition to lower gradients near the shoreline. The majority of the Project reservoir consists of undeveloped riverbanks with steep slopes and tree cover and there is limited upland area within the study area.

Over 62 percent of the Roanoke River basin is forested, about 25 percent is cropland and pasture, and 10 percent is urban (Appalachian 2019). Land use categories within the study area include open water (51%), forest (31%), developed land (0.22% high-intensity; 5.4% medium-intensity; 24% low intensity), and hay/pasture (3%) (USGS 2011). Within the general Project vicinity, land cover along the river is primarily deciduous forest, with low-intensity development along the left descending bank due to the presence of the CSX railroad track. Land use in the western portion of the Project boundary is primarily low- and medium-intensity development. Areas of hay and pastureland exist along areas along Tinker Creek. The upstream portion of the study area (Tinker Creek and the upper reach of the Roanoke River) is located in an urban area associated with the towns of Roanoke and Vinton. These urban areas have a high concentration of impervious surface; therefore, the upper Roanoke River and Tinker Creek in this portion of the study area experience flashy stormwater flows during rainfall events. In general, high flow events increase the probability of stream bank erosion in any watershed, but bank erosion can be accelerated in urban areas. Riparian buffers are limited in the upstream portions of the study area and become wider downstream of the confluence of the Roanoke River and Tinker Creek.

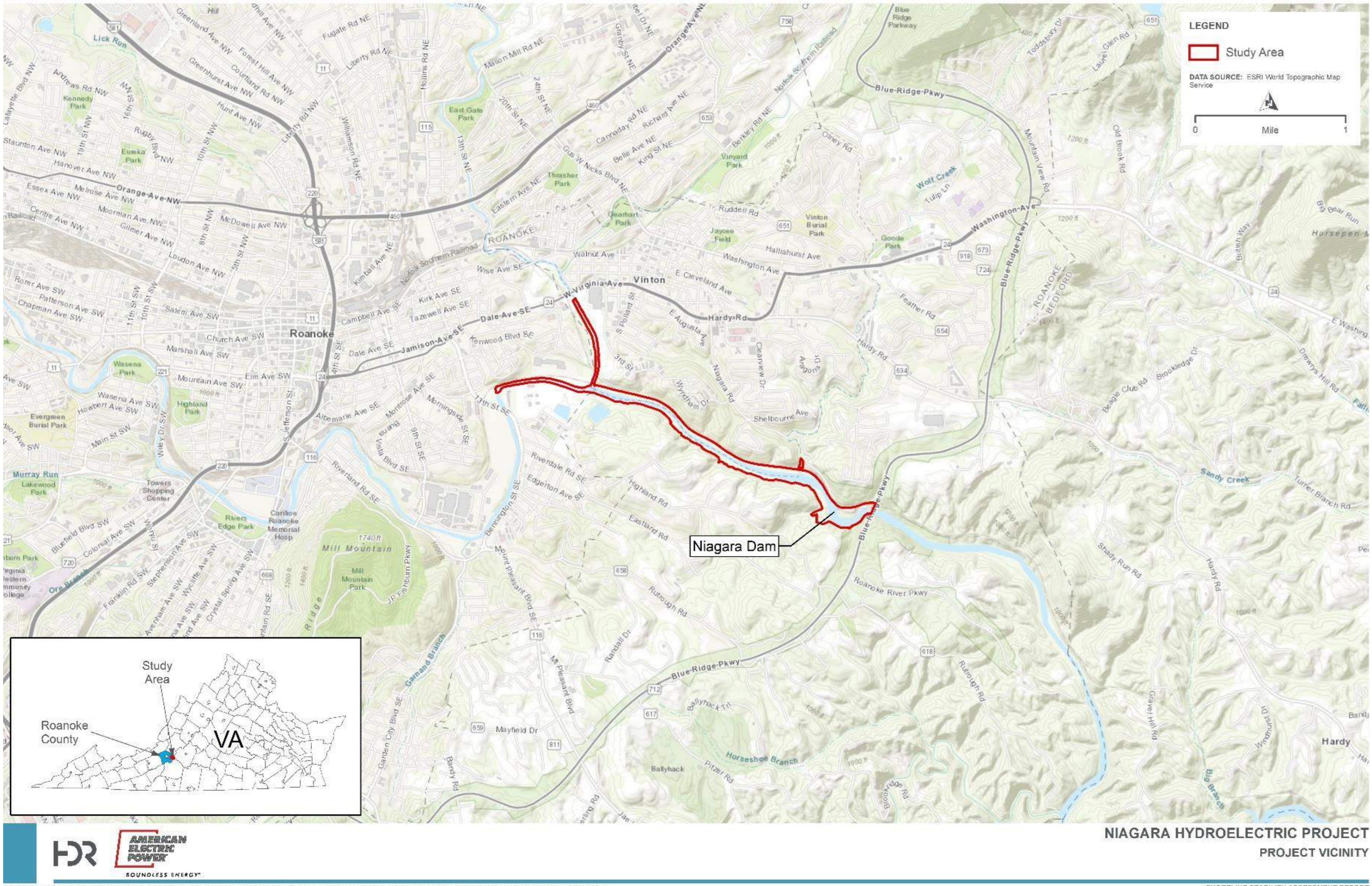

Figure 1. Niagara Shoreline Stability Assessment Study Area

5 Methodology

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 the riverine section of the Roanoke River and its tributary streams identified in the desktop analysis as requiring confirmation or additional investigation. The shoreline was assessed in the field for susceptibility to erosion, and for need and potential for remediation. The study methods provide adequate information to assess shoreline-erosion effects by Project operations.

5.1 Literature Review

HDR reviewed Geographic Information System (GIS) layers including ESRI and Virginia Geographic Information Network (VGIN) aerial photos, U.S. Geological Survey topographic maps, and Natural Resources Conservation Service soil surveys to assess bank composition and erosion potential in the study area.

5.2 Shoreline Survey

The field surveys for the Shoreline Stability Assessment Study were conducted on June 22nd and June 23rd, 2021. Streambanks were assessed based on visual observations by two, two-person field crews either by canoe or walking along the bank. Best professional judgement was used to estimate root depths and density since bank materials were not disturbed or removed during the study.

Rivers are dynamic systems and streambank erosion is a natural function of flow, streambank character (i.e., erodibility), and hydraulic/gravitational forces (Rosgen 2001). Some streambank erosion is normal and necessary to maintain habitat and the dynamic equilibrium of a river system; however, excessive streambank erosion can negatively impact the function of a river and the complexity of predicting streambank erosion rates has limited the application of available models. 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) (see Table 1). These metrics are associated with scores and are totaled to categorize the overall condition of the stream reach assessed. The scores and corresponding categories are shown in Table 2.

Note that the BEHI total score is calculated using scores assigned to five separate physical processes/conditions determined in the field. Field assessments were carried out by HDR field scientists with Rosgen-based training; however, certain criteria in the field (e.g., location of bankfull elevation) may vary slightly between field assessors and results can be subject to user bias. The assignment of streambanks into Rosgen categories is a quantitative process, however, the category assigned to a specific reach (i.e., “high”, “moderate”) should be considered in the context of all other factors that contributed to that score. For example, four out of the five factors for an assessed streambank may yield a favorable score/category (i.e., “low”), however, because that particular stream bank had a type of vegetation prone to shallow root depth, that one variable alone could drive the score up into the higher category. Therefore, nomenclature such as "high" or "very high" can be misleading; it is important to consider all of the variables that yielded a specific score.

Table 1. Description of Rosgen (2001) Metrics for BEHI Evaluation

Metric	Description
Ratio of bank height to bankfull height	Requires accurate identification of bankfull indicators.
Ratio of root depth to bank height	Root depth (RDH) is the ratio of the average plant root depth to the bank height, expressed as a percent (e.g. roots extending 2 feet into a 4 foot tall bank = 0.50).
Root density	Root density (RD), expressed as a percent, is the proportion of the streambank surface covered (and protected) by plant roots (e.g. a bank whose slope is half covered with roots = 50 percent).
Surface Protection	Surface protection (SP) is the percentage of the stream bank covered (and therefore protected) by plant roots, downed logs, branches, rocks, etc. In many streams surface protection and root density are synonymous.
Bank Angle	Bank angle (BA) is the angle of the lower bank – the bank from the waterline at base flow to the top of the bank, as opposed to benches that are higher on the floodplain. Bank angles great than 90 percent occur on undercut banks. Bank angle can be measured with an inclinometer, though given the broad bank angle categories, visual estimates are generally sufficient. Bank angle is perhaps the metric most often estimated incorrectly.

Table 2. Streambank Characteristics used to develop BEHI (Rosgen 2001)

BEHI Category	Bank Height Ratio	BH Score	Root Depth	RDH Score	Root Density	RD Score	Surface Protection	SP Score	Bank Angle	BA Score	Total Score
V. low	1.0-1.1	1.45	90-100	1.45	80-100	1.45	80-100	1.45	0-20	1.45	≤7.25
Low	1.1-1.2	2.95	50-89	2.95	55-79	2.95	55-79	2.95	21-60	2.95	7.26-14.75
Moderate	1.3-1.5	4.95	30-49	4.95	30-54	4.95	30-54	4.95	61-80	4.95	14.76-24.75
High	1.6-2.0	6.95	15-29	6.95	15-29	6.95	15-29	6.95	81-90	6.95	24.76-34.75
V. high	2.1-2.8	8.5	5-14	8.5	5-14	8.5	10-14	8.5	91-119	8.5	34.76-42.50
Extreme	>2.8	10	<5	10	<5	10	<10	10	>119	10	42.51-50

6 Study Results

6.1 Literature Review

The soils in the Project Boundary downstream from the confluence of Tinker Creek, along the shoreline of the Roanoke River, are generally very stony Hayesville channery fine sandy loam with 25 to 50 percent slopes (Figure 2). The Hayesville series consists of very deep, well-drained soils on gently sloping to very steep ridges and side slopes of the Southern Appalachian Mountains. They most commonly form in residuum weathered from igneous and high-grade metamorphic rocks such as granite, granodiorite, mica gneiss, and schist, but in some places formed from thickly-bedded metagraywacke and metasandstone (USDA 2017).

The soils within the Project Boundary upstream from Tinker Creek vary and primarily include occasionally flooded Speedwell-Urban land complex with 0 to 2 percent slopes, Chiswell-Litz complex with 25 to 50 percent slopes, urban land, and Udorthents-Urban land complex. The Speedwell series consists of very deep, well-drained, moderately permeable soils on floodplains. They formed in medium-textured alluvium. The Chiswell series consists of shallow, well-drained, moderately permeable soils on uplands. They formed in materials weathered from shale, siltstone, and fine-grained sandstone. The Litz series consists of moderately deep, well-drained soils formed in residuum from leached calcareous shale and with widely spaced thin layers of limestone (USDA 2017).

As previously described in Appalachian (2019), canopy vegetation is present in the reservoir area, as well as groundcover layers of vegetation (shrubs, small trees, perennials) that thrive under tree canopies. Grasses and perennial species grow along the shoreline in various areas, and the vegetation located along the shoreline of the reservoir prevents shoreline erosion.

The shoreline downstream of the Project's dam and powerhouse is generally steep and graded in areas (especially near the powerhouse). The downstream shoreline typically consists of relatively steep slopes with forest canopy vegetation and underlain in areas by established shrub and herbaceous layers. Large boulders and exposed bedrock are the prevalent substrates along the downstream shoreline. There is no known evidence of erosion, slumping, or slope instability around bypass reach.

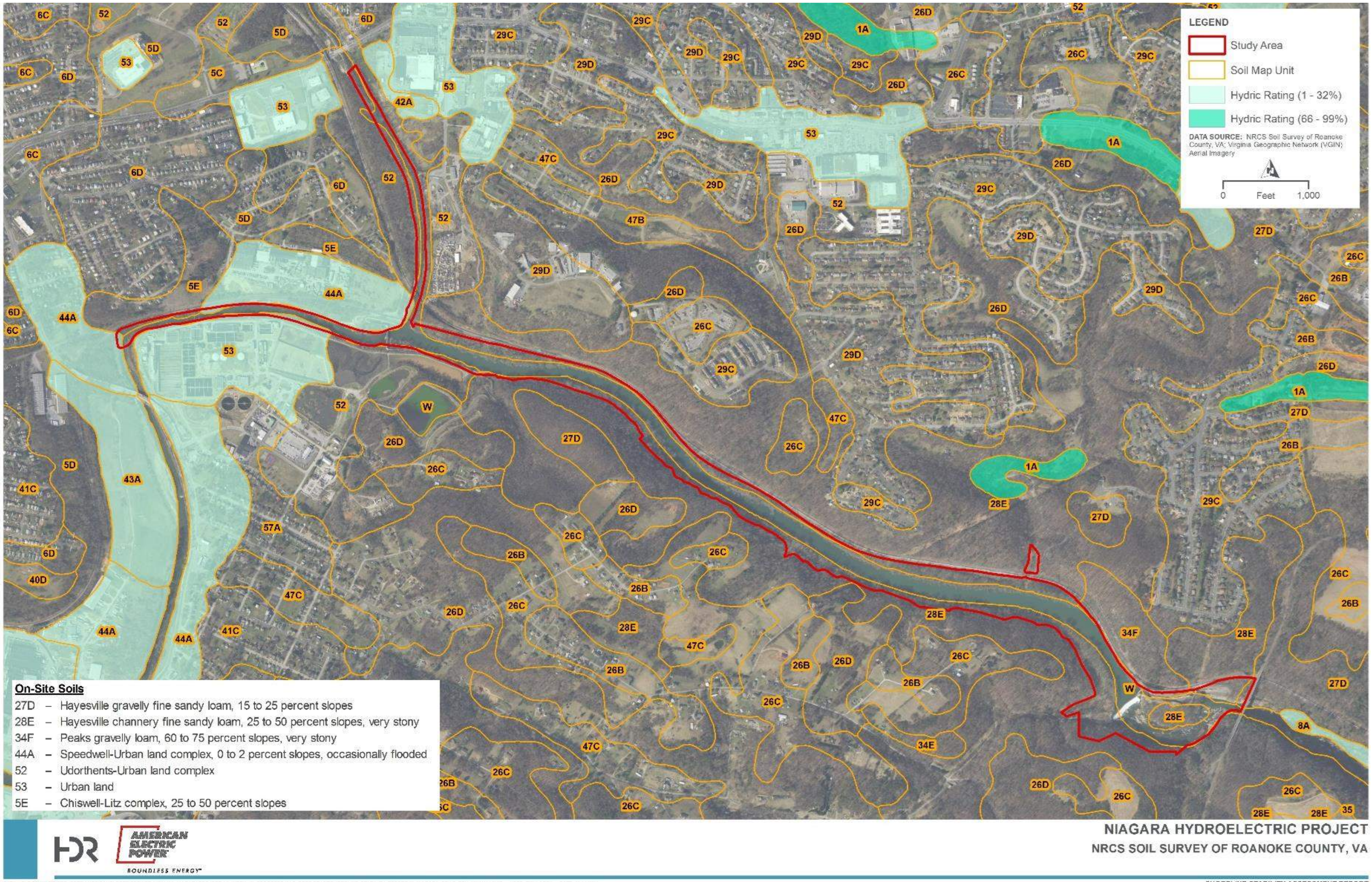

Figure 2. Niagara Shoreline Stability Assessment Soils Map

6.2 Shoreline Survey

Of the approximate seven miles of shoreline assessed, results of the field investigation indicated that approximately 90 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 13.75 (low) to 33.85 (high) (see Table 3). There were no areas categorized as having extreme or very high erosion potential. Where erosion was noted, coordinates were recorded on the upstream and downstream side of the erosion area, and in between, if necessary. Individual points within each area of erosion scored into the same total category (i.e., high, moderate, low). The average scores for each area of erosion are provided in Table 3. Figure 3 shows the locations of the erosion areas assessed within the study area.

The majority of the banks with some level of visible erosion had moderate to high root depth, moderate to high surface protection, and moderate to high bank angle. Generally, banks that were steep exhibiting moderate to high channel incision (BH Ratio >1.5) were least stable. High erosion potential was observed in localized areas along both banks of Tinker Creek and immediately downstream of the confluence of Tinker Creek and the Roanoke River. Streambanks in the upstream portion of the Roanoke River exhibited generally moderate erosion potential. Erosion areas were mainly concentrated in areas in the upstream reaches that experienced higher and/or more flashy flows. No active erosional areas were observed further downstream on the Roanoke River (below the confluence of Tinker Creek) or below Niagara Dam and bypass reach (see Figure 3).

Table 3. BEHI Scores for Erosion Areas of Shoreline Stability Assessment

Map	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	103	2.95	4.95	4.95	4.95	6.95	24.75	Moderate
Erosion Area 2	45	4.95	4.95	2.95	2.95	8.5	24.3	Moderate
Erosion Area 3	28	1.45	2.95	2.95	6.95	6.95	21.25	Moderate
Erosion Area 4	21	2.95	4.95	4.95	6.95	4.95	24.75	Moderate
Erosion Area 5	107	4.95	1.45	1.45	1.45	8.5	17.8	Moderate
Erosion Area 6	98	2.95	1.45	1.45	1.45	8.5	15.8	Moderate
Erosion Area 7	56	4.95	2.95	4.95	2.95	4.95	20.75	Moderate
Erosion Area 8	72	2.95	2.95	1.45	1.45	4.95	13.75	Low
Erosion Area 9	358	2.95	2.95	4.95	4.95	4.95	20.75	Moderate
Erosion Area 10	128	4.95	8.5	6.95	6.95	4.95	32.3	High
Erosion Area 11	225	2.95	6.95	6.95	6.95	6.95	30.75	High
Erosion Area 12	326	4.95	2.95	6.95	6.95	4.95	26.75	High
Erosion Area 13	261	4.95	4.95	6.95	4.95	4.95	26.75	High
Erosion Area 14	336	2.95	2.95	4.95	4.95	4.95	20.75	Moderate
Erosion Area 15	209	2.95	2.95	4.95	6.95	2.95	20.75	Moderate
Erosion Area 16	176	4.95	6.95	8.5	6.95	6.95	34.3	High
Erosion Area 17	99	4.95	6.95	8.5	8.5	4.95	33.85	High
Erosion Area 18	272	4.95	4.95	4.95	6.95	4.95	26.75	High
Erosion Area 19	289	4.95	6.95	8.5	8.5	4.95	33.85	High

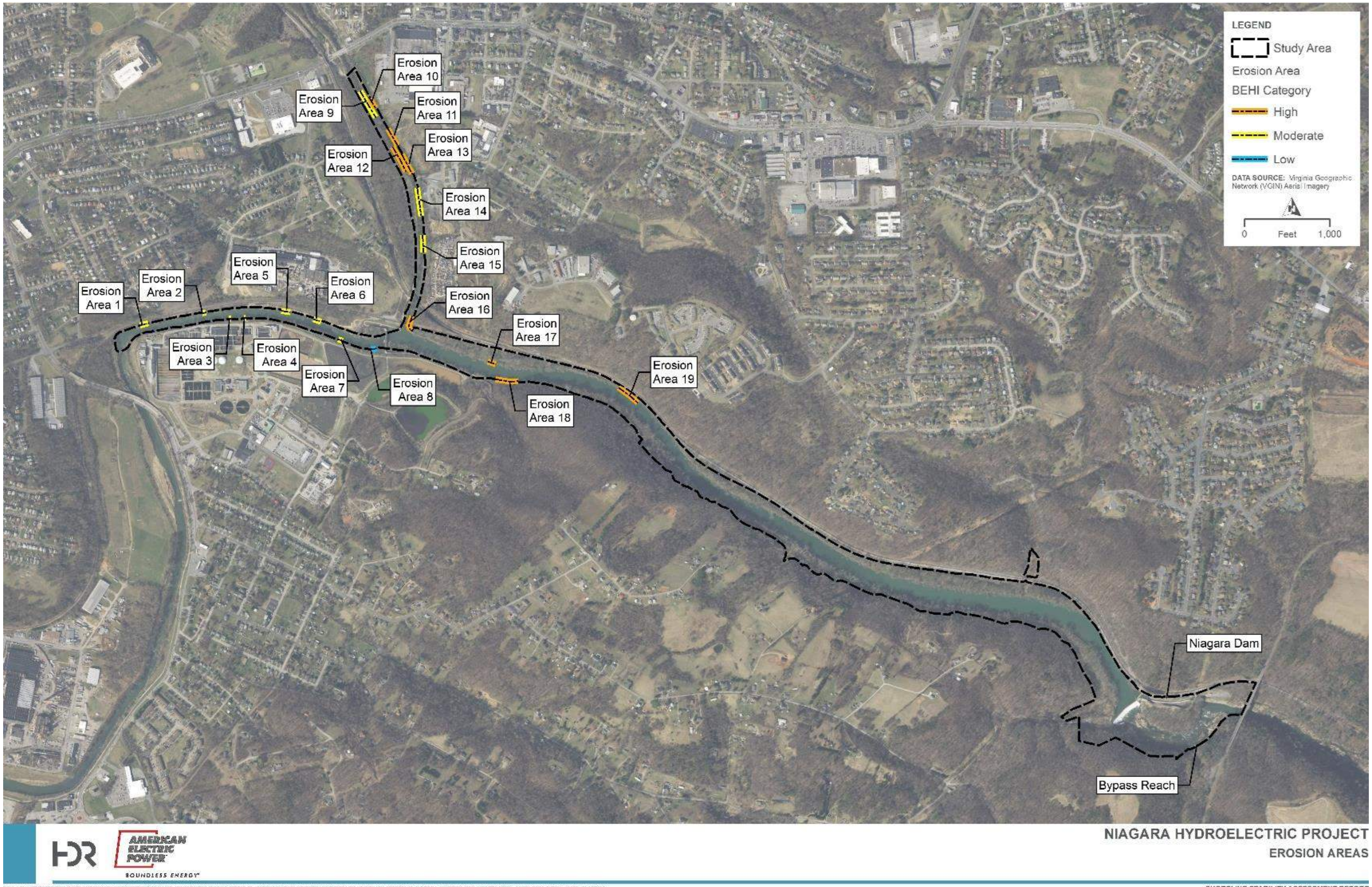

Figure 3. Erosion Areas in the Study Area Categorized by BEHI

7 Summary and Discussion

The Shoreline Stability Assessment provides an evaluation of the relative stability of approximately seven miles on Project shoreline based on the observed bank conditions. Study results indicated that approximately 90 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 (refer to categories listed in Table 2) under present conditions. Erosion areas that received a "high" bank erosion score (i.e., Erosion Areas 10-13 in the upstream reach of Tinker Creek and Erosion Areas 16-19 downstream of the confluence of Tinker Creek and the Roanoke River) are the most susceptible to high flows during storm events and subsequent potential accelerated erosion rates. The remaining erosional areas were categorized as "moderate" or "low".

It is important to note that streambank erosion is often a symptom of larger, more complex problems in the watershed and long-term solutions often involve much more than bank stabilization. Streambank erosion is a normal physical process in a river system and is important for creating and maintaining habitat for aquatic resources; however, drivers of erosion are often difficult to determine because they are integrated with other natural and anthropogenic variables and responses within the watershed upstream. Streambed aggradation or degradation is typically a noticeable indicator of system-wide stream channel instability. Overall, visual inspection of the majority of the Project shoreline during this study indicated stable banks, no noticeable aggradation/degradation, and only localized streambank erosion. The most significant signs of erosion observed during the study occurred in the upper Roanoke River reach and Tinker Creek reach, which are located in urban areas. Accelerated shoreline erosion due to anthropogenic impacts is a well-documented phenomenon and is not driven by operations at the Project. Appalachian does not propose remediation of any shoreline areas in the Project Boundary or study area at this time.

8 Variances from FERC-Approved Study Plan

This study was performed in accordance with the FERC-Approved Study Plan.

9 Germane Consultation and Correspondence

No consultation with state or federal agencies was undertaken for the Shoreline Stability Assessment.

10 References

Appalachian Power Company. 2019. Pre-Application Document. Niagara Hydroelectric Project FERC No. 2466. January 2019.

Rosgen, David L. 2001. A Practical Method of Computing Streambank Erosion Rate. 7th Federal Interagency Sediment Conference, March 25-29, Reno, Nevada.

U.S. Department of Agriculture (USDA). 2017. Official Soil Series Descriptions. Online [URL}: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053587

U.S. Geological Survey (USGS). 2011. Multi-Resolution Land Characteristics Consortium National Land Cover Database. [URL]: https://www.mrlc.gov/data/nlcd-2011-land-cover-conus.

West Virginia Department of Environmental Protection (WVDEP). 2015. Assessing Bank Erosion Potential Using Rosgen's Bank Erosion Hazard Index (BEHI) Available at https://dep.wv.gov/WWE/getinvolved/sos/Documents/SOPs/BEHI-Overview.pdf

Attachment 1

Attachment 1 – Erosion Area Photographs

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Erosion Area 1; Category "Moderate"

Erosion Area 2; Category "Moderate"

Erosion Area 3; Category "Moderate"

Erosion Area 4; Category "Moderate"

Erosion Area 5; Category "Moderate"

Erosion Area 6; Category "Moderate"

Erosion Area 7; Category "Moderate"

Erosion Area 8; Category "Low"

Erosion Area 9; Category "Moderate"

Erosion Area 10; Category "High"

Erosion Area 11; Category "High"

Erosion Area 12; Category "High"

Erosion Area 13; Category "High"

Erosion Area 14; Category "Moderate"

Erosion Area 15; Category "Moderate"

Erosion Area 16; Category "High"

Erosion Area 17; Category "High"

Erosion Area 18; Category "High"

Erosion Area 19; Category "High"