I. INTRODUCTION

This report reviews the original application submitted by Burnshire Hydroelectric, LLC (Applicant), on March 27, 2019 to the Low Impact Hydropower Institute (LIHI) for Low Impact Hydropower Certification for the Burnshire Hydroelectric Project (Burnshire or Project). A LIHI Intake Review was completed January 8, 2019. BH provided supplemental information for review in response to the Intake Review and subsequent inquiries from the application Reviewer on March 27, 2019.

The LIHI Certification application characterized the Project with a long history for supplying electric power. The Project was originally a grist mill, originally known as Old Rush’s Mill. In the late 1800’s it was converted into an electric power source. It was later updated after a flood, which destroyed the original powerhouse. Three hydro turbines were installed to provide the first electricity for the town of Woodstock in 1921 and expanding to other areas in 1923.

The Project was purchased by VEPCO in 1956, now known as Dominion Energy, and was decommissioned. The site was then purchased, and power generation restored with two powerhouses in the late 1980’s with a renewed national interest in hydroelectric development with energy shortage concerns. In the 1990’s, the Project became inactive and power generation ceased. Burnshire Hydroelectric, LLC purchased the site in 2012. Under the current ownership all three turbines have been restored and one propeller turbine is generating power. The second propeller turbine will be fully powered by the end of 2019. The third turbine is slated to be generating power in the near future. The Project currently has a nameplate capacity of 0.232 MW.

II. PROJECT’S GEOGRAPHIC LOCATION

The site is located in rural Shenandoah County, Virginia near the town of Woodstock and is surrounded by farm land and limited residential areas. See Figure 1, below. It is located on the North Fork Shenandoah River at approximately river mile (RM) 41.7. The location coordinates are: LAT: 38° 52’ 31.7” N, LONG: -78° 27’ 59.7” W. Upstream of the Project are several dams: Chapman Dam at RM 50, Edinburgh at RM 58.8 and Timberville at RM 84.9. Downstream of the Project is Winchester Dam at RM 6.5 and Warren at RM 52 (FERC P-2391). There is an upstream USGS Gauge #01633000 in Mount Jackson VA and a downstream USGS gauge # 01634000 located in Stratsburg VA. The watershed area at the Project is approximately 262 square miles.
III. PROJECT AND IMMEDIATE SITE CHARACTERISTICS

The Project is a run-of-river facility with three Leffel turbines; two being Leffel 27-B4 propeller turbines and one Leffel 21-Z Francis turbine. Total nameplate capacity is 0.232 MW with an average annual generation of 1400 MWh. Since 2012 the Project has undergone facility upgrades with an interconnection agreement established with Dominion Power in 2016. The dam is 13.1 feet tall at a mean sea level of 670 feet. It is approximately 400 feet long with an uncontrolled spillway length of approximately 280 feet. The project does not contain spillway gates. Water passes freely over the dam if inflows exceed the power generation draw from the impoundment. The Project impoundment is approximately 38 acres.
with a storage capacity of 200-acre feet. The maximum pool elevation is 670 feet. The Project contains a forebay, which is approximately 150 long.

Burnshire operates as a run of the river facility. The variable speed turbine adjusts to the headpond elevation for regulating generation. The Project has the capacity to operate in a wicket gate range from 5% to fully open due the installation of a unique permanent magnet generator (PMG) coupled to a four-quadrant inverter. This method of operation allows for incoming river flow to match outflow, while still allowing generation in a wider range than for typical turbine/generators. River inflow is measured indirectly via multiple in-channel pressure gauges that monitor for drops in surface elevation. Water surging can occur when the river flow drops below 200 cubic feet per second (cfs). During these times, in addition to the automated controls, a review of the USGS upstream and downstream flow data occurs. This gauge data review determines if Burnshire is matching river flow and not affecting the impoundment elevation. If a discrepancy is determined, the wicket gates are adjusted to either increase or decrease water flow to the turbines.

The Project has recently performed deferred maintenance on the forebay intake with the installation of gabion walls replacing the original native material embankment. The installation of the gabion walls ended the silting and clouding downstream during start up and shut down of the turbines. The forebay improvement project was completed in the summer of 2017.

The Project also serves as a research and development site in a partnership with area universities. Ongoing research is taking place with local stakeholders, specifically the town of Strasburg water authority, to study what, if any, measures or actions Burnshire can take during an extreme drought emergency to assist downstream water users. This ongoing effort was initiated by Burnshire and is not a requirement of any regulatory agency. To date, Burnshire along with students from Virginia Tech™ and James Madison University have completed a study on the conservation of water for towns downstream in cases of drought conditions and how Burnshire could supply emergency water flow in a severe drought or environmental emergency (see Attachment 10). Future studies that are just now forming will include more accurate river modeling with assistance from Virginia DEQ hydrologist Robert Burgholzer.
IV. ZONES OF EFFECT

The Burnshire Hydroelectric project site has two designated zones of effect for this application. Zone 1, the impoundment, see 5, is defined at the upstream start of the impoundment (dam) where the water flows into the turbines. The impoundment zone extends 500 feet upriver where the river begins to curve. This zone border was roughly determined by a student research project in 2016 and defined by the location where the river bottom sounding (measured with a simple string and weight) water elevation and topography would normalize if no dam existed.

Zone 2, the downstream reach, see Figure 6, is defined by the area extending from the outlet of the power house, downstream to where the tailrace outflow stream meets the end of a wall in the tailrace. The tailrace outflow then merges with the main channel river flow approximately 100 feet from the power house.

The Applicant selected Standard 1: Not Applicable / De Minimis Effect for all A-H LIHI Criteria. In addition, the Applicant selected the PLUS Standard for Criterion G: Cultural and Historic Resource Protection in the Impoundment and Downstream Zones of Effect and for Criterion B: Water Quality in the Downstream Zone of Effect. The Applicant’s selected LIHI Standards are shown below in Table 1 and Table 2.
Table 1: LIHI standards selected for Zone of Effect No. 1 - Impoundment

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Alternative Standards</th>
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<tbody>
<tr>
<td>A Ecological Flow Regimes</td>
<td>X</td>
</tr>
<tr>
<td>B Water Quality</td>
<td>X</td>
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<tr>
<td>C Upstream Fish Passage</td>
<td>X</td>
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<td>D Downstream Fish Passage</td>
<td>X</td>
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<tr>
<td>E Watershed and Shoreline Protection</td>
<td>X</td>
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<tr>
<td>F Threatened and Endangered Species Protection</td>
<td>X</td>
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<tr>
<td>G Cultural and Historic Resources Protection</td>
<td>X</td>
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<tr>
<td>H Recreational Resources</td>
<td>X</td>
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Table 2: LIHI standards selected for Zone of Effect No. 2 - Downstream

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Alternative Standards</th>
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<tbody>
<tr>
<td>A Ecological Flow Regimes</td>
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In reviewing the Alternative Standards above the Applicant accurately selected Standard 1 for all LIHI evaluation Criteria A-H. The Applicant could have also selected Standard 2 for the upstream and downstream fish passage. The Virginia Department of Game and Inland Fisheries (DGIF) had made informal recommendations for upstream passage evaluation and night-time operation recommendations for downstream passage for American eel. Given that there are existing dams upstream and downstream of the Project functioning as potential barriers to the American eel, the Applicant provided evidence of the absence of the American eel in the North Fork with a Nature Conservancy study, Chesapeake Fish Passage Prioritization Report (7/1/2013). The study fulfills Standard 1, demonstrating the absence of migratory species at the Project.

V. REGULATORY AND COMPLIANCE STATUS

The Applicant’s evidence was reviewed and further researched to establish regulatory compliance. The following agency records were reviewed.

Federal Energy Regulatory Commission:

On September 22, 1982, the Project was given FERC Project No. 3287, in an Order granting exemption from Licensing of a Small Hydroelectric Project of 5 MW or less. The FERC e-Library was searched for documentation for the last 10 years for any record of compliance issues related to the LIHI Low Impact Certification standards. On February 27, 2012 the Department of Energy published in the Federal Register the transfer of the exemption
from FERC licensing to Burnshire Hydroelectric, LLC, the Applicant. On October 22, 2012 the Applicant provided FERC a plan and schedule, in response to two FERC inspections, outlining the necessary rehabilitation projects to bring the Project back into operational compliance for producing hydroelectricity. In 2013, the Applicant began the following actions: elevated a cofferdam to a 10-year flood level, replaced the powerhouse floor, removed drive shafts and wicket gate shafts, installed main support for #3 turbine shaft, repaired #3 thrust bearing, and hired a hydro consultant to source a generator. The FERC record contains further progress reports on the rehabilitation until all actions were completed in 2015. In 2016, the Applicant updated the Project’s Public Safety Plan. On May 15, 2017 the Project filed a resumption of power production notice. In July 2018 FERC conducted their annual Dam Safety Inspection with no findings for further actions. No evidence of non-compliance was noted in the document review.

US Army Corp of Engineers
On April 5, 2012 the U.S Army Corps of Engineers issued a Regional Permit (08-RP-40) for the requested maintenance dredging conducted as part of Project rehabilitation.

Virginia Department of Environmental Quality
On March 22, 2012 the Virginia Department of Environmental Quality (DEQ) responded to the Project’s application for maintenance dredging of the forebay, forebay entrance and tailrace of approximately 1851 cubic yards. DEQ stated that the Project qualified for an U.S. Army Corps of Engineers Regional, General, or Nationwide Permit. Presuming that the Project would be authorized under a Regional or Nationwide Permit, the March 22, 2012 letter serves as the §401 Certification for the dredging action.

The Applicant reviewed the DEQ water monitoring station data provided on the DEQ website. Water quality in the state of Virginia is based on whether or not the water can fulfill all six of the designated uses for waters. These six designated uses are: aquatic life, fish consumption, public water supplies (where applicable), recreation (swimming), shell fishing, and wildlife. The North Fork in the Project vicinity is not impaired for water quality per the Applicant’s review of the state lists of impaired waters in the state water quality standard’s designated uses for waters.

The DEQ characterizes river quality as: fully supporting, insufficient information, and not supporting. This references whether the water supports the water quality standards appointed by the DEQ. The Project area is listed as “fully supporting” the applicable designated uses on the 2016 Water Quality Map shown in the application’s Figure 2. Using the hyperlink above, one is able to search for Woodstock, VA, then select “monitoring stations” and “2016 Rivers” to verify “fully supporting” designation. This information was verified as part of this report and validated here


VI. PUBLIC COMMENTS RECEIVED OR SOLICITED BY LIHI
LIHI solicited public comments on the Application beginning on April 1, 2019. LIHI did not receive any public comments during the 60-day comment period which ended on May 31, 2019.

Based on the evidence presented by the Applicant, it was determined that direct outreach to state and federal agencies within the Project’s regulatory jurisdiction is not warranted. Therefore, no comments were directly solicited for the Application beyond the standard Public Comment period.
VII. DETAILED CRITERIA REVIEW

To determine if the Applicant has met the required criteria in the LIHI Handbook (2nd Edition, Revision 2.03, 12/20/2018), the respective Goal for each Criterion (A-H) is presented, the Standard (1-4) is presented, followed by an analysis if the Goal has been obtained by meeting the Standard with the Applicant’s evidence. In addition, if the Applicant selected one or more PLUS Standards for Criterion A-H, their evidence to meet the PLUS Standard is evaluated, with a determination if the evidence supports meeting the PLUS Standard.

A. Ecological Flow Regimes

Goal: The flow regimes in riverine reaches that are affected by the facility support habitat and other conditions suitable for healthy fish and wildlife resources.

The Applicant selected Standard the following Standard for both the Upstream and Downstream Zones of Effect:

**STANDARD A-1. Not Applicable/De Minimis Effect:** The facility operates in a true run-of-river operational mode and there are no bypassed reaches or water diversions associated with the facility; or the facility is located within an existing water conduit that does not discharge into natural waterways.

The Project meets these conditions as a run of river facility with the variable speed flow operation matching inflow to outflow. The impoundment is held at a consistent elevation with installed pressure gauges allowing for spill of any flow beyond the generation capacity flow.

Based on the review of the application and supporting documentation, the Project satisfies the Ecological Flow Regimes criterion.

B. Water Quality

Goal: Water quality is protected in waterbodies directly affected by the facility, including downstream reaches, bypassed reaches, and impoundments above dams and diversions.

The Applicant selected the following Standard for both the Upstream and Downstream Zones of Effect:

**STANDARD B-1. Not Applicable/De Minimis Effect:** The facility does not alter the physical, chemical, or biotic water characteristics necessary to support fish and wildlife resources or human water uses (e.g., water supply or recreation);

The Project does not possess a 401 Clean Water Act Certification as the Project being FERC exempt was not required to qualify for such. In lieu of such a Certification the Applicant is required to demonstrate Project compliance with State and/or Federal water quality standards. The Applicant has met this Standard based on
the review of the application with its supporting documentation demonstrating that the Project meets all six of the designated uses for waters. The Applicant provided satisfactory evidence that the DEQ considers the river area within which the Project lies, as *Fully Supporting* the applicable designated uses on the 2016 Water Quality Map. The Project satisfies the Water Quality criterion.

The Applicant selected a PLUS Standard in Water Quality.

**STANDARD B-PLUS:** In addition to satisfying one or more of the standards above, the facility has deployed advanced technology to enhance ambient water quality or is operating an adaptive management program to regularly evaluate the operation of the facility with respect to enhancing water quality.

The Applicant provided evidence of installing gabion baskets along the forebay intake banks to reduce siltation and bank erosion. In addition, the Applicant stated that the installation of the gabion baskets created a micro habitat for vegetation and fauna in the forebay. There was no evidence provided to support this statement. It is the reviewer’s opinion that the installation of the gabion baskets is a deferred maintenance action that in turn results in lower turbidity, but its application is not “advanced”. The LIHI Handbook, Appendix A defines Advanced Technology as:

**Advanced technology:** A technology or mitigation technique based on new ideas, new technology, or unique, site-specific conditions which has a reasonable possibility of providing the desired results (e.g., effective fish passage, improved water quality).

The review of Standard B-Plus based on the evidence provided does not meet the Criterion B-Water Quality PLUS Standard.

**C. Upstream Fish Passage**

**Goal:** The facility allows for the safe, timely, and effective upstream passage of migratory fish. This criterion is intended to ensure that migratory species can successfully complete their life cycles and maintain healthy, sustainable fish and wildlife resources in areas affected by the facility.

The Applicant selected the following Standard for both the Upstream and Downstream Zones of Effect:

**STANDARD C-1. Not Applicable/De Minimis Effect:** The facility does not create a barrier to upstream passage, or there are no migratory fish in the vicinity of the facility and the facility is not the cause of extirpation of species that were present historically; or
The Applicant provided a detailed analysis in support of the C-1 Standard. The Applicant demonstrated that there are no downstream migrating species in the North Fork except potentially the American eel. There are existing instream barriers in place downstream of the Project and there has been no indication that the American eel is present at the Project. FERC required that Virginia DGIF issue an input statement prior to transfer of the exemption to Burnshire in 2012. DGIF stated that the American eel is still present in the river despite these existing upstream and downstream barriers. The nearest upstream barrier is Chapman dam which is approximately eight river miles away from the facility. Figure 14 of the Application shows the barriers in relation to Burnshire. To resolve this difference of opinion of American eel presence, the Applicant presented the finding from a 2013 Chesapeake Fish Passage Prioritization report by the Nature Conservancy (Freshwater Network application) which demonstrated that the North Fork does not possess the American eel. While the DGIF statement in 2012 may be in contradiction to the 2013 Nature Conservancy report, the DGIF was provided opportunity during the Public Comment period as part of this certification process. DGIF did not provide any supporting evidence of American eel presence during these opportunities for comment.

Based on the review of the application and supporting documentation, the Project satisfies the Upstream Passage criterion for both Impoundment and Downstream Zones of Effects.

D. Downstream Fish Passage

**Goal:** The facility allows for the safe, timely, and effective downstream passage of migratory fish. For riverine (resident) fish, the facility minimizes loss of fish from reservoirs and upstream river reaches affected by facility operations. All migratory species can successfully complete their life cycles and to maintain healthy, sustainable fish and wildlife resources in the areas affected by the facility.

The Applicant selected the following Standard for both the Upstream and Downstream Zones of Effect:

| **STANDARD D-1. Not Applicable/De Minimis Effect:** | The facility does not create a barrier to downstream passage, or there are no migratory fish in the vicinity of the facility; if migratory fish were present historically, the facility did not contribute to the extirpation of such species; the facility does not contribute adversely to the sustainability of riverine fish populations or to their access to habitat necessary for the completion of their life cycles. |

The Applicant provided evidence of the Virginia DGIF operational recommendation made in January 2012 of altering night time operations to curtail power generation during the nightly out-migration of adult American eels from September through December of any given year. However, that was not a formal, science-based recommendation. There are existing barriers upstream and downstream of the Project, as well as the 2013 Chesapeake Fish Passage Prioritization by the Nature Conservancy demonstrating no evidence of any migratory species in the Project vicinity on the North Fork of the Shenandoah River. Despite this, the Applicant voluntarily complies with the agency recommendation just in case any eels may be present.

Other fish species that occupy the North Fork include bullhead catfishes, trout, killifishes, minnows, suckers, sculpins, perchs, sunfishes, black bass, fallfish, rock bass, and muskellunge. Water flow through the facility passes through trash racks with a FERC recommendation of one-inch bar spacing which promotes fish safety. Further, the water velocity at the trash racks is less than the FERC two foot per second criterion which
also reduces fish entrainment and promotes fish safety. This recommendation was mentioned by FERC in a discussion during the annual inspection and it is further referenced by FERC, the EPA, and the US Fish and Wildlife agency regarding recommended trash rack spacing (1”) and water velocity at trash racks (<2 fps).

Based on the review of the application and supporting documentation, the Project satisfies the Downstream Passage criterion for both Impoundment and Downstream Zones of Effects.

E. Shoreline and Watershed Protection

_Goal:_ The facility has demonstrated that sufficient action has been taken to protect, mitigate or enhance the condition of soils, vegetation and ecosystem functions on shoreline and watershed lands associated with the facility.

The Applicant selected the following Standard for both the Upstream and Downstream Zones of Effect:

**STANDARD E-1. Not Applicable/De Minimis Effect:** There are no lands associated with the facility where the facility owner has direct or indirect ownership or control over lands surrounding the facility and its riverine zones that have significant ecological value for protecting water quality, aesthetics, or low-impact recreation, and the facility is not subject to any Shoreline Management Plan (SMP) or similar protection plan.

There are no lands within the Impoundment (Zone 1) and Downstream (Zone 2) Zones of Effect deemed of significant ecological value. However, some lands in the vicinity the Project have protected status under conservation easements, or state park or federal forest lands. The portion of the North Fork going through the Project boundary has a wooded riparian buffer. Land within the immediate vicinity of the Project is predominately rural and agricultural. The run of river operation further provides evidence of no shoreline impact. The Project is not required to have a Shoreline Management Plan.

Based on the review of the application and supporting documentation, the Project satisfies the Shoreline and Watershed criterion for both Impoundment and Downstream Zones of Effects.

F. Threatened and Endangered Species Protection

_Goal:_ The facility does not negatively impact federal or state listed species.

The Applicant selected the following standard for both the Upstream and Downstream Zones of Effect:

**STANDARD F-1. Not Applicable/De Minimis Effect:** There are no listed species present in the facility area or downstream reach, and the facility was not responsible for the extirpation of listed species that historically were present; or
The Applicant provided evidence of the absence of protected species with the US Fish and Wildlife Service GIS mapping for Critical Habitat. In addition, the Applicant reviewed the Virginia Department of Conservation and Recreation Virginia Natural Heritage Database. The Project lies within the Narrow Passage Creek-North Fork Shenandoah River sub watershed. The Applicant’s search showed that there were no threatened or endangered species in the Project boundary.

Based on the review of the application and supporting documentation, the Project satisfies the Shoreline and Watershed criterion for both Impoundment and Downstream Zones of Effects.

G. Cultural and Historic Resource Protection

Goal: The facility does not unnecessarily impact cultural or historic resources that are associated with the facility’s lands and waters, including resources important to local indigenous populations, such as Native Americans.

The Applicant selected the following Standard for both the Upstream and Downstream Zones of Effect:

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**STANDARD G-1. Not Applicable/De Minimis Effect:** There are no cultural or historic resources present on facility lands that can be potentially threatened by construction or operations of the facility, or facility operations have not adversely affected those that are or were historically present; or

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The Applicant provided evidence from the Virginia Department of Historic Resources (DHR), Archaeological Site Record, (October 1, 2018) as well as emails from the Virginia Department of Historic Resources dated October 2, 2018 demonstrating the historic significance of the Project.

Based on the evidence provided, the Burnshire dam is listed as a historic site by the Virginia Department of Historic Resources. Its record as a historic site states that demolition is a threat to the resource. DHR only maintains their records of such for 10 years if there is an adverse effect to historic properties. At the request of DHR, the Applicant provided DHR a letter describing the reason for the review request, a description of the rehab work and future operations plan, and photographs of the existing dam and powerhouse (interior and exterior). The DHR responded with an opinion that the historic properties within the Area of Potential Effects will not be adversely affected by the proposed undertaking. These elements are documented fully in the Applicants LIHI application.

Based on the review of the application and supporting documentation, the Project satisfies the Cultural and Historical Resources criterion for both Impoundment and Downstream Zones of Effects.

The Applicant selected the following PLUS Standard for both the Upstream and Downstream Zones of Effect.
The Applicant provided evidence that the Project serves as an educational opportunity by Virginia Tech and James Madison University engineering students as an active laboratory. The Project functions as a field lab with discussion focusing on the history of the site providing the first electricity to the Shenandoah Valley, as well as on hydropower in general and the variable speed turbine/generator. The Burnshire Hydroelectric website extensively details the history of the site along with photos [http://www.burnshirehydro.com/history](http://www.burnshirehydro.com/history).

Based on the review of the application and supporting documentation, the Project satisfies the Cultural and Historical Resources PLUS criterion for both Impoundment and Downstream Zones of Effects.

**H. Recreational Resources**

**Goal:** The facility accommodates recreation activities on lands and waters controlled by the facility and provides recreational access to its associated lands and waters without fee or charge.

The Applicant selected the following Standard for both the Upstream and Downstream Zones of Effect:

**STANDARD H-1. Not Applicable/De Minimis Effect:** The facility does not occupy lands or waters to which the public can be granted safe access and does not otherwise impact recreational opportunities in the vicinity of the facility.


The small Project footprint precludes providing recreational access. The FERC exemption does not require recreational facilities and there is no Recreation Management Plan. However, there is informal access to the river near the Project across the property of other landowners. There are several other dams and low water bridges in the North Fork that affect navigability and boating activities upstream. There are several boat access locations upstream of the Burnshire facility. These locations include the community of Leisure Point (private) and Chapman’s Landing (public) which has a concrete boat ramp. Portage around the dam is not hindered or
discouraged. The Project’s Public Safety Plan demonstrated compliance with the FERC required warning signs are posted of “Dam Ahead” adjacent to the boat ramp at Burnshire site.

Based on the review of the application and supporting documentation, the Project satisfies the Recreation Resources criterion for both Impoundment and Downstream Zones of Effects.

VIII. GENERAL CONCLUSIONS AND REVIEWER RECOMMENDATION

The Project demonstrates the true tenants of the value of hydroelectric power from its history of providing the area its first power resource in the 1800’s to then later ceasing generation, to then being rebuilt for power production in the last few years.

Based on this review, the Burnshire Project meets the LIHI criteria for certification as a Low Impact Hydropower facility and, since it meets Standard 1 for all eight LIHI criterion, it is eligible for a 10-year term as a Very Low Impact Project. While the Project’s educational opportunities meet the PLUS Standard for Cultural and Historic Resources, the maximum LIHI term is 10 years and no additional term can be awarded for the PLUS Standard.