Supplemental Historically Significant Waterpower Equipment Study Report

Lowell Hydroelectric Project (FERC No. 2790)

November 1, 2021

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List of Acronyms

ASME	American Society of Mechanical Engineers
ASCE	American Society of Civil Engineers
Boott	Boott Hydropower, LLC (or Licensee)
C.F.R.	Code of Federal Regulations
Commonwealth	Commonwealth of Massachusetts
CRI	Cultural Resources Inventory
FERC	Federal Energy Regulatory Commission (or Commission)
HAER	Historic American Engineering Record
ILP	Integrated Licensing Process
ISR	Initial Study Report
LCD	Lowell Locks and Canals Historic District
LNHP	Lowell National Historical Park
MACRIS	Massachusetts Cultural Resource Inventory system
MADCR	Massachusetts Department of Conservation and Recreation
MSL	mean sea level
MHC	Massachusetts Historical Commission
MW	megawatt
NGVD	National Geodetic Vertical Datum 1929 (NGVD 29)
NHL	National Historic Landmark
NPS	National Park Service
NRHP	National Register of Historic Places
Project	Lowell Hydroelectric Project (or Lowell Project)
Proprietors	Proprietors of the Locks and Canals
RSP	Revised Study Plan
SPD	Study Plan Determination
Study Workshop	Lowell Hydroelectric Project Study Workshop

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1 Introduction and Background

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20.2-megawatt Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5.

In accordance with 18 C.F.R. § 5.15, Boott has conducted studies as provided in the study plan and schedule approved in the Commission's March 13, 2019 Study Plan Determination (SPD) for the Project. The Commission issued a *Determination on Requests for Study Modifications for the Lowell Hydroelectric Project* (2021 Study Determination) on June 23, 2021. As directed in the 2021 Study Determination, this report supplements the February 25, 2021 Historically Significant Waterpower Equipment Study conducted in support of a new license for the Project. The February 25, 2021 Historically Significant Waterpower Equipment Study is appended to this report as Appendix A.

1.1 Project Description and Background

The Lowell Project is located at river mile 41 on the Merrimack River in the City of Lowell in Middlesex County, Massachusetts, with an impoundment extending approximately 23 miles upstream into Hillsborough County, New Hampshire. The existing Lowell Project consists of:

1) A 1,093-foot-long, 15-foot-high masonry gravity dam (Pawtucket Dam) that includes a 982.5-foot-long spillway with a crest elevation of 87.2 feet National Geodetic Vertical Datum 1929 (NGVD 29) topped by 5-foot-high pneumatically-operated crest gates deployed in five independently-operable zones;
2) A 720-acre impoundment with a normal maximum water surface elevation of 92.2 feet NGVD 29;
3) A 5.5-mile-long canal system which includes several small dams and gatehouses;
4) A powerhouse (E.L. Field) which uses water from the Northern Canal and contains two turbine-generator units with a total installed capacity of 15.0 megawatts (MW);
5) A 440-foot-long tailrace channel;
6) Four powerhouses (Assets, Bridge Street, Hamilton, and John Street) housed in nineteenth century mill buildings along the Northern and Pawtucket

Canal systems containing 15 turbine-generator units with a total installed capacity of approximately 5.1 MW;

7) A 4.5-mile-long, 13.8-kilovolt transmission line connecting the powerhouses to the regional distribution grid;
8) Upstream and downstream fish passage facilities including a fish elevator and downstream fish bypass at the E.L. Field Powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam; and
9) Appurtenant facilities.

At the normal pond elevation of 92.2 feet NGVD 29 (crest of the pneumatic flashboards), the surface area of the impoundment encompasses an area of approximately 720 acres. The gross storage capacity between the normal surface elevation of 92.2 feet and the minimum pond level of 87.2 feet is approximately 3,600 acre-feet. The Project operates essentially in a run-of-river mode using automatic pond level control and has no usable storage capacity.

The Project's primary features are located along the Merrimack River in the City of Lowell, Massachusetts. The City of Lowell was founded in the early 1820s by Boston merchant capitalists and became one of the most significant planned industrial cities in America (Hay 1991). Lowell's factory system, which used the waterpower of the Merrimack River, incorporated new technologies to provide for the mass production of cotton cloth in mills throughout the city (National Park Service [NPS] 1981). Lowell established the pattern for large-scale waterpower development for the next 50 years (Hay 1991).

Several Project facilities are located within overlapping locally, state, and nationally designated parks and historic properties/preservation districts. The Project's Pawtucket Dam and E.L. Field Powerhouse are located along the mainstem of the Merrimack River. The Project's two-tiered network of man-made canals extends throughout downtown Lowell. In addition to the Pawtucket Dam and hydroelectric developments, the Project also includes miscellaneous civil works in the City of Lowell, including the Guard Lock and Gates, Moody Street Feeder Gatehouse, Lawrence Dam, Hall Street Dam, Tremont Wasteway, Lower Locks and Dam, Swamp Locks and Dam, Merrimack Dam, Rolling Dam, and Boott Dam.

The canal system, the downtown mill sites, and many of the Project's civil works, are contributing resources to Lowell Locks and Canals National Historic Landmark (NHL) District. The canal system and many Project facilities are also located within the Lowell National Historical Park (LNHP) managed by the NPS and the larger Lowell Historic Preservation District. The LNHP was established by Congress in 1978 to "preserve and interpret the nationally significant historical and cultural sites, structures, and districts in Lowell, Massachusetts, for the benefit and inspiration of present and future generations." The park is by design a partnership park in which federal, state, and local governments as well as the private sector and local community carry out the legislative intent of the park unit. The LNHP is also listed on the National Register of Historic Places (NRHP), and certain properties within the park overlap with properties in the NHL District.

The Lowell Heritage State Park, established in 1974 as a precursor to the LNHP, is also located within the City of Lowell and is comprised of linear greenways along the Merrimack River and canal system and a collection of historic buildings and structures related to the industrial development of the city. These buildings and structures include Project features and properties located within the NHL District. The Lowell Heritage State Park is operated by the Massachusetts Department of Conservation and Recreation (MADCR) and features exhibits created in partnership with the NPS (MADCR 2018). With the exception of the Rynne Bathhouse, all of the built resources within the Lowell Heritage State Park fall within the Lowell Historic District, designated by the City of Lowell to "…ensure that development activities within the district are consistent with the preservation of its 19th century setting" (MADCR 2014). Portions of the Lowell Heritage State Park also overlap with the Lowell Locks and Canals NHL District and the LNHP.

2 Study Goals and Objectives

As approved in the March 13, 2019 SPD, the goal of this study is to identify and document historically significant waterpower equipment in consultation with the NPS. The specific objectives of this study are as follows:

- Consult with the NPS and conduct a site visit to identify historically significant waterpower equipment of interest to the NPS for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery;
- Photo-document historically significant waterpower equipment identified in consultation with the NPS;
- Conduct background research on the history of identified waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used;
- Document current ownership of historically significant waterpower equipment; and
- Prepare a report summarizing the results of the Historically Significant Waterpower Equipment Study.

3 Study Area

The study area includes the Project's historic canal system, associated flow control structures and the Project's civil works within the existing Project Boundary.

4 Methodology

4.1 Site Visit and Consultation

In consultation with the NPS, Boott clarified the goals of this study during the December 18, 2019 Study Workshop[1] held at the Lowell National Historical Park Visitor Center. The main goal of the study, as provided for in the approved study plan, was the identification of historically significant waterpower equipment "of interest to the NPS." However, Boott understands NPS's goals for this study include the determination of what original hydroelectric equipment is owned/operated by Boott within the Project Boundary is historically significant on a national level, not necessarily simply "of interest to the NPS." In other words, the selection of equipment to include in the analysis should not be limited to NPS' explicitly stated interest.

In July 2020, a site visit was held at Lowell to visit various locations associated with the control of water through the canal system. This tour included inspection of the Swamp Locks Gate House, the Hamilton Gatehouse, the Lower Locks Gatehouse, the Boott Dam Gatehouse, the Moody Street Feeder Gatehouse, and the Northern Canal Gatehouse. Various types of gate operating mechanisms were observed. The purpose of the site visit was to identify specific equipment or structures as historically significant at a national level given that discussions with NPS personnel indicated that they viewed the gatehouses and their mechanisms as part of a larger system.

4.2 Documentary Research

Gray & Pape, on behalf of Boott, conducted documentary research in the records held by the NPS at Lowell to identify the component elements of the larger canal system and the equipment used to operate water control devices throughout the system. The research effort also focused on developing a chronology of the alterations to individual components of the system.

To the extent possible, Boott researched, documented, and summarized relevant information of the history of waterpower equipment and structures of the Lowell canal system. This included review of the extensive 1976 Historic American Engineering Record (HAER) documentation of the individual components of the canal system in Lowell, the LNHP and Historic Preservation District's Cultural Resources Inventory (CRI) (Shepley, Bulfinch, Richardson, and Abbott 1981), and available documentation from Massachusetts Historical Commission (MHC) available through the Massachusetts Cultural Resource Information System (MACRIS).

[1] The meeting minutes of the December 18, 2019 Study Workshop are appended to the February 25, 2020 Initial Study Report.

4.3 Photo-documentation

During the July 2020 site visit, and on October 7-8, 2021, Boott digitally photo-documented known historic waterpower equipment and facilities, including but not limited to Pawtucket Canal-Guard Locks; Pawtucket Canal-Swamp Locks; Lower Pawtucket Canal-Lower Locks; Western Canal Tremont Gatehouse; Western Canal-Lawrence Dam, Wasteway; Moody Street Feeder Gatehouse; Boott Dam Gatehouse; and Northern Canal Waste Gatehouse. The specific photos depended on the nature, accessibility, and type of equipment or facility.

4.4 Identification of Historically Significant Waterpower Equipment

In conformance with the SPD, of the components of the Lowell canal system examined during the July 2020 site visit, researched, and photographed, Boott then identified specific waterpower equipment or structures potentially significant at a national level, distinct from their role as a part of the larger system. Based on available information, Boott compiled further information on these identified structures and equipment including current ownership, designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used.

5 Study Results

5.1 Documentation and Photographic Log

The results of Gray & Pape's documentary research in the records held by the NPS at Lowell are appended as Appendix A to this supplemental report. This research effort by Gray & Pape focused on developing a chronology of the alterations to individual components of the system, including the Guard Locks Complex, Swamp Locks Complex, Lower Locks, and the Pawtucket Gatehouse. The results of this documentary records research found indications of enormous strain on the various system components due to wear and tear associated with daily operations, as well as floods, freshets, and other natural events. Many of the gates, sluices, and other elements that controlled the flow of water originally were constructed of wood and, therefore, subject to rot, and in need of regular maintenance, repair, and replacement. The various component parts of the system have been subject to almost continuous repair, alteration, replacement, or improvement over 200 years.

Significant prior research and studies have been conducted to document historic buildings and structures associated with the canal system, including Project facilities. In 1976, HAER documented the history of the canal system in Lowell. The HAER study included detailed narratives, photographs, drawings, and maps of the historic canal system. The HAER Database assigns an HAER number to each identified historic structure, and provides photographs, a data pages with all known information regarding

designer, owner, and historical significance. The HAER Documentation is being filed with this report as Appendix B.

The LNHP and Historic Preservation District CRI (Shepley, Bulfinch, Richardson, and Abbott 1981), also provides a comprehensive and detailed inventory of historic buildings and structures within the park unit and surrounding preservation area. The CRI provides data sheets for identified historic structures containing information such as construction dates, owners, uses, architectural style and an additional descriptive and historical information section. The CRI report was filed with FERC on April 30, 2018 as Volume II of the Pre-Application Document.

The MHC has converted their paper record (which includes their own documentation as well as pieces of HAER and CRI documentation), into a digital format as part of ongoing projects to scan records of the Inventory of Historic Assets of the Commonwealth and NRHP for Massachusetts. These documents are available to download from MACRIS. The MACRIS Database assigns an Inventory Number to each identified historic structure, and provides photographs, data pages with all known information regarding designer, owner, and historical significance. MACRIS documentation is being filed with this report as Appendix C.

Additionally, other documents were reviewed including the 1976 Lowell Locks and Canals Historic District (LCD) Nomination Form to the NRHP, the LNHP Nomination Form to the NRHP, and the Designation as a National Historic Civil and Mechanical Engineering Landmark by the American Society of Mechanical Engineers (ASME) and American Society of Civil Engineers (ASCE). These documents are appended to this report as Appendix D.

Table 5-1 below summarizes relevant documentation reviewed from HAER, MACRIS, and CRI regarding historical Project structures.

A photographic log of Lowell canal system historical structures and equipment is provided in Appendix E.

Table 5-1. Relevant Prior Documentation Reviewed on Historical Project Structures

Identified Structure	HAER Number	MACRIS Inventory Number(s)	LCD NRHP Nomination Form	Included in LNHP CRI
Pawtucket Dam	HAER MASS,-9-LOW,8A-; HAER MASS, 9-LOW,8-	LOW.937	X	X
Pawtucket Canal	HAER MASS,9-LOW,9-; HAER MASS, 9-LOW,8-	LOW.929; LOW9.019	X	X
Guard Locks Complex	HAER MASS,9-LOW,9A-; HAER MASS, 9-LOW,8-	LOW.9028	X	X
Swamp Locks Complex	HAER MASS,9-LOW,9B-; HAER MASS, 9-LOW,8-	LOW.932	X	X
Lower Locks Complex	HAER MASS,9-LOW,9C-; HAER MASS, 9-LOW,8-	LOW.931	X	X
Pawtucket Gatehouse	HAER MASS,9-LOW,15A-; HAER MASS, 9-LOW.8-	LOW.73	X	X
Northern Canal	HAER MASS,9-LOW,15-	LOW.935	X	X
Northern Canal Waste Gatehouse & Waste Gates	HAER MASS,9-LOW,15C-; HAER MASS, 9-LOW,8-	LOW.9018	X	X
Northern Canal Walk and Great River Wall	HAER MASS 9-LOW,15B-;HAER MASS 8B	LOW.935; LOW.936	X	X
Western Canal	HAER MASS,9-LOW,12-; HAER MASS, 9-LOW,8-	LOW.939	X	X
Lawrence Dam	HAER MASS,-LOW,13A-; HAER MASS, 9-LOW,8-	LOW.979	X	--
Lawrence Wasteway	--	LOW.9016	X	--
Hall Street Dam	HAER MASS,9-LOW,12A-	LOW.980	X	--
Merrimack Canal	HAER MASS,9-LOW,10-; HAER MASS, 9-LOW,8-	LOW.933	X	X

Identified Structure	HAER Number	MACRIS Inventory Number(s)	LCD NRHP Nomination Form	Included in LNHP CRI
Moody Street Feeder & Gatehouse	HAER MASS,9-LOW,16A-; HAER MASS, 9-LOW,8-	LOW.934	X	X
Tremont Gatehouse	HAER MASS,9-LOW,12B;	--	--	--
Eastern Canal	HAER MASS,9-LOW,14-; HAER MASS, 9-LOW,8-	LOW.923	X	X
Merrimack Dam	HAER MASS,9-LOW,10A-; HAER MASS, 9-LOW.8-	LOW.984	X	--
Boott Dam and Gatehouse	HAER MASS,-LOW,14A-; HAER MASS, 9-LOW,8-	LOW.961	X	--
Rolling Dam	HAER MASS,9-LOW,10A-; HAER MASS, 9-LOW,8-	LOW.983	X	--
Hamilton Canal	HAER MASS,9-LOW,11-; HAER MASS, 9-LOW,8-	LOW.930	X	X
Hamilton Canal Gatehouse	HAER MASS,9-LOW,11B-	LOW.992	X	--
Hamilton Canal Guard Gates	HAER MASS,9-LOW,11A-	LOW.990	X	--

5.2 Background Information on Historical Structures

5.2.1 Ownership of Historical Facilities and Internal Waterpower Equipment

As fully documented in the *Resources, Ownership, Boundaries, and Land-Rights Study Report* filed with FERC on November 1, 2021, Boott extensively documented the ownership of various historical structures of the Lowell canal system. The 1984 *Deed, Bill of Sale and Grant of Easements*, also known as the "Great Deed" the Great Deed executed between Proprietors of the Locks and Canals (Proprietors) and Boott, conveyed a considerable portion of the Lowell canal system to Boott (Proprietors 1984). Notably, certain portions or resources that were not conveyed to Boott in the 1984 Great Deed were later obtained by the Commonwealth of Massachusetts (Commonwealth), acting as MADCR, through the December 1, 1986 *Order of Taking* (Commonwealth 1986), or remain under the legal ownership of Proprietors.

Proprietors owns much of the Pawtucket Canal and structures of the Pawtucket Canal. Boott owns the Northern Canal, Western Canal, Merrimack Canal, Eastern Canal, and Hamilton Canal. Boott owns specific dams, lock structures, and hydroelectric equipment, and this is largely determined based on elevation. MADCR owns most of the gatehouses and several other historical structures throughout the Lowell canal system. Table 5-2 below provides an overall summary of ownership of historical Project structures in the Lowell canal system. A photographic log of Lowell canal system historical structures and equipment is provided in Appendix E.

Table 5-2. Ownership of Historical Project Structures

Structure	Owner of Historical Superstructure (Elevation)	Owner of Historical Substructure (Elevation)	Owner of Internal Waterpower Equipment*
Pawtucket Canal	Proprietors	--	--
Guard Locks Gatehouse	MADCR [above 88.2 ft mean sea level (MSL)]	Proprietors [below 88.2 ft mean sea level (MSL)]	Proprietors
Francis Gatehouse	MADCR (above 106.2 ft MSL)	Proprietors (below 106.2 ft MSL)	Proprietors
Guard Locks Locking Gatehouse	MADCR (above 99.2 ft MSL)	Proprietors (below 99.2 ft MSL)	Proprietors

Structure	Owner of Historical Superstructure (Elevation)	Owner of Historical Substructure (Elevation)	Owner of Internal Waterpower Equipment*
Swamp Locks Gatehouse	MADCR (above 89.2 ft MSL)	Proprietors (below 89.2 ft MSL)	Proprietors
Swamp Locks Dam	Proprietors	--	--
Lower Locks Gatehouse	MADCR (above 74.2 ft MSL)	Proprietors (below 74.2 ft MSL)	Proprietors
Lower Locks Dam	MADCR	--	--
Pawtucket Gatehouse	MADCR (above 101.2 ft MSL)		Boott
Northern Canal	Boott	--	--
Northern Canal Waste Gatehouse & Gates	MADCR (above 92.2 ft MSL)	Boott (below 92.2 ft MSL)	Proprietors
Northern Canal Walk and Great River Wall	Proprietors	--	--
Western Canal	Boott	--	--
Lawrence Dam	Boott	--	--
Lawrence Wasteway	Boott	--	--
Hall Street Dam	Boott	--	--
Merrimack Canal	Boott	--	--
Moody Street Feeder	Boott	--	--
Moody Street Feeder Gatehouse	NPS (above 92.2 ft MSL)	Boott (below 92.2 ft MSL)	NPS
Tremont Gatehouse	MADCR (above 90.2 ft MSL)	Boott (below 90.2 ft MSL)	Boott
Eastern Canal	Boott	--	--
Merrimack Dam	Boott	--	
Boott Dam	Boott	--	--
Boott Dam Gatehouse	MADCR (above 74.2 ft MSL)	Boott (below 74.2 ft MSL)	Boott

Structure	Owner of Historical Superstructure (Elevation)	Owner of Historical Substructure (Elevation)	Owner of Internal Waterpower Equipment*
Rolling Dam	Boott	--	--
Rolling Dam Gatehouse	MADCR (above an elevation of 83.7 ft MSL)	Boott (below an elevation of 83.7 ft MSL)	Boott
Hamilton Canal	Boott	--	--
Hamilton Canal Gatehouse and Gates	MADCR (above an elevation of 90.2 ft MSL)	Boott (below an elevation of 90.2 ft MSL	Boott

Notes:
*Based on the 1984 *Great Deed* and 1986 *Order of Taking*, this is defined as mechanisms, controls, and other machinery and equipment which are necessary for the control and operation of water levels, lands, dams, and gates.

5.3 Identified Historically Significant Waterpower Equipment

Gray & Pape conducted documentary research in the records held by the NPS at Lowell to identify the component elements of the larger canal system and the equipment used to operate water control devices throughout the system. The research effort also focused on developing a chronology of the alterations to individual components of the system. Gray & Pape's research on the status, significance, and historical background of the Lowell canal system components can be found in Appendix A.

As determined by Gray & Pape, it is the totality of the system of waterpower and water-control machinery at Lowell that is historically significant. Removal and replacement of individual pieces of equipment was nearly continual, from the day the system first became operational. Removal or alteration of existing equipment would constitute an adverse effect upon the qualities that make the existing system historically significant if they prevented or precluded the system from operating. These and other factors meant that since the initial construction of the Lowell Canal system nearly 200 years ago, the various component parts of the system have been subject to almost continuous repair, alteration, replacement, or improvement.

However, as identified by Gray & Pape, several pieces of equipment or structures appear to be nationally historically significant, distinct from their role as a part of the larger significant system. These structures or pieces of equipment include:

- The surviving 1870 hydraulic gate hoist system at the Pawtucket Canal Guard Locks;

- The Francis turbine powered belt-and-line shafting gate operating system at the Pawtucket Gatehouse;
- The extant gate operating system at the Moody Street Feeder Gatehouse;
- Northern Canal Waste Gatehouse hydraulic equipment; and
- The Boott Dam Gatehouse hydraulic operating system.

In conformance with the SPD, Boott was directed to conduct background research on the history of identified significant waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used. To the extent this information is available, the following sections detail the history of the identified historically significant pieces noted above.

5.4 Background Information on Identified Historically Significant Equipment or Structure

5.4.1 Guard Locks Hydraulic Gate Hoist System

The historically significant 1870 hydraulic gate hoist system at the Guard Locks Gatehouse consists of two water-powered metal cylinders, each measuring 27 inches in diameter and 10 feet tall, located on either end of the hoisting mechanism. The hoist system was designed by James B. Francis and cylinders, pistons, and rods manufactured by IP Morris & Company (the rest of hoisting apparatus manufactured by Lowell Machine Shops)(PLC 1813-1962). The other three hydraulic hoisting cylinders located between the two 1870 originals were installed there in 1965 (Molloy 1976). The purpose of the hoisting mechanism is to control water level and flow into the Pawtucket Canal (Malone 1975).

As noted above in Table 5-2, the internal waterpower equipment at the Guard Locks Gatehouse is owned by Proprietors, while the gatehouse itself is owned by MADCR (above an elevation of 88.2 ft MSL). The 1870 hydraulic gate hoist system is owned by Proprietors (Proprietors 1984; Commonwealth 1986).

5.4.2 Francis Turbine Belt-and-Line Shafting Gate Operating System at the Pawtucket Gatehouse

The historically significant Francis Turbine belt-and-line shafting gate operating system at the Pawtucket Gatehouse was designed by James B. Francis and built between 1846 and 1848. The ten sluice gates of the Pawtucket Gatehouse were originally operated by the Francis Turbine powering the belt-and-line shaft. The ten turbine-powered sluice gates were designed to control the flow of water into the Northern Canal. The belt-and-line shaft operating system was used until 1923, when it was superseded by an electric-motor drive (Molloy 1976).

As noted above in Table 5-2, the internal waterpower equipment at the Pawtucket Gatehouse is owned by Boott, while the gatehouse itself is owned by MADCR (above an elevation of 101.2 ft MSL). The surviving Francis turbine belt-and-line shafting gate system is owned by Boott (Proprietors 1984; Commonwealth 1986).

5.4.3 Operating System at the Moody Street Feeder Gatehouse

The Moody Street Feeder Gatehouse and internal components were constructed in 1848 and designed by James B. Francis. The Moody Street Feeder was a part of the Northern Canal project. Opened in 1849, the Feeder delivered Northern Canal water (via the Western Canal) to the Merrimack Manufacturing Company on the Merrimack Canal. Indirectly, the Feeder also increased the Eastern Canal's supply, via the Boott penstock off the augmented Merrimack Canal (Appendix C).

The Moody Street Feeder Gatehouse contains three manually operated sluice gates equipped with counterweighted rack and pinion equipment. This equipment is original except for the counterweights, which were added in 1853. Each of the gates are used to control the amount of flow between the Western Canal and Merrimack Canal. The three gates are angled at nearly forty-five degrees to the walls of the gatehouse. The Moody Street Feeder below takes this angle to allow the water to flow with less friction and turbulence into the Merrimack Canal. The framework of the gates is tied into the rafters of the gatehouse. The gates and their mechanisms are all original fabric and are in functioning condition (Molloy 1976; Appendix B).

As noted above in Table 5-2, the Moody Street Feeder Gatehouse and all internal hydropower equipment is owned by NPS. This is determined based on an examination of the 2001 Deed between Proprietors and the United States of America (NPS) attached to this report as Appendix F.

5.4.4 Northern Canal Waste Gatehouse Hydraulic Equipment

The Northern Canal Waste Gatehouse on the downstream end of the Great River Wall originally included only four waste gates and their manually powered operating machinery, along with a waste weir divided into multiple bays by cast iron standards. The four manually operated waste gates drew water into the canal and two scouring holes to removed silt. These works were completed in 1847 as part of the Great River Wall project. Major modification took place in 1872 when one of the scouring holes was converted into a wheel pit where a turbine was installed to power mechanical gate operating equipment which was added atop the original manually operated mechanisms. At the same time, the Northern Canal Gatehouse was erected over the waste gates, and a hip-roofed, light-timber-framed building was built over the waste weir (ASME 1985; Molloy 1976). The designer of the Northern Canal Waste Gatehouse is listed as unknown in HAER and MACRIS databases (Appendix B; Appendix C).

As noted above in Table 5-2, the internal waterpower equipment at the Northern Canal Waste Gatehouse is owned by Proprietors, while the gatehouse itself is owned by MADCR (above an elevation of 92.2 ft MSL) (Proprietors 1984; Commonwealth 1986).

5.4.5 Boott Dam Gatehouse Hydraulic Equipment

The Boott Dam was originally built in 1835 to control the level of the Eastern Canal, completed at the same time. In 1878, the sluice way with portcullis gate was built into the dam to facilitate the removal of ice from the Eastern Canal. The present Boott Dam Gatehouse was built in 1892 to accommodate hydraulic equipment to lift the sluice gate, equipment that is still in place (Molloy 1976). The designer/engineer of the Boott Dam Gatehouse and associated equipment is listed as unknown in HAER and MACRIS databases and was not discovered during this research (Appendix B; Appendix C).

As noted above in Table 5-2, the internal waterpower equipment at the Boott Dam Gatehouse is owned by Boott, while the gatehouse itself is owned by MADCR (above an elevation of 74.2 ft MSL) (Proprietors 1984; Commonwealth 1986).

6 Conclusions

As noted above, it is the totality of the system of waterpower and water-control machinery at Lowell that is historically significant. The significance of the Lowell canal system is inherently bound up in the fact that it is a system whose successful operation is dependent upon all its individual component elements. No individual component element is more significant than any other since the successful functioning of the system relies upon all the components. Since the initial construction of the Lowell Canal system nearly 200 years ago, the various component parts of the system have been subject to almost continuous repair, alteration, replacement, or improvement. These changes may be made to components of the system without adversely affecting the qualities and characteristics that make the system itself eligible for the NRHP.

However, as identified by Gray & Pape, several pieces of equipment or structures appear to be historically significant distinct from their role as a part of the larger significant system. These structures or pieces of equipment include:

- The surviving 1870 hydraulic gate hoist system at the Pawtucket Canal Guard Locks;
- The Francis turbine powered belt-and-line shafting gate operating system at the Pawtucket Gatehouse;
- The extant gate operating system at the Moody Street Feeder Gatehouse;
- Northern Canal Waste Gatehouse hydraulic equipment; and
- The Boott Dam Gatehouse hydraulic operating system.

7 Variances from FERC-Approved Study Plan

The Historically Significant Waterpower Equipment Study was conducted in full accordance with the methods described in the FERC-approved study plan. However, Boott notes that the information detailed in this report was limited to the research and existing documentation made available to Boott at the time of this study.

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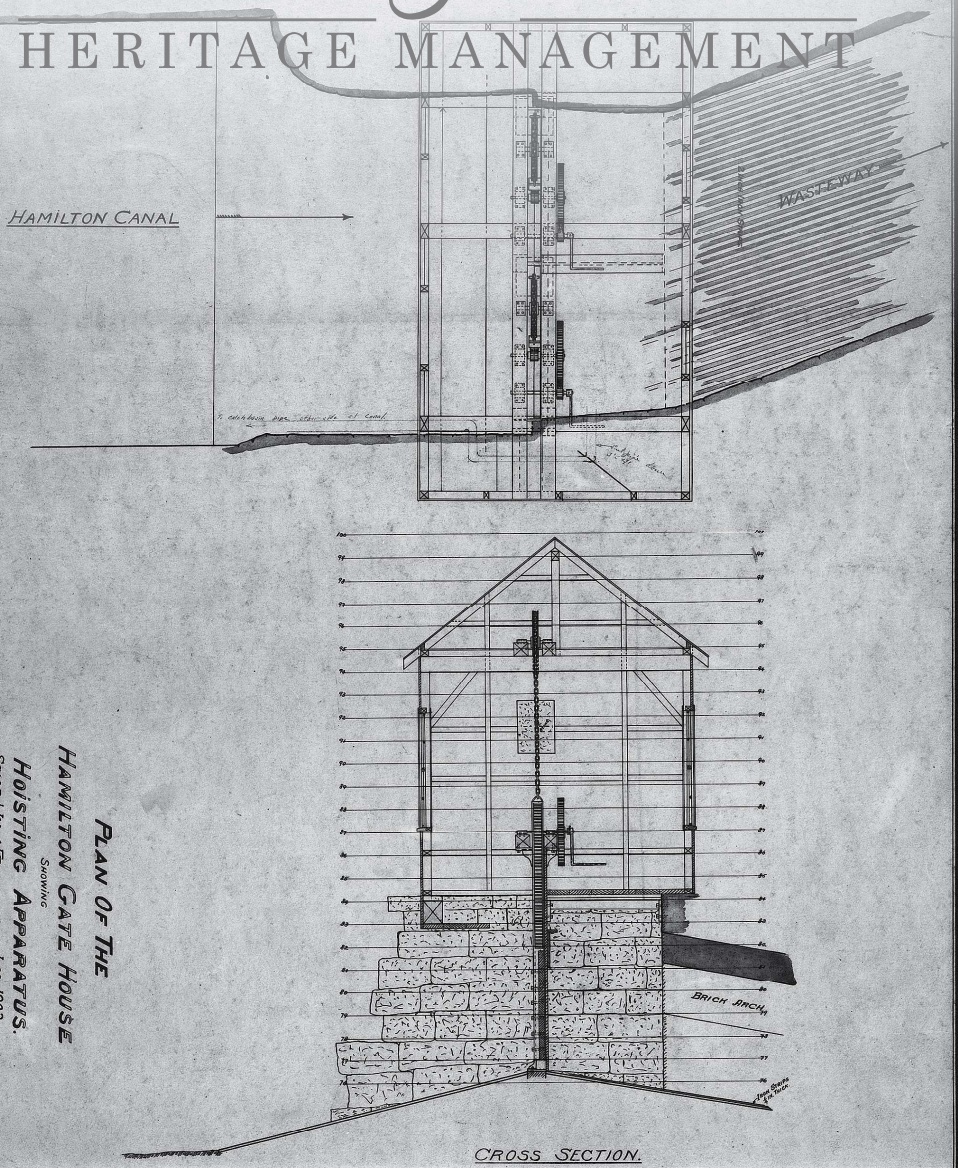
Appendix A – Gray & Pape Study Report

GRAY & PAPE

HERITAGE MANAGEMENT



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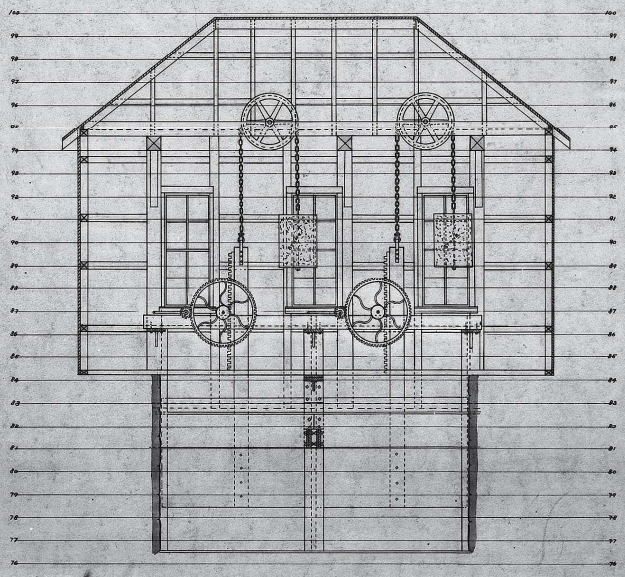

LONGITUDINAL SECTION.

Historically Significant Waterpower Equipment Study, Boott Hydropower, LLC, Lowell, Massachusetts

LEAD FEDERAL AGENCY:
Federal Energy Regulatory Commission
FERC No. 2790

PREPARED FOR:
HDR
1304 Buckley Road, Suite 202
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60 Valley Street, Suite 103
Providence, Rhode Island 02909

20-60301.001

GRAY & PAPE
HERITAGE MANAGEMENT

20-60301.001

Historically Significant Waterpower Equipment Study, Boott Hydropower, LLC, Lowell, Massachusetts

Lead Agency:
Federal Energy Regulatory Commission
FERC No. 2790

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February 19, 2021

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1.0 INTRODUCTION

Boott Hydropower, LLC (Boott) is the licensee, owner, and operator of the 20.2-megawatt Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP), as defined in 18 Code of Federal Regulations (C.F.R.) Part 5. In accordance with 18 C.F.R. § 5.15, Boott has initiated the Historically Significant Waterpower Equipment Study as provided in the study plan and schedule approved in the Commission's March 13, 2019, Study Plan Determination (SPD) for the Project. This report presents the results of the Historically Significant Waterpower Equipment Study.

The Study Report's stated goals were to:

- Consult with the National Park Service (NPS) and conduct a site visit to identify historically significant waterpower equipment of interest to the NPS for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery;
- Photodocument historically significant waterpower equipment identified in consultation with the NPS;
- Conduct background research on the history of identified waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used;
- Document current ownership of historically significant waterpower equipment; and
- Prepare a report summarizing the results of the Historically Significant Waterpower Equipment Study.

2.0 HISTORIC BACKGROUND

The City of Lowell is considered the birthplace of large-scale manufacturing in the United States. Lowell's success depended upon a variety of factors, but one of the most significant was the efficient use of the Merrimack River's waterpower. Begun as a transportation canal, the Lowell Canal System evolved during the nineteenth century into one of the nation's most important waterpower sites.

The Merrimack River originates south of Franklin, New Hampshire, where the Pemigewasset and the Winnepesaukee rivers join. From this point, the Merrimack flows 110 miles, and drops 269 vertical feet, to its mouth in Newburyport, Massachusetts. One of the principal vertical drops along this route occurs at Pawtucket Falls, just south of the New Hampshire state line in Lowell. Here the free-flowing Merrimack dropped more than thirty feet over a series of rapids. Below Pawtucket Falls, the Merrimack swings sharply to the southeast where, after a mile or so, the Concord River flows into the mainstream from the south. The river then swings back to the northeast and continues roughly thirty-seven miles to the sea.[1]

In 1792, a group of Newburyport merchants formed a company to build a canal around Pawtucket Falls. Circumventing the falls was expected to increase the flow of forest products from New Hampshire to Newburyport. The Proprietors of the Locks and Canals on Merrimack River (PLC), as the enterprise was styled, began construction in fall 1792. Work progressed in fits and starts, with the canal opening to traffic in fall 1796.[2]

The canal had to be deepened and its locks rebuilt or repaired several times during its first decade of operation. By 1821, the canal, then known as the Pawtucket Canal, included three single locks, the Guard Locks, Minx Locks, and Swamp or Upper Locks, and a flight of three locks in a row, known as the Lower Locks.

In 1821, the Boston Manufacturing Company (BMC), founded in 1813 by Francis Cabot Lowell, a Boston merchant, was seeking a location for new cotton mills. The BMC operated a fully integrated cotton mill in Waltham, Massachusetts, the first such mill in the world. Raw cotton entered the mill and, because of mechanical operations driven by waterpower, emerged as cloth. In 1821, the firm sought a new location for the production and printing of calicoes, a form of cloth not then produced in the United States. The firm sought land and adequate waterpower for factories, print works, and corporate housing, and began secretly purchasing the stock of the PLC, as well as land near the Pawtucket Canal. By 1822, the new venture had acquired control of the PLC, had formed itself as the Merrimack Manufacturing Company, and was ready to enlarge the Pawtucket Canal, erect its first mill, and construct a branch canal to the mill site.[3]

The purpose of every modification to the canal system was to provide a dependable and predictable flow of water to each mill site. Initially, this involved securing a reliable flow through Pawtucket Canal. The gates of the canal's locks opened and closed, admitting and releasing water into the system in accordance with the needs of traffic on the canal. This method of operation failed to provide the predictable flow of water required by the mills, so one of the first major building campaigns entailed construction of dams at each of the canal locks. Between 1822 and 1824, the Merrimack

[1] J.W. Meader, *The Merrimack River: Its Source and Its Tributaries* (Boston, MA: B.B. Russell, 1869).
[2] Patrick M. Malone. *Waterpower in Lowell: Engineering and Industry in Nineteenth-Century America* (Baltimore, MD: Johns Hopkins University Press, 2009), 12.
[3] Ibid., 22–24.

Manufacturing Company rebuilt the Pawtucket Canal to enable it to serve as both a power and transportation canal. The locks at the Guard Locks, Swamp Locks, and Lower Locks were rebuilt in stone, lined with wood. New dams, fitted with sluice gates, were constructed at each location. These dams created pools of water that could be used to provide water to the downstream mills, regardless of whether the canal locks were open or closed.[4]

Over a period of about twenty-five years, following the Merrimack Manufacturing Company's acquisition of control of the PLC in 1822, the transportation canal constructed around Pawtucket Falls was expanded and enlarged in a series of major building campaigns (Figure 2-1). By 1823, the newly constructed dam at Swamp Locks provided water for the Merrimack Canal. By 1826, the Lowell Canal branched off the Merrimack Canal and provided power for the Lowell Mills, while the Hamilton Canal branched off the Pawtucket Canal above Swamp Locks and provided power to the Appleton and Hamilton mills. In 1831, the Western Canal also branched off the Pawtucket Canal and served the Suffolk, Lawrence, and Tremont mills. In 1836, the Eastern Canal branched off the lower Pawtucket Canal and powered the Boott Mills. By 1836, the first stage of canal construction was complete. It constituted a two-level system, with the Western, Merrimack, Lowell, and Hamilton canals, all of which took their water from above Swamp Lock Dam, comprising the upper portion of the system, and the Lower Pawtucket and Eastern canals, fed from below Swamp Locks Dam, comprising the lower portions. The second great phase of construction was completed by 1848. Beginning in 1846, the construction of the Northern Canal and the Pawtucket Gatehouse brought water directly from the Merrimack River to the lower reaches of the Western Canal, reversed the flow of water in the upper reaches of the Western Canal, and, by means of the Moody Street Feeder, brought water to the lower stretch of the Merrimack Canal.[5]

This complex system of canals delivered the waterpower of the Merrimack River to the mills of ten textile corporations. Beside the lower Pawtucket Canal, stood the mills of the Hamilton, Appleton, Lowell, and Merrimack corporations, as well as the massive machine shop of the PLC. The Massachusetts and Boott mills stood between the Eastern Canal and the Merrimack River, while upstream were the Merrimack mills and the printworks and factories of the Lawrence Corporation. The Tremont and Suffolk mills flanked the Western Canal. This network of canals "formed a dynamic system which was only in equilibrium when proper water levels were maintained."[6] The engineering plan called for water to generate power on both levels of the system, to enter the lower canals only after passing through the wheel pit of an upper-level mill. This required upper-level water users to discharge at least as much water as the lower mills required.

Reduced discharge from upper-level mills could be offset by allowing supplemental water to flow directly from the upper to the lower levels. On the Western Canal, this could be done at the Hickey Hall Dam, while the flow in the Pawtucket Canal could be augmented by releasing water at Swamp Locks Dam. Managing the flow of water through this complex system required careful coordination. A system of dams and gatehouses helped control the flow of water and was intended to assure that all users were adequately supplied with power.

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[4] Anne Booth. "Historic Structure Report: Pawtucket Canal and Northern Canal Lock Structures: Historical Data Section." 3 vols., Harlan D. Unrau, ed. (Denver, CO: National Park Service Denver Service Center, 1981), 1:2.
[5] Louis C. Hunter. *A History of Industrial Power in the United States, 1780–1930; Volume One: Waterpower in the Century of the Steam Engine* (Charlottesville: University Press of Virginia, 1979), 255–261
[6] Patrick M. Malone. *Lowell Canal System* (Washington, D.C.: Historic American Engineering Record, 1975), 107.

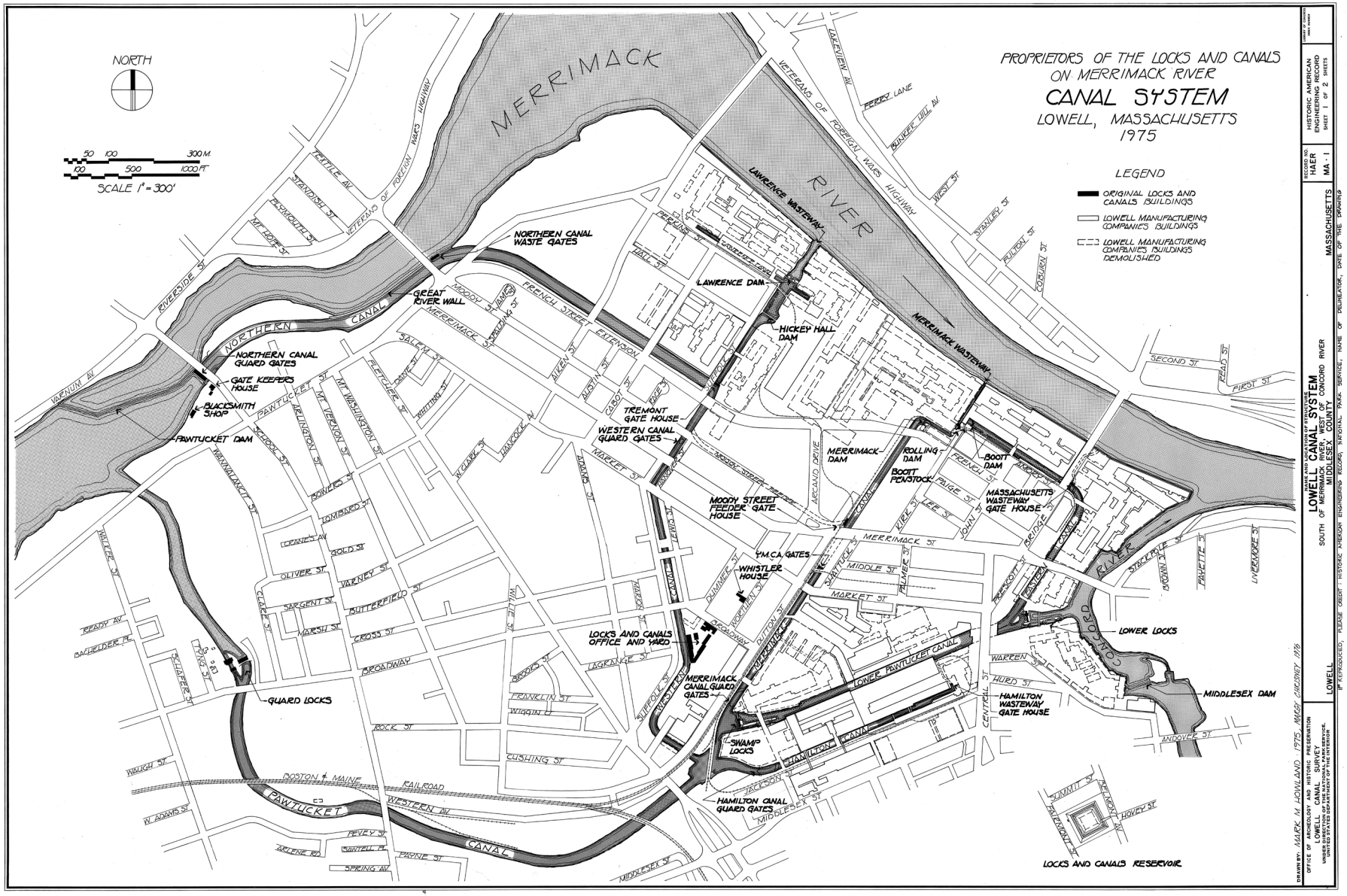

Figure 2-1. Historic American Engineering Record, Lowell Canal System, 1975.

3.0 STATUS AND SIGNIFICANCE

The Lowell Locks and Canals Historic District was listed in the National Register of Historic Places (NRHP) in 1976. The nomination's statement of significance reflects the standards of the time, and states that the district is significant "for its contributions to the development of Lowell as the first great industrial city in the United States." The statement of significance acknowledges the complex engineering involved in the construction of the canals and notes that "each new canal was built in an attempt to solve the problem of keeping all the mills supplied with a sufficient supply of power."[7] The established period of significance for the district is 1790–1870, though this periodization privileges the period when waterpower was used to directly drive mill machinery through the use of shafting and belting, and does not encompass the entire period of significance for the locks and canal system and its component resources.

The significance of the Lowell canal system is inherently bound up in the fact that it is a system whose successful operation is dependent upon all its individual component elements. No individual component element is more significant than any other since the successful functioning of the system relies upon all the components. Certainly, a particular canal, or a particular mill, could function without some elements of the system, but the system, as a whole, depended upon all its component elements. The resource is the system, not the system's individual elements.

After the initial design and construction of this system, lay a continuing series of engineering and management challenges to maintain and operate the system and, over time, to expand the system to meet growing demand. These challenges included meeting the at times conflicting requirements of power users, devising methods and equipment for measuring and monitoring the use of water, discouraging the waste of water, and, in periods of seasonal shortage or drought, rationing the use of the available water. Increasing the efficiency of the system by eliminating waste and improving the efficiency of every system component became imperative. This imperative applied to the penstocks, gates, and waterwheels of the mills, as well as to the dams and canals that supplied the water to the mills.[8]

The daily operation of this complex waterpower system, with multiple canals, dams, gate houses, and lesser elements, placed an enormous strain on the various system components. Floods, freshets, and other natural events compounded the wear and tear associated with daily operation. Many of the gates, sluices, and other elements that controlled the flow of water originally were constructed of wood and, therefore, subject to rot, and in need of regular maintenance, repair, and replacement. In addition to the daily wear and tear on system components, changes in the operations at individual mills could change demands for water, necessitating modifications to the system to meet this demand.[9]

These and other factors meant that since the initial construction of the Lowell Canal system nearly 200 years ago, the various component parts of the system have been subject to almost continuous repair, alteration, replacement, or improvement. In this environment of continual change, it follows that changes may be made to components of the system without adversely affecting the qualities and characteristics that make the system itself eligible for the NRHP.

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[7] Christine Boulding and Joe Orfant. "Lowell Locks and Canals Historic District," National Register of Historic Places Inventory-Nomination Form (Washington, D.C.: National Register of Historic Places, 1976).
[8] Hunter. *A History of Industrial Power*, 207.
[9] Ibid., 273–275.

4.0 CONSULTATION WITH NPS

In consultation with the NPS, Boott clarified the goals of this study during the December 18, 2019, Study Workshop held at the Lowell National Historical Park Visitor Center. The main goal of the study, as provided for in the approved study plan, was the identification of historically significant waterpower equipment "of interest to the NPS." However, Boott understands NPS's goals for this study include the determination of what original hydroelectric equipment is owned/operated by Boott within the Project Boundary is historically significant on a national level, not necessarily simply "of interest to the NPS." In other words, the selection of equipment to include in the analysis should not be limited to NPS' explicitly stated interest.

In July 2020, a site visit was held at Lowell to visit various locations associated with the control of water through the canal system. This tour included inspection of the Swamp Locks Gate House, the Hamilton Wasteway Gate House, the Lower Locks Gate House, the Boott Dam Gate House, the Moody Street Feeder Gate House, and the Northern Canal Gate House. Various types of gate operating mechanisms were observed. Discussions with NPS personnel indicated that they viewed the gate houses and their mechanisms as part of a larger system, as outlined above.

The majority of the gate operating equipment consisted of a rack-and-pinion system, originally operated by hand, but subsequently converted to electrical operation. The Boott Dam Gate House featured a hydraulic operating system, while the Northern Canal Gate House retained its original belt-driven line shafting, originally powered by the first Francis turbine installed in the United States.

5.0 HISTORICAL BACKGROUND OF OPERATING SYSTEM COMPONENTS

Gray & Pape conducted documentary research in the records held by the NPS at Lowell to identify the component elements of the larger canal system and the equipment used to operate water control devices throughout the system. The research effort also focused on developing a chronology of the alterations to individual components of the system. The results of the research effort are presented below (organized by canal) and progressing from upstream to downstream.

5.1 Pawtucket Canal - Guard Locks[10]

Between 1822 and 1823, Kirk Boott oversaw the reconstruction of the Guard Locks. Boott had a new channel cut around the existing locks and built a guard dam, with sluice gates, in this channel to regulate the flow of water downstream. In 1832, the dam was removed and rebuilt approximately 23 feet further downstream. At this date, the dam had five sluice gates sheltered in a wooden gate house. Subsequent modifications include:

- 1848 dam raised in height;
- 1856 sluice gates replaced;
- 1869 Francis-designed rack-and-pinon system for operating gates;
- 1870 Francis-designed hydraulic gate hoist system that employed five water-powered metal cylinders, each measuring 27 inches in diameter and 10 feet tall (cylinders, pistons, and rods manufactured by IP Morris & Company, rest of hoisting apparatus by Lowell Machine Shops[11]);
- 1870 existing brick gate house constructed;
- 1902 headgate sluices enlarged and extended;
- 1965 three middle hydraulic operating cylinders replaced, with oil hydraulic cylinders and pistons.

5.2 Pawtucket Canal - Swamp Locks[12]

Between 1822 and 1823, a 13-foot-tall stone dam, with sluice gates, was built adjacent to the Swamp Locks. The dam was rebuilt in a stepped configuration in 1841, at which time it is likely that the deep gate and sluiceway were added in the south portion of the dam. The dam underwent extensive repairs in 1850, and a gatehouse was constructed at about that time. Later alterations include:

- 1918 dam raised 1 foot in height;
- 1922 installed 2 additional 8-foot square waste gates and a small hydroelectric station to carry the Locks & Canal Yard light and power load; installation of waste gates required removal of 4 feet from top of dam for 20 feet[13];
- 1927–1928 sluice gate constructed between dam and locks, with gate house,

[10] Booth, "Historic Structure Report," 1:50–112.
[11] Proprietors of Locks and Canals Records, 1813–1962. Series II. General Files. Box 49, Folder 8 – Old Guard Locks, 1917–1949. On file at Lowell National Historic Park.
[12] Booth, "Historic Structure Report," 2:218–246.
[13] Proprietors of Locks and Canals Records, 1813–1962. Series II. General Files. Box 50, Folder 1 – Swamp Locks, 1897–1952. On file at Lowell National Historic Park.

- 1952 deep gate operation motorized with 3/4hp gear head motor, with sprockets and chain;
- 1953 gates converted to operate by remote control;
- 1971 north segment of gate house, covering 11 bays, removed.

5.3 Lower Pawtucket Canal - Lower Locks[14]

The Lower Locks were rebuilt in 1823, with a new dam constructed north of the locks. About 1841, a sluiceway was constructed at the north end of the dam. This was reconstructed and fitted with waste gates in 1887. Between 1946 and 1958, three concrete spillways were constructed over the dam.

5.4 Merrimack Canal[15]

In 1918, Locks and Canals proposed constructing a gate structure at Merrimack Dam. The Holyoke Machine Company of Worcester, Massachusetts, provided information for a hand-operated hoist system to be used for operation of a 3- by-8-foot gate. In October 1918, the work was delayed.

- Merrimack Canal Guard Gates
- YMCA Gates
- Moody Street Feeder Gate House
- Boott Penstock
- Merrimack Wasteway

5.5 Hamilton Canal - Wasteway Gate House

The two gates located in this building are operated by a rack-and-pinion system, with granite counterweights (Figure 5-1). The hoisting apparatus dates from 1903 and is similar in design and appearance to extant rack-and-pinion mechanisms in other locations, such as Swamp Locks and Lower Locks, within the system. This suggests that these rack-and-pinion mechanisms may all date from ca. 1900 (Figure 5-2).

5.6 Western Canal - Tremont Gates[16]

A 1911 blueprint shows a proposed arrangement for hoisting the gates by electric motor. In 1937, control of these gates was managed remotely from Lawrence Dam.

5.7 Western Canal - Lawrence Dam, Waterway & Canal[17]

In 1918, modifications were made to the existing hoist mechanism, which operated an 8.5-foot wide by 4.75-foot tall gate. The existing mechanism entailed three pairs of 12-inch iron wheels that rolled on an iron plate. The modifications were intended to permit operation by one man.

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[14] Booth, "Historic Structure Report," 2:323:343.
[15] Proprietors of Locks and Canals Records, 1813–1962. Series II. General Files. Box 50, Folder 5 - Merrimack Dam, 1915–1918. On file at Lowell National Historic Park.
[16] Proprietors of Locks and Canals Records, 1813–1962. Series II. General Files. Box 50, Folder 2 - Tremont Gates, 1911–1948. On file at Lowell National Historic Park.
[17] Proprietors of Locks and Canals Records, 1813–1962. Series II. General Files. Box 50, Folder 4 - Lawrence Dam, Wasteway, and Canal, 1913–1917. On file at Lowell National Historic Park.

Figure 5-1. Hamilton Wasteway Gate House, rack-and-pinion hoisting mechanism.

5.8 Northern Canal - Pawtucket Gate House[18]

The Northern Canal, which extended from the Merrimack River, just downstream from the Pawtucket Dam to the Western Canal, was designed and constructed between 1846 and 1848. The canal was intended to raise the total head of water by three feet. The Northern Canal Guard Gates, housed within the brick Guard House, control the flow of water into the canal. The ten guard, or sluice gates, were originally operated by a Francis turbine, the first turbine of this design ever constructed, that drove a system of belting and shafting (Figure 5-3, 5-4, 5-5, and 5-6). Alterations to the guard gates since 1848 include:

[18] Booth, "Historic Structure Report," 3:397–447.

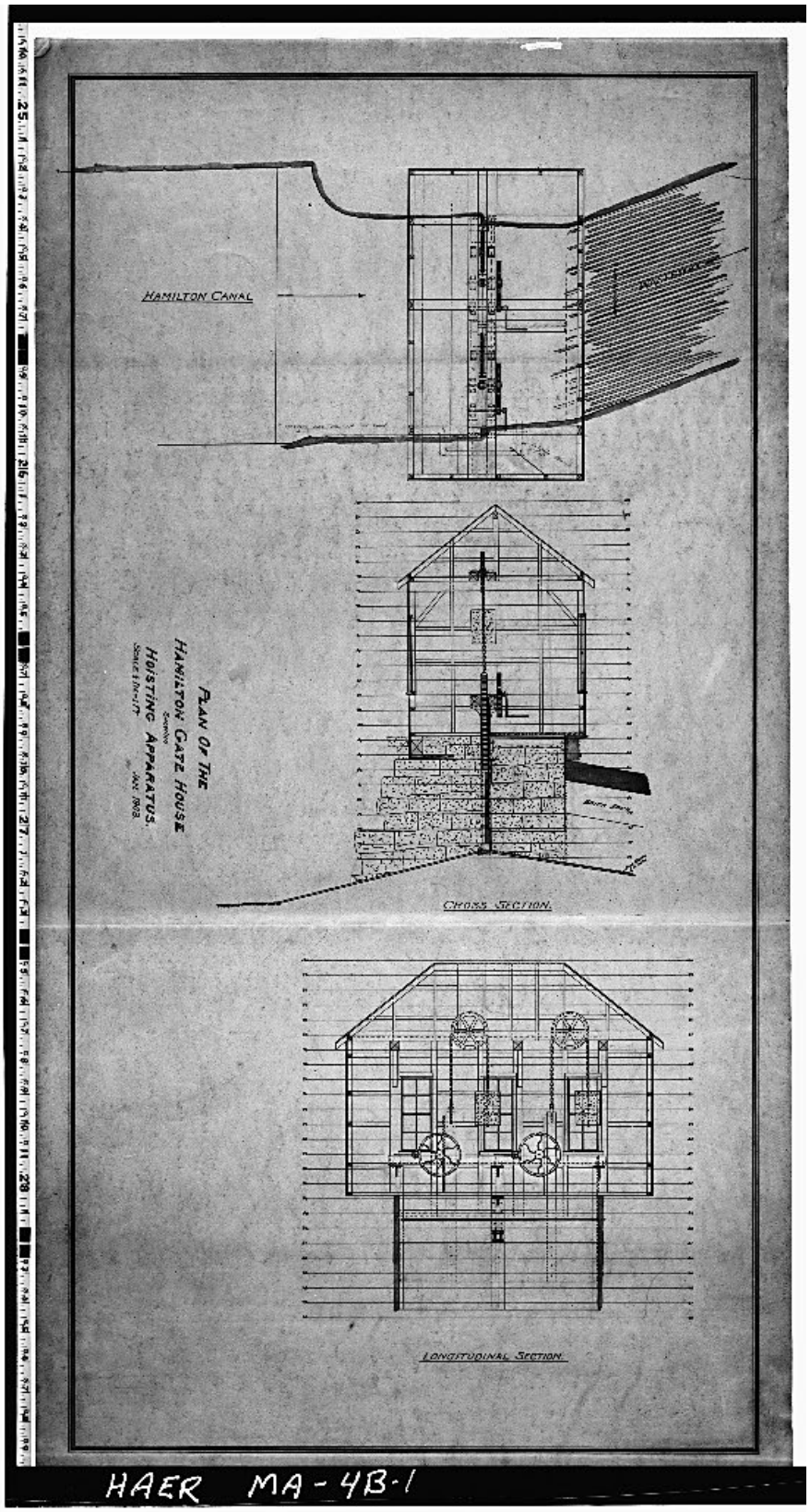

Figure 5-2. Hamilton Gate House hoisting apparatus, January 1903.

Figure 5-3. Belt drive sheave mounted atop Francis turbine.

Figure 5-4. Pawtucket Gate House, belt-and-line shaft system.

1878 main belt (96 feet long and 20 inches wide) replaced,
1881 main line shaft replaced,
1883 smaller belt pulleys replaced by friction pulleys and a clutch mechanism that permitted independent operation of each gate,
1891 turbine abandoned and hoist mechanism electrified,
1928 3 1891 electric motors replaced with a single 25-horsepower motor,
1950s 1928 electric motor replaced with a 10-horsepower motor for each gate.[19]

- Pawtucket Gate House
- Northern Canal Waste Gates
- Moody Street Feeder

[19] Thomas F. Mahlstedt. "Historic Structure Report: Northern Canal Guard Gatehouse Complex, Francis Gate Complex, Swamp Locks, Lower Locks: Archaeological Data Section." (Denver, CO: National Park Service Denver Service Center, 1983), 55.

Figure 5-5. Pawtucket Gate House, belt-and-line shaft system with electric motor drive in foreground.

Figure 5-6. Pawtucket Gate House, sluice gate casings, with belt drives above.

6.0 HISTORICALLY SIGNIFICANT WATERPOWER EQUIPMENT

As noted above, it is the totality of the system of waterpower and water-control machinery at Lowell that is historically significant. Removal and replacement of individual pieces of equipment was nearly continual, from the day the system first became operational. Removal or alteration of existing equipment would constitute an adverse effect upon the qualities that make the existing system historically significant if they prevented or precluded the system from operating. Several pieces of equipment appear to be historically significant, distinct from their role as a part of the larger system. These pieces of equipment include the surviving 1870 hydraulic gate hoist system at the Pawtucket Canal Guard Locks, and the Francis turbine powered belt-and-line shafting gate operating system at the Pawtucket Gate House. The extant gate operating system at the Moody Street Feeder Gate House (Figure 6-1 and 6-2) is likely also significant in its own right.

Figure 6-1. Moody Street Gate House, gate hoisting mechanisms.

Figure 6-2. Moody Street Gate House, detail of gate hoisting mechanism

7.0 CURRENT OWNERSHIP

Boott owns, or is responsible for, the equipment located within the canal systems gatehouses and other facilities, but is not responsible for most buildings, the canal prism, lock gates, or dams. In essence, Boott is only responsible for the equipment and devices that control the flow of water through the canal system. These elements, including flashboards, gates, and their operating equipment, have been upgraded and altered on many occasions.

The 1870 hydraulic gate hoist system at Pawtucket Canal Guard Locks is likely owned in part by PLC and the Commonwealth of Massachusetts, acting through the Massachusetts Department of Recreation and Conservation (MADCR). MADCR appears to own the Francis turbine-powered belt-and-line shafting gate operating system at the Pawtucket Gate House. The extant gate operating system at the Moody Street Feeder Gate House is also likely owned by PLC.

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