Low Impact Hydropower Institute's (LIHI) Certification Review for Waterbury Hydroelectric Project

1. BACKGROUND

The U.S. Army Corps of Engineers (USACE) built the Waterbury dam and outlet works in 1938 to provide flood control in the downstream Winooski River. The Winooski River is a tributary of Lake Champlain approximately 90 miles long and located in the northern half of Vermont. It drains about 1,080 square miles (SQMI) from the Green Mountains to Lake Champlain. The Little River, with a drainage area of about 127 SQMI, drains into the Winooski River from the north. The Waterbury Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) No. 2090 is located at river mile (RM) 2.5 on the Little River in the town of Waterbury, Washington County, Vermont and is the only hydroelectric plant located on the Little River. The drainage area at the Project is 109 SQMI (See Figure 1).

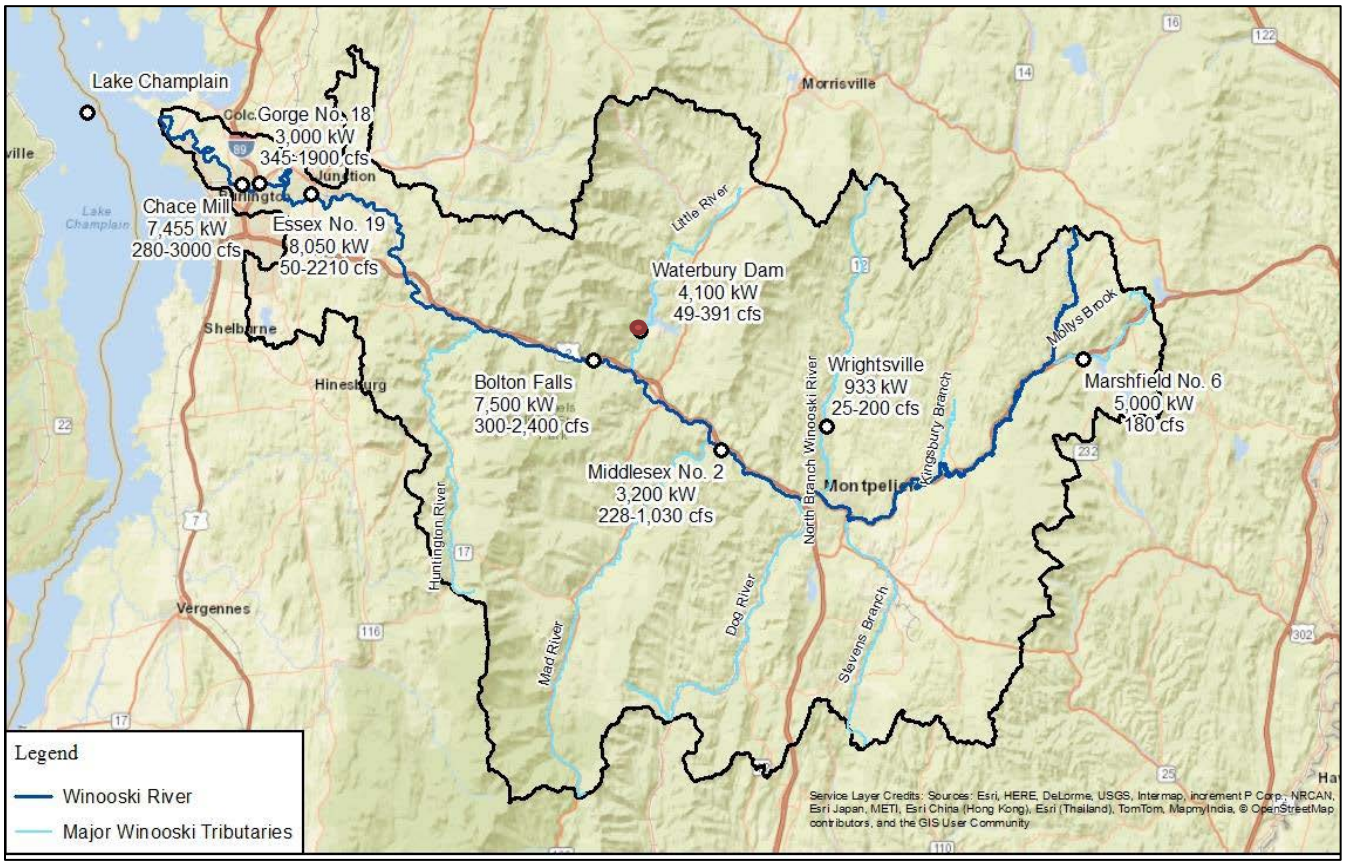

Figure 1 - Location Map within the Winooski River Basin

The State of Vermont owns the dam and outlet works. The Green Mountain Power Corporation (GMP) operates the Project for power generation. The GMP's LIHI coordinator is John Greenan[1].

Because of USACE oversight, the dam and reservoir are not part of the Project works or Project boundary. The Project works are limited to the powerhouse, penstock, and the transmission lines from the powerhouse

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to the adjacent substation. FERC issued the Waterbury Project a new 40-year operating license on February 19, 2016. The license expires on January 31, 2056[2].

Non-hydropower dams located upstream of Project include the Moscow Mills Dam at RM 9.3, owned by Moscow Mills Inc. and the Pike Dam at RM 11.6, owned by Tim Meehan. No dams are located downstream of the Project on the Litter River. The Bolton Falls Hydroelectric Project (FERC No. 2879), located on the Winooski River is also owned by GMP. This project is the first dam located downstream of the Waterbury Dam. No operating agreements are in effect with other surrounding facilities.

GMP submitted an application for certification of the Project on October 5, 2018. On October 26, 2018, LIHI notified GMP that the intake review for the Project was complete. The intake review found that only a small amount of supplemental information was needed. GMP supplied a revised application dated October 31, 2018. On November 20, 2018, I committed to perform the certification review for the Project.

2. PROJECT DESCRIPTION

The Waterbury Dam, located at RM 2.5 on the Little River in the town of Waterbury, Washington County, Vermont (Latitude: 44° 22' 54.41" N, Longitude 72° 46' 17.29" W) was constructed in 1938. (See Figure 2).

Construction of the Project's hydroelectric facilities began in 1951. Construction was completed in 1953. Project operation began in 1953. The Project originally had a single 5.52-megawatt (MW) turbine generator unit. The recent turbine runner replacement has reduced the turbine nameplate capacity to 4.102 MW in accordance with current FERC approved efforts for conversion of the Project's operation to run-of-river operations.

The new 4.102 MW vertical Francis turbine, built by the James Leffel Company, is coupled to a General Electric generator with a maximum output of 5.52 MW. The turbine can operate from a minimum hydraulic capacity of 49 cubic feet per second (CFS) to a maximum hydraulic capacity of 391 CFS. The Project's estimated average annual generation (AAG) is 17,562 megawatt-hours (MWh), which corresponds to an annual plant factor of 48.9%.

[2] FERC License - https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14150313

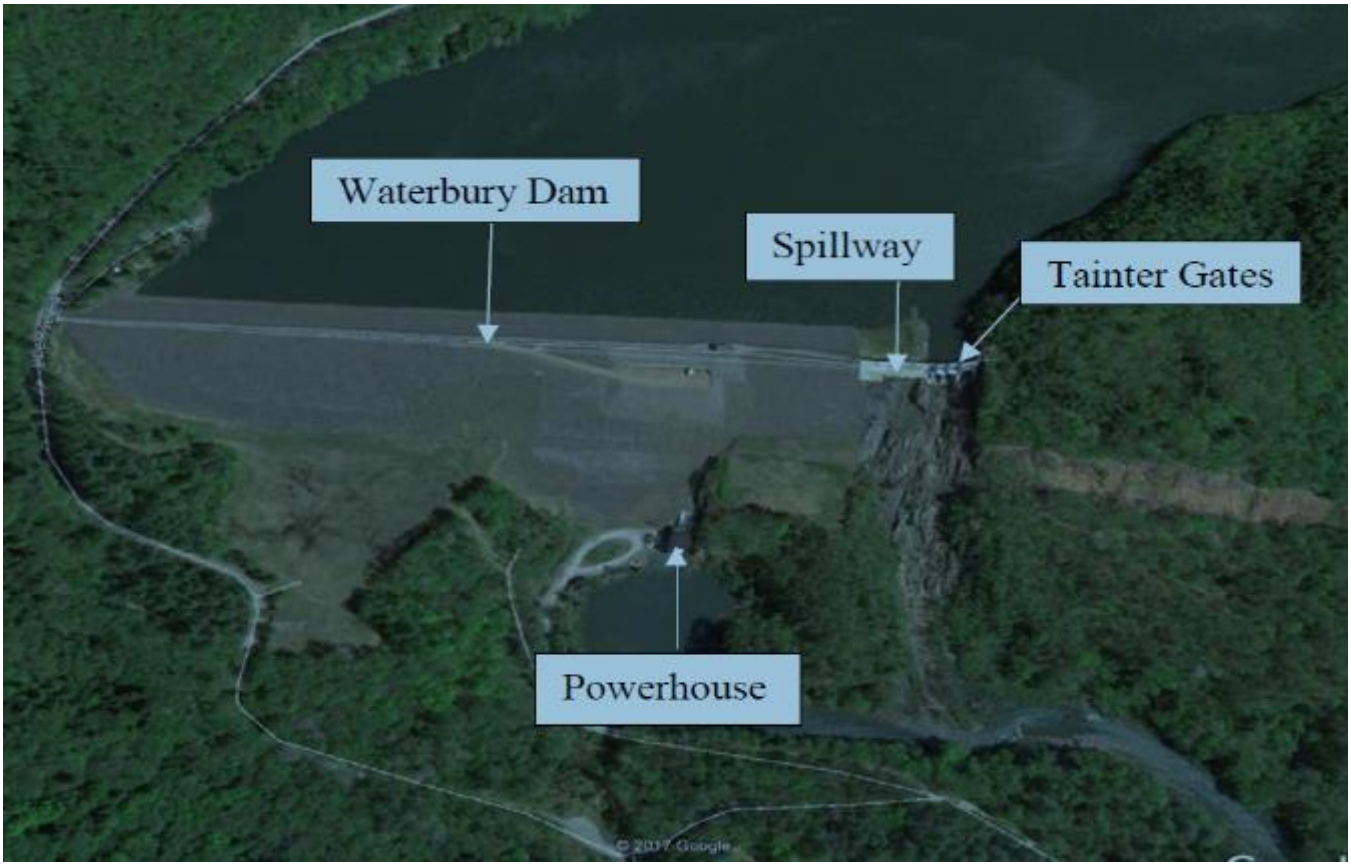

Figure 2 - Waterbury Dam and Project Works

The Project works are limited to the powerhouse, penstock, and the transmission lines from the powerhouse to the adjacent substation. A view of the powerhouse is shown in Figure 3.

The licensed Project consists of:

- An existing concrete intake structure and broom gate;
- An existing 825-foot-long, 10.5-foot-high, 14-foot-wide horseshoe shaped reinforced concrete tunnel;
- Two existing 205-foot-long, 4.5-foot-diameter penstocks;
- An existing 25-foot-long, 6.7-foot-diameter penstock with a new 6.5-foot-diameter butterfly valve;
- An existing 58-foot-long, 35-foot-wide powerhouse containing a 5.52 MW generator unit with a new 4.102 MW turbine;
- An existing 12-foot-long, 2.0-foot-diameter penstock drain pipe and valve;
- A new 60-foot-long, 4.0-foot-diameter bypass penstock with a 4.0-foot-diameter butterfly valve connected to a 2.0-foot-diameter Howell-Bunger valve (See Figure 4);
- An existing 50-foot-long, 33-kilovolt (kV) transmission line from the powerhouse to the substation.

Figure 3 - Powerhouse, Bypass Valve and Substation Looking Upstream

Figure 4 - Bypass Valve Discharge

In addition, the license includes three stages of operation as defined in the 2016 Reservoir and Flow Management Plan[3] (RFMP):

- Stage I covered operations before the Project modifications described in the 2016 license.
- Stage II operations began in the spring of 2018 after completion of modifications (completed).
- Stage III operations will commence when VT and the USACE complete improvements to the Tainter gates and spillway (not yet implemented).

Project modifications in the RFMP required by the FERC license include:

- Installation of a new 4.102 MW turbine runner designed to operate between 49 and 391 CFS;
- Installation of a new bypass flow pipe. The new bypass pipe will be a 60-inch-diameter pipe designed to pass 250 CFS. The pipe will terminate with an adjustable Howell-Bunger valve to the east of the powerhouse (but west of an existing State-owned bypass pipe);
- Installation of a butterfly valve for the bypass pipe;
- Installation of a new, automated bypass pipe Programmable Logic Controller (PLC) for transitioning of flow between the unit and bypass pipe.

GMP completed construction of the pipes, valves, and runner replacement described above in the spring of 2018. Flow from Waterbury reservoir enters the Project through a submerged gated intake structure and then passes into a tunnel. Flow from the tunnel enters into two steel penstocks and then passes into a single penstock with a butterfly valve that supplies water to the turbine. A penstock pipe and valve can drain the Project's penstock.

A bypass penstock with a butterfly valve is connected to a Howell-Bunger valve used to supply conservation flows to the tailrace during Stage II and Stage III operations. Water releases from Waterbury reservoir are possible through a bypass penstock constructed in 1985 by the State of Vermont. The bypass penstock connects to the Project penstock upstream of the powerhouse and releases water into the tailrace though a Howell-Bunger discharge valve. This state-owned bypass penstock provides a means for emergency reservoir drawdown in the event of a powerhouse shutdown or mechanical failure.

In addition, GMP must provide funds to the USGS for the installation and operation of a new gage on the Little River upstream of the reservoir to monitor inflow – USGS gage 04288295. Completion of the new gage installation occurred in August 2016[4]. The Project's average annual inflow from 1953-1980 and 1987-1995 is 194 CFS[5].

GMP is also required to provide funds annually for continued operation of USGS gages 04288500, 04289000, and the newly installed gage 04288295 upstream of the reservoir. USGS gage 4288500 (Waterbury Reservoir near Waterbury, VT) is located in the Waterbury Reservoir and adjacent to the dam. USGS gage 04289000 (Little River in Waterbury VT) is approximately 1 mile downstream from the Project. USGS gage 04288295 (Little River near Stowe, VT) is located approximately 5.5 miles upstream of the dam.

[3] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14333642
[4] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14535308.
[5] Flows from 1981-1986 were excluded because the reservoir was drained.

3. REGULATORY SUMMARY

A. Summary of Project Licensing and Agency Consultation Process

The FERC issued the original license for the Project in 1954, backdated to September 1, 1951, with a license expiration date of August 31, 2001. On August 31, 1999[6], GMP filed an application for a new FERC license to continue operation and maintenance of the Project. GMP operated the Project under annual licenses pending the final disposition of its license application.

On February 18, 2000[7], the FERC issued a public notice accepting the application for filing and setting April 18, 2000, as the deadline for filing motions to intervene and protest. American Whitewater (AW), Champlain Valley Canoe and Kayak Series (CVCKS), Trout Unlimited (TU) and Central Vermont Chapter of Trout Unlimited jointly filed timely motions to intervene. Umiak, LTD and the Friends of Little River (FLR) jointly filed timely motions to intervene. The Vermont Natural Resources Council (VNRC) and Vermont Paddlers Club (VPC) filed timely motions to intervene. The U.S. Department of the Interior (USDOI) filed a late motion to intervene, which was granted.

On September 26, 2002[8], the FERC issued a public notice indicating the application was ready for environmental analysis and set November 25, 2002, as the deadline for filing motions to intervene, comment, or make recommendations pertaining to terms and conditions and fishway prescriptions. The Vermont Agency of Natural Resources (VANR) filed a timely motion to intervene. AW and New England Flow (NEF) jointly filed to intervene. The U.S. Fish and Wildlife Service (USFWS), VANR, and VNRC filed comments and recommendations. GMP filed reply comments on January 9, 2003[9].

FERC issued a draft Environmental Assessment (DEA) analyzing the impacts of the proposed project and alternatives for comment on August 20, 2004[10]. On September 17, 2004[11], Gomez and Sullivan Engineers (GSE) on behalf of GMP, USFWS, Winooski One Partnership, AW, FLR, VANR, VNRC, VPC, and the USACE filed comments on the DEA. On August 15, 2005[12], the FERC issued a final Environmental Assessment (FEA). The interventions, comments, recommendations, and conditions were fully considered in determining whether, and under what conditions, to issue the license.

On September 13, 2005[13], GMP reapplied for Section 401 Water Quality Certification (WQC) for the Project. On July 17, 2006[14], GMP withdrew its September 13, 20005 application for WQC and reapplied. Once again, on May 1, 2007[15], GMP withdrew its prior request made on July 17, 2006, and reapplied for the WQC. Again, on March 3, 2008[16], January 12, 2009[17], September 1, 2010[18], June 7, 20011[19], March 14, 2012[20], February 12, 2013[21] and December 11, 2013[22], GMP reapplied for a WQC.

[6] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=9239570:1
[7] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10846935
[8] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=9568226
[9] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10597236
[10] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10227098
[11] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10247570
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[20] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=12941516
[21] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13181194
[22] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13414352

The Vermont Department of Environmental Conservation (VDEC) issued a Project water quality certification (WQC) on December 11, 2014[23]. The WQC states that drawdowns will no longer occur as part of regular operations and that the operating mode will become year-round instantaneous run-of-river (ROR). The FERC issued the Waterbury Project a new 40-year operating minor license on February 19, 2016[24]. The WQC is incorporated into the FERC license.

B. Compliance Issues

My review of the FERC docket found that no non-compliance issues have occurred. In recent years, GMP has requested a time extension on two occasions. On June 30, 2017[25], GMP submitted a request for a 90-day extension to submit a Dam Safety Surveillance Monitoring Plan for the Project. On December 13, 2017[26], GMP requested additional time to provide supplemental information and complete construction at a recreation site. In both cases, FERC granted a time extension.

4. ZONES OF EFFECT (ZOEs)

The Project has two ZOEs (See Figure 5). The Applicant has defined ZOEs from upstream to downstream and numbered them consecutively.

ZOE 1 is the impoundment from RM 2.5 to RM 6.1 (3.6 miles) upstream of Waterbury Dam. ZOE 2 is the river reach downstream of the dam from RM 2.5 to RM 0.0 (confluence with the Winooski River).

As stated in the 2004 FERC DEA[27], there is no bypassed reach present at the Project. A state-owned bypass flow pipe runs underground, traverses from the powerhouse intake to a Howell Bunger valve located at the powerhouse. The State operates the bypass pipe for emergency drawdown purposes.

In the spring of 2018, a second new bypass pipe was installed to the west of the existing bypass pipe and it terminates with an adjustable Howell-Bunger valve. This bypass pipe and valve provides conservation flows of up to 250 CFS from the powerhouse going forward.

[23] https://elibrary-backup.ferc.gov/idmws/common/opennat.asp?fileID=14150313
[24] FERC License - https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14150313
[25] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14662703
[26] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14776567
[27] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10227098

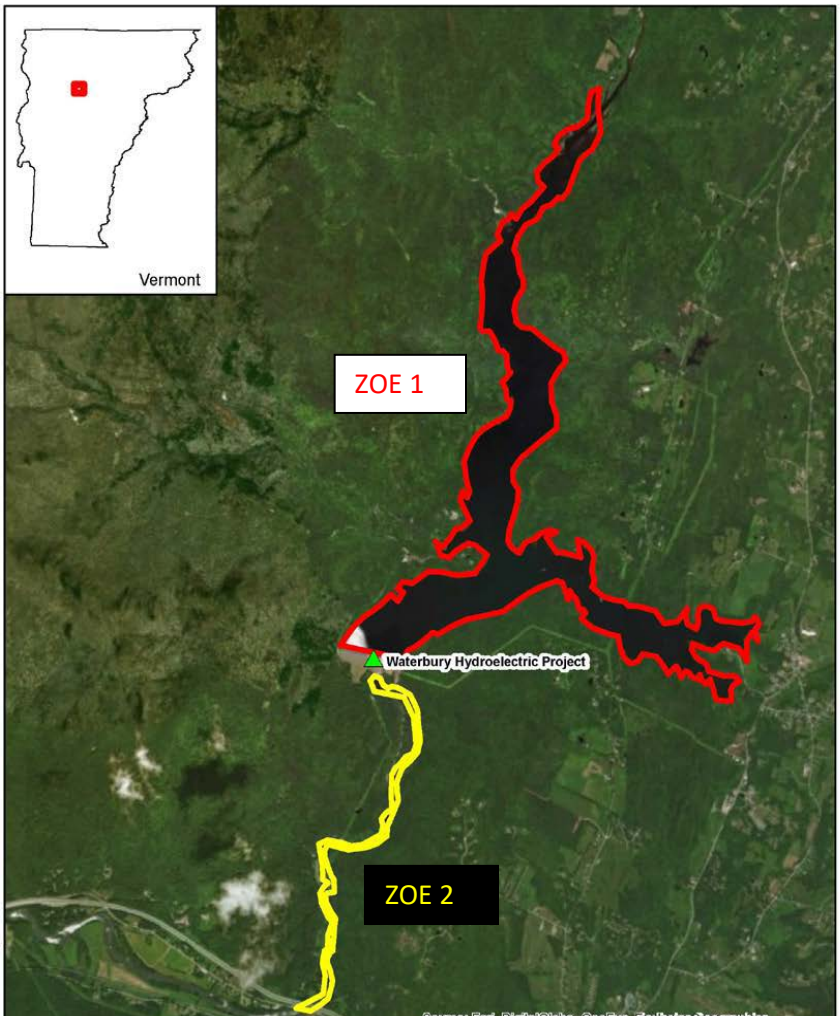

Figure 5 -ZOEs

5. LIHI CERTIFICATION PROCESS

GMP submitted an application for certification of the Project on October 5, 2018. On October 26, 2018, LIHI notified GMP that the intake review for the Project was complete. The intake review found that only a small amount of supplemental information was needed. GMP supplied a revised application dated October 31, 2018.

A. Comment Letters

On November 20, 2018, LIHI opened the public comment period for the application. Comments must be received on or before 5 pm Eastern time on January 19, 2019 to be considered. No public comments were received.

B. Agency Correspondence

As part of my review, I conducted a FERC e-library search to verify claims in the certification application. My review concentrated on the entire period from January 1983 through December 2018, for FERC docket number P-1417. I found no major issues in the docket search.

On November 20, 2018, LIHI emailed contacts[28] listed in the Project application as knowledgeable about the Project stating, *"… You may have already received this notice if you are on the LIHI email list. However, you were also identified as an agency contact on the LIHI certification application recently submitted by Green Mountain Power for the Waterbury Hydroelectric Project. The application reviewer, Gary Franc (copied here), may be in contact with you if he has questions about the project or wishes to clarify any aspects of the LIHI application. You may also provide comments directly to LIHI as indicated below …"* *https://lowimpacthydro.org/wp-content/uploads/2018/11/Waterbury-LIHI-Application-10-31-2018_FINAL-Application.pdf*

On January 18, 2019, LIHI received emailed agency input from Eric Davis at VANR who stated that the agency supports LIHI Certification of the Project. He noted that the Project is currently operating under Stage II procedures, and VANR and GMP are working toward refinements of run-of-river operations and flow verification since installation of a streamflow gage upstream of the Project. Mr. Davis recommended that a condition be added to the certification as follows: "*Upon completion of the current water year under Stage II operations (Oct. 1, 2018 – Sep. 30, 2019), GMP shall provide a report to VANR that documents run of river compliance, adjustments made over the monitoring period, and recommendations for any additional refinement and/or monitoring needed to ensure compliance. The report shall be provided to the parties by December 31, 2019.*"

6. CERTIFICATION REVIEW

This section contains my certification review of the Project with regard to the LIHI Certification criteria.

A. LIHI Criterion-Flows

In order to comply with license and WQC requirements to modify operations to become true, instantaneous run-of-river, GMP completed an extensive construction project that included the installation of a new bypass pipe and valve to allow for continuous bypass flows, a new turbine with a reduced upper flow range for run-of-river operations, plus modern electrical equipment. These efforts make it possible to allow run-of-river operations intended to enhance habitat conditions for aquatic species, generally.

The application states that the Project satisfies the LIHI flows criterion in ZOE 1 by meeting alternative standard A-1[29] and in ZOE 2 by meeting alternative standard A-2[30]. ZOE 1 is the Project impoundment. ZOE 2 is the downstream reach of the Little River from the dam to the confluence with the Winooski River.

Stage III construction work is pending. This construction will increase dam freeboard, increase spillway capacity and improve reservoir control. Stage III operating procedures will commence after the State's completion of the spillway and Tainter gate work. As described in the State's email dated February 21, 2018 (Appendix A, page A-2), a work start and work completion date for the Waterbury spillway and Tainter gate replacement is yet to be determined. The State will perform a risk assessment and conceptual design in the next year. The replacement work is estimated to occur in the next 5-10 years.

Until then, the Project will continue to operate in accordance with Stage II operations. During Stage II operations, the timing and drawdown level of the reservoir's seasonal drawdown/refill remains the same as in Stage I except that the maximum instantaneous outflow during the drawdown will be 200 CFS, or inflow if greater.

[28] Jeff Crocker - jeff.crocker@vermont.gov; Eric Davis - eric.davis@vermont.gov; Peter McHugh - peter.mchugh@vermont.gov; Elizabeth Peebles - elizabeth.peebles@vermont.gov ; Scott Dillion - scott.dillon@vermont.gov ; Melissa Grader - Melissa_Grader@FWS.gov ; Susan Bulmer - susan.bulmer@vermont.gov

[29] NA.

[30] Agency recommendation.

The reservoir is drawn down beginning no earlier than January 1 to an elevation no lower than 550.00 FTMSL. During this drawdown, a 60 CFS conservation flow will be a fixed minimum flow until the drawdown pond level is reached at which time outflows shall match inflows.

Spring refill commences no later than March 15 with reservoir levels rising or stable at all times until the NOL is reached by no later than May 15. From May 15 until the next drawdown, GMP maintains the reservoir level at the normal operating level (NOL) of 589.50 feet mean sea level (FTMSL). The two-foot cycling range (1 foot above and 1 foot below the NOL), allowed during Stage I is no longer permitted. In effect, during this period of the year, the Project is operating in ROR mode.

During high inflows periods, when inflow to the reservoir exceeds Project capacity, the Project will operate at its maximum capacity (maximum turbine capacity plus maximum bypass capacity) as the elevation of the reservoir exceeds 589.50 FTMSL. GMP will operate the Project at its maximum capacity until inflows recede and the reservoir returns to elevation 589.50 FTMSL.

During future Stage III operations, GMP will operate the Project in year-round instantaneous ROR mode. Seasonal drawdowns will no longer occur, and the year-round target elevation of the reservoir will be the NOL. Under license article 402, GMP must operate the Project consistent with the USACE's Revised Waterbury Dam and Reservoir Regulation Manual, dated September 2005. GMP must comply with any future regulations prescribed by the USACE in the interests of flood control.

GMP's August 18, 2016 RFMP, based on consultation with the VDEC and USFWS, was supplemented on March 16, 2017[31]. FERC approved the revised RFMP on April 6, 2017[32].

The RFMP requires GMP to maintain a maximum conservation flow of 60 CFS or inflow if lower from March 16 through March 31 of the year, and 108 CFS or inflow if lower from April 1 through May 15. Outside of the drawdown/refill period, GMP will use the valve, up to its full capacity, when inflows exceed the turbine capacity, except after June 15 when use of the valve may be suspended if the reservoir level is below elevation 592.0 feet and inflow is less than the maximum capacity of the turbine.

On December 20, 2017[33], FERC granted an extension of the construction completion date for the Moscow Canoe Access Site and Little River Boat Access, located adjacent to the impoundment, to December 31, 2019, to align with completion of the other recreation facilities. As part of this process, on April 2, 2018[34], GMP requested a two-month waiver of flow and pond level requirements at the Project. Specifically, GMP was seeking to drawdown the reservoir from the normal pond elevation of 589.50 FTMSL to 582.00 FTMSL starting November 11, 2018; and maintaining the reservoir at elevation 582.00 FTMSL pending weather and inflow conditions, until the annual winter drawdown commences on January 1, 2019. This drawdown improves construction and safety conditions while the Moscow Canoe Access, Blush Hill, and Waterbury Dam boat launch improvements are constructed.

On January 28, 2019, GMP submitted a draft annual Reservoir and Flow Management Monitoring Report for 2018 to VDEC. VDEC has not yet responded with comments. The annual reports must also be filed with FERC by March each year. The 2018 report documents completion of Stage II modifications in May 2018 that included installation of the new aerating turbine and new bypass pipes, PLC controls to monitor and adjust flows, and installation of two new USGS gages to estimate inflow to the reservoir and measure reservoir water surface elevation. The report also documents that during 2018, the Project met the overall goal of the Stage II operating parameters, namely, to match the shape of hydrographs from the downstream

[31] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14520106
[32] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14548771
[33] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14781347
[34] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14882811

and upstream USGS gages, while conducting initial troubleshooting as part of start-up. Stage II operating parameters in effect now are summarized in the table below.

Table 1:
Stage II Operating Requirements Summary

Time Period	Reservoir Level	Minimum Downstream Flow	Maximum Downstream Flow
May 16 – January 1: Normal Pool	NOL: 589.5 (higher levels allowed when inflow exceeds Project capacity)	Inflow (except if inflow exceeds Project capacity: release max Project capacity)	Inflow (except if reservoir level is above NOL due to prior high inflows: release @ Project capacity)
January 1 – March 14: Winter Drawdown	550.0 – 589.5	60 cfs (except when fully drawn-down: inflow up to Project capacity)	200 cfs, or inflow if higher (except when fully drawn-down: inflow up to Project capacity)
March 15 – March 31: Early Spring Refill	Steady increase or stable	60 cfs or inflow if less	Inflow or Project capacity, whichever is less
April 1 – May 15: Late Spring Refill	Steady increase or stable	108 cfs or inflow if less	Inflow or Project capacity, whichever is less

It is my recommendation that the Project complies with resource agency conditions and recommendations issued regarding flow conditions and impoundment fluctuation, and therefore satisfies the flows criterion.

Stage II operations are now in effect and GMP is required to notify VDEC of operational deviations within 24 hours and then file a report with FERC and VDEC within 14 days of a deviation incident. GMP continues to consult with VANR to verify run-of-river operations. Therefore, VANR's request for a condition is appropriate, and included (reworded) in this recommendation as follows:

> Upon completion of the current water year under Stage II operations (Oct. 1, 2018 – Sep. 30, 2019), the facility Owner shall provide a report to VANR and LIHI that documents run of river compliance, adjustments made over the monitoring period, and recommendations for any additional refinement and/or monitoring needed to ensure compliance. The report shall be provided by December 31, 2019. Thereafter, the facility Owner shall provide annual status summaries of run-of-river operations in annual compliance submittals to LIHI.

B. LIHI Criterion-Water Quality

The Applicant states that the Project satisfies the LIHI water quality criterion in ZOE 1 and 2 by meeting alternative standard B-2[35].

The VANR designates the Little River as Class B waters. Class B waters are managed to achieve and maintain a high level of quality that is:

- suitable for bathing;
- consistently exhibits good aesthetic value;
- provides high quality habitat for aquatic biota, fish and wildlife;
- suitable for public water supply with filtration and disinfection, and;
- suitable for irrigation and other agricultural uses.

The VANR manages the reservoir as a mixed-water fishery, with sections of the river below and above the reservoir managed as cold-water fisheries. The 2016 State of Vermont 303(d) List of Impaired Waters[36] lists the Project's reservoir as an impaired waterway, due to sedimentation and turbidity[37]. During Project relicensing, the VANR identified erosion and sedimentation resulting from Project winter drawdown operations as a concern. GMP's study of the reservoir during the seasonal drawdown period indicated that reservoir sediments exposed during the winter drawdown are subsequently flushed from the reservoir during high spring inflows and reservoir refilling.

In addition, GMP monitored turbidity in the tailrace during 1997, 1998 and 2000. The monitoring documented periods when tailrace turbidity exceeded the state standard of 10 NTUs[38]. The standard was exceeded on two occasions, in March and April of 1998, and again in April of 2000 when the reservoir was refilling. During Project relicensing, the VANR determined that to protect water quality in the Little River, the elimination of the winter drawdown was needed to prevent suspension of sediments in the tailrace.

Within the WQC, Condition B prescribed phasing out the reservoir's seasonal drawdowns and converting the Project to ROR operation over a series of three operational stages. GMP is currently undergoing the prescribed process and is operating the Project using Stage II conditions.

The river in ZOE 2 is designated a cold-water fishery. Dissolved oxygen (DO) levels must be maintained above 7 milligrams per liter (MG/L) and 80 percent saturation with turbidity below 10 NTU's. The Little River located downstream of the reservoir is not listed as impaired in the 2016 State of Vermont 303(d) List of Impaired Waters.

During Project relicensing, GMP conducted water quality monitoring for DO and temperature within the Project reservoir and downstream of the dam. The monitoring showed that the tailrace exhibited low DO levels, from 4.6 to 6.9 MG/L, during the late summer months. The low DO levels were attributed to the Project's deep-water intake from the non-Project Waterbury reservoir. During periods of reservoir stratification, the intake draws oxygen deficient water from the hypolimnion zone[39], which discharges into the tailrace.

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[35] Agency recommendation.

[36] http://dec.vermont.gov/sites/dec/files/documents/WSMD_mapp_303d_Part_A_2016_final_complete.pdf

[37] Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air.

[38] The propensity of particles to scatter a light beam focused on them is considered a more meaningful measure of turbidity in water. Turbidity measured this way uses an instrument called a nephelometer with the detector set up to the side of the light beam. More light reaches the detector if there are lots of small particles scattering the source beam than if there are fewer small particles. The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units (NTUs). One NTU is approximately equal to 1 part per million [PPM].

[39] The part of a lake below the thermocline made up of water that is stagnant and of essentially uniform temperature except during the period of overturn. The thermocline zone being the region in thermally stratified bodies of water that separate warmer surface water from colder deep water.

In order to meet DO standards for Class B cold-water habitat, WQC Conditions F (Tailrace Dissolved Oxygen Plan) and G (Dissolved Oxygen Effectiveness Monitoring) were incorporated into FERC license Article 401.

On August 18, 2016[40], GMP filed a Tailrace Dissolved Oxygen Enhancement and Monitoring Plan (TDOEMP) pursuant to Article 401. FERC approved the plan on January 24, 2017[41]. In accordance with the TDOEMP, GMP proposes to implement a four-phased approach, if needed, to meet DO standards in the area immediately downstream of the Project powerhouse. Phases I through III rely on using the new turbine and draft tube modification to re-aerate the water and increase DO of water exiting the powerhouse. If Phases I through III are not successful in adequately increasing DO, Phase IV entails exploring alternative methods.

GMP monitors water temperature and DO in the Project's penstock and downstream of the Project's powerhouse during periods of reservoir stratification to confirm the Project meets class B cold water fish habitat standards for temperature and DO. Monitoring is scheduled for five consecutive years after physical modifications at the Project are completed. Onset HOBO data loggers log data every 15 minutes and are downloaded once per month. After five years, GMP will consult with the VDEC and the FERC to determine whether additional monitoring is necessary.

GMP implemented Phase I enhancements during the first stratification period following completion of GMP's construction activities in the spring of 2018 and conducted the first of five years of water quality monitoring from late May to early November 2018 with operation of the Phase I passive reaeration mechanism. Results indicate that while DO downstream of the powerhouse was significantly higher than DO in the penstock strainer, on several occasions downstream DO fell below the state water quality standard for that location of 7 mg/l and 75% saturation, higher than the normal state standard of 6 mg/l and 70% saturation. The special standard at the Project is due to VDEC having determined that the Little River downstream of the Project is important to establishing a salmonid fishery.

A draft monitoring report was submitted to VDEC on December 24, 2018, but to date VDEC has not responded with comments. The report recommends implementing Phase II in 2019 in accordance with the TDOEMP which will include pumping of ambient air directly into the draft tube for aeration and monitoring for the second year. Phase III would be implemented in 2020 if warranted. Finally, if needed, Phase IV would be implemented after the summer of 2022, due to a two-year or longer design and construction phase needed in advance of implementing Phase IV.

The annual reports include a summary of the data collected and compared against water quality standards including graphs, charts and/or time series plots for comparing penstock DO against downstream DO. The reports also include operations data, flows through the turbine, flows through the bypass pipe, and will indicate when the reaeration mechanism in the penstock is utilized. The annual reports will also include documentation of any consultation with the VTDEC. If DO standard violations persist, GMP will revise the TDOEMP to include additional or alternate measures to meet DO standards, as approved by the VTDEC.

GMP is also requesting that the TDOEMP be evaluated by LIHI under a PLUS standard given that the TDOEMP employs advanced technologies to enhance water quality and GMP will perform monitoring in up to four phases, Phases II-IV will only be implemented if attainment of DO standards is not met during the previous phase. In addition, the TDOEMP is an adaptive management approach given that the plan may be altered over time in consultation with resource agencies should it be needed.

[40] https://elibrary.ferc.gov/IDMWS/common/opennat.asp?fileID=14333647
[41] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14471759

Detail of the phases of the TDOEMP are:

- Phase I - A passive reaeration method where powerhouse air is passively drawn into the draft tube sleeve;
- Phase II – A more aggressive pumping of ambient air into the draft tube sleeve;
- Phase III - Pumping pure oxygen into the draft tube sleeve;
- Phase IV - Entails exploring alternative methods to reaerate and increase DO levels.

For Phase I, GMP worked closely with NORCAN Hydraulic Turbine, Inc. (NORCAN) to explore the most effective way to configure the new turbine so passive reaeration can occur in the draft tube. A computational fluid dynamics (CFD) model was developed and various options were simulated (See Appendix A, page A-4). Based on simulation results, GMP installed an aeration chamber within the existing discharge draft tube along with the replacement runner to increase the DO from the turbine discharge. This installation additionally required reducing the Project's installed capacity from 5.52 MW to 4.102 MW so that passive reaeration can occur.

It is my recommendation that the Project satisfies water quality criterion based on the agency recommendations and Project improvements intended to meet water quality standards once the TDOEMP is fully implemented, despite some deviations from DO standards in the downstream reach evidenced to date. GMP has proactively engaged in significant consultation on water quality issues; is implementing an adaptive management approach to resolving those issues that may be caused at least in part by stratification in the non-Project Waterbury reservoir; and GMP has made significant investments in new equipment, modified operations, and reduction of licensed plant capacity for the purposes of environmental stewardship. However, it seems premature for LIHI to grant the PLUS standard and three additional years of certification at this time, since 2018 water quality monitoring results do not indicate that the Phase I adaptive management-based TDOEMP implementation measures are completely effective and VDEC has not yet provided input on the monitoring results and next steps under the TDOEMP.

C. LIHI Criterion-Upstream Fish Passage

The Applicant states that the Project satisfies the LIHI upstream fish passage criterion in ZOE 1 and 2 by meeting alternative standard C-2.

The Project does not have any current fish passage requirements. License Article 403 reserves authority for the FERC to require GMP to construct, operate and maintain upstream fishways as may be prescribed by the USDOI. In addition, WQC Condition H states the USFWS may require the applicant to provide upstream fish passage facilities or participate in a trap-and-transport facility that moves migratory fish upstream of the dam.

As stated in the FEA, the Little River is managed by the VANR for self-supporting populations of resident and migratory salmonids and cold-water fish, particularly brook, brown, and rainbow trout. The impoundment supports brook, brown, and rainbow trout, rainbow smelt, smallmouth bass and yellow perch. Trout and smelt within the impoundment move upstream into the Little River and other tributaries to spawn.

The Little River downstream of the Project supports an assemblage of resident cold-water fish species including trout, dace, suckers, and sculpin. The Vermont Department of Fish and Wildlife (VDFW) electrofishing surveys indicate that fish abundance in the Little River is low, especially downstream of the Project. The Little River downstream of the Project consists of riffles (39 percent), runs (30 percent), and pools (18 percent). There is little structure or cover habitat for fish other than the pools. The river substrate is rather uniform and comprised of cobble and gravel. The fish community in the Project area is supported

by both natural reproduction and periodic stocking and no state or federally listed threatened or endangered species are known to occur in the Project area.

As stated within GMP's recent downstream (on the Winooski River) Bolton Falls Hydroelectric Project (FERC No. 2879) Pre-Application Document[42], several species of migratory fish are present in Lake Champlain and the downstream Winooski River, including lake sturgeon, landlocked Atlantic salmon, and steelhead rainbow trout. The Bolton Falls Project, located at RM 43 on the Winooski River, is upstream of the extent of the natural range for lake sturgeon, but landlocked Atlantic salmon and steelhead rainbow trout are present in the Bolton Falls Project area due to upstream fish passage efforts at downstream projects.

At the Winooksi One/Chace Mill project, the most downstream dam on the Winooski River in Burlington, Vermont, an upstream fish lift and a trap and truck program, funded in cooperation with other upstream dam owners (including GMP), provides access to upstream Winooski River areas above the Essex 19 Hydropower Project (RM 17.6) and to the tailwaters of the Bolton Falls Project. To date, resource agencies have not required upstream fish passage beyond Bolton Falls, thus that Project creates a barrier to upstream fish passage at the Waterbury Project.

It is my recommendation that the Project meets concerns for upstream passage of anadromous and catadromous fish and satisfies the upstream fish passage criterion.

D. LIHI Criterion-Downstream Fish Passage

The Applicant states that the Project satisfies the LIHI downstream fish passage criterion in ZOE 1 and ZOE 2 by meeting alternative standard D-2.

The Project's dam does not have any current downstream fish passage requirements. License Article 403, reserves authority for the FERC to require GMP to construct, operate and maintain downstream fishways as may be prescribed by the USDOI.

As stated within the FEA, the Little River is managed by the VANR for self-supporting populations of resident and migratory salmonids and cold-water fish, particularly brook, brown, and rainbow trout. The impoundment supports brook, brown, and rainbow trout, rainbow smelt, smallmouth bass and yellow perch. Trout and smelt within the reservoir move upstream into the Little River and other tributaries to spawn. The Little River downstream of the Project supports an assemblage of resident cold-water fish species including trout, dace, suckers, and sculpin. VDFW electrofishing surveys indicated that fish abundance in the Little River is low, especially downstream of the Waterbury Project which consists of riffles (39 percent), runs (30 percent), and pools (18 percent). There is little structure or cover habitat for fish other than the pools, the substrate is rather uniform and comprised of cobble and gravel.

The fish community in the Project area is supported by both natural reproduction and periodic stocking and no state or federally listed threatened or endangered species are known to occur in the Waterbury Project area. In accordance with the 2016 FERC license, the Waterbury Project is not currently slated for the provision of downstream passage.

It is my recommendation that the Project meets concerns for downstream passage of anadromous and catadromous fish and satisfies the downstream fish passage criterion.

[42] https://elibrary.ferc.gov/IDMWS/common/opennat.asp?fileID=14480216

E. LIHI Criterion-Shoreline and Watershed Protection

The applicant states the LIHI shoreline and watershed protection criterion in ZOEs 1 and 2 are satisfied by meeting alternative standard E-1.

The watershed upstream of the Project is about 109 square miles. As stated within the FEA, the watershed upstream of the Project is 80 percent forested, 15 percent agricultural, 3 percent urban, and 2 percent residential.

During Project relicensing, no shoreline management plan or similar protections were prescribed. GMP did conduct a shoreline erosion study to locate erosion sites along the reservoir shoreline and the Little River downstream and to assess the influence of hydroelectric operations on erosion[43]. Erosion was documented at 12 sites along the impoundment shoreline. The study concluded that the principal causes of the erosion are natural erosive processes, such as wind, waves, ice scour, and surface runoff, along with human and animal influences. Reservoir fluctuations, considered a secondary cause, were identified as influencing erosion in 11 of the 12 sites along the reservoir.

In 2001, a study by BBC&M Engineering, Inc. (BBC&M) revealed that when the reservoir draws down to 550.10 FTMSL in the winter, lacustrine[44] silt deposits along the reservoir shoreline are exposed. When these deposits freeze, needle ice formations occur that loosen the soil and increase the erosion potential. In addition, repeated freeze-thaw cycles continue to loosen the soil already susceptible to the erosion caused by the needle ice. The BBC&M report concluded that to lessen the amount of sediment eroding, the exposure of loosened soil to moving water must be reduced. This could occur through submerging the silt deposits, either by filling the reservoir earlier than normal in February or by limiting the winter reservoir drawdown. However, the report noted that at any minimum reservoir elevation, the silt that erodes from the lacustrine silt deposits will continue to deposit in the reservoir, and the silt deposits would continue to move into the Little River even if the reservoir did not exist.

After that study, the agreement to move toward run-of-river operations was made, and once Stage III operations are in effect and impoundment drawdowns no longer occur, the resource agency consensus is that the secondary influences on erosion that could be caused by Project operations should no longer occur. Therefore, while the Project may currently be influencing some erosion processes, those effects appear to be small and will ultimately be eliminated once run-of-river commences.

It is my recommendation that the Project satisfies the shoreline and watershed protection criterion.

F. LIHI Criterion-Threatened and Endangered Species

The applicant states the LIHI Threatened and Endangered Species criterion is satisfied in ZOE 1 and ZOE 2 by meeting alternative standard F-2.

A review of the Vermont Natural Resources Atlas Endangered and Threatened Species Layer does not identify any endangered or threatened state species presence within the Project area[45].

On August 30, 2000, the USFWS stated that no federally listed threatened or endangered species or critical habitat are known to occur in the Project area (See Appendix A, page A-19). However, subsequent to this letter, the USFWS listed the northern long-eared bat as threatened under the federal Endangered Species Act (ESA). An August 24, 2017 review of USFWS's *Information, Planning, and Conservation System*

[43] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=10227098

[44] Lacustrine deposits - sedimentary rock formations formed in the bottom of lakes.

[45] https://anrmaps.vermont.gov/websites/anra5/

(IPaC) decision support system confirms that the federally threatened northern long-eared bat (State of Vermont engendered species) could occur in Washington County, Vermont (See Appendix A, page A-20). This species is not known to inhabit the Project area and there are no critical habitat for the species at the Project. The FERC Project boundary encloses approximately 4 acres consisting of the hydroelectric generation related facilities including the intake, tunnel, penstocks, powerhouse, and transmission line. The Waterbury dam and reservoir are federal facilities (USACE), therefore, they are not included in the license boundary. Given the limited Project footprint, the Project is unlikely to have any effect on the threatened northern long-eared bat.

It is my recommendation that the Project satisfies the threatened and endangered species protection criterion.

G. LIHI Criterion-Cultural Resource Protection

The applicant states the LIHI cultural and historic resources criterion in ZOEs 1 and 2 is satisfied by meeting alternative standard G-2.

In 1998, GMP conducted a cultural resources investigation and Phase 1A archeological sensitivity study within the Project's Area of Potential Effect (APE). Based on additional information requests from the FERC, GMP contracted in 2001 and 2002 to conduct:

- An historic and photographic documentation of the Waterbury dam;
- An intensive archeological survey in proposed dam reconstruction areas around the Waterbury dam, and;
- An historic/archeological mapping and testing study around the drawdown area of the Waterbury reservoir[46].

No prehistoric archeological sites or other Native American properties were identified within the Project's APE. It was surmised the probable reasons for this result were the massive ground disturbing activities associated with the original construction of the Waterbury dam.

License Article 405 required GMP to implement a Programmatic Agreement (PA) between the FERC and the Vermont's Historic Preservation Officer (SHPO). The PA pertains to the management of historic properties potentially affected by issuing a license to GMP for the continued operation of the Project. The final PA was executed on October 19, 2004[47]. The PA required GMP to file a Historic Properties Management Plan (HPMP) within one year of license issuance.

On February 16, 2017[48], GMP filed a request with FERC for a sixty-day time extension to submit the HPMP. FERC granted an extension until April 20, 2017. On April 19, 2017[49], GMP requested a second time extension to file the HPMP until July 19, 2017. FERC approved the request[50] and on July 19, 2017[51], GMP filed the HPMP for FERC approval. On January 26, 2018[52], GMP filed an updated HPMP incorporating a revision requested by the SHPO. On February 14, 2018[53], FERC issued its order approving the HPMP.

[46] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=10733542
[47] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10280617
[48] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14495217
[49] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14565355
[50] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14580005
[51] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14639748
[52] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14807832
[53] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14822475

In accordance with the HPMP, GMP submits annual reports to the SHPO and the FERC summarizing projects completed during the preceding year. If no work is completed, the report documents that no work occurred. To date, the first annual HPMP has not appeared in the FERC docket. Its scheduled submittal should be in February of 2019.

It is my recommendation that the Project satisfies the cultural and historic resources protection criterion.

H. LIHI Criterion-Recreation

The applicant states the LIHI recreation criterion in ZOEs 1 and 2 is satisfied by meeting alternative standard H-2.

The Project offers year-round recreational opportunities to the public and is an integral part of the recreational resources of central Vermont. Between Memorial Day and Labor Day, GMP maintains a stable reservoir level to support popular reservoir activities such as boating and fishing. During the winter, snowmobiling, and ice fishing occur on or near the reservoir.

The State of Vermont owns nearly all the lands surrounding the Project and the impoundment. The lands are managed as a State Forest (Mt. Mansfield State Forest) or as a State Park. The Vermont Department of Forest Parks and Recreation (VDFPR) manages two state parks, the Little River State Park (LRSP) and the Waterbury Center State Park (WCSP), located on the west and east side of the impoundment, respectively.

The LRSP is open from mid-May to Columbus Day and provides:

- camp sites for RVs and tents;
- hiking trails;
- a swimming area, and;
- a boat launch available to park campers.

The WCSP is a day-use park open from mid-May to the Labor Day weekend providing:

- a swimming area;
- a boat launch, and;
- picnic facilities.

Both boat launches provide boat trailer parking for a fee.

Along the reservoir, within the Mt. Mansfield State Forest, three additional boat launches, and 29 primitive campsites are provided. Two of the boat launches are located adjacent to the dam. The other boat launch is located at the Blush Hill site, southeast of the dam, and provides boat trailer parking. A car-top boat launch is located at the north end of the reservoir at the Moscow Access Site. No fee is required to launch a boat at any of these sites.

Water-skiing opportunities are also available. Two slalom ski courses are located near the reservoir; one is permanent, while the buoys for the other can be lowered when not in use. All of the reservoir's recreation facilities are located outside of the Project boundary. The town of Waterbury owns and operates the boat ramp at Blush Hill. The VDFPR or VTDEC owned and maintained all remaining facilities.

License Article 404 requires GMP to file a Recreation Plan (RP) within 6 months of license issuance. Recreational facility improvements must be developed and constructed in consultation with the VTDEC,

VDFW and VDFPR. GMP submitted its original RP on October 19, 2016[54] with a supplement filed on January 6, 2017. FERC approved the RP on March 1, 2017[55].

The RP requires GMP to make the following improvements within ZOE 1:

- Waterbury Reservoir Boat Launch – GMP will install a one-lane boat ramp made of precast concrete planks in place of the existing gravel ramp (See Figure 6).
- GMP will resurface the gravel parking lot and install a waterless restroom and "No Swimming" signs. Storm water and erosion control will be improved by minor grading, adding and removing gravel in select locations, and cleaning and reconstructing, if necessary, an existing ditch.
- Blush Hill Boat Ramp - GMP will replace the existing gravel ramp with a precast concrete ramp, regrade and stabilize the area between the parking area and shoreline with bio-matting and native plantings, add riprap next to the boat ramp to prevent erosion, and reestablish a drainage ditch to channel runoff away from the ramp (See Figure 6);
- Moscow Canoe Access – GMP will install wooden steps at the access point, stabilize the shoreline adjacent to the access, resurface the gravel parking lot, and install a vegetated swale and level spreader for storm water management (See Figure 6).

[54] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14379702
[55] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14507078

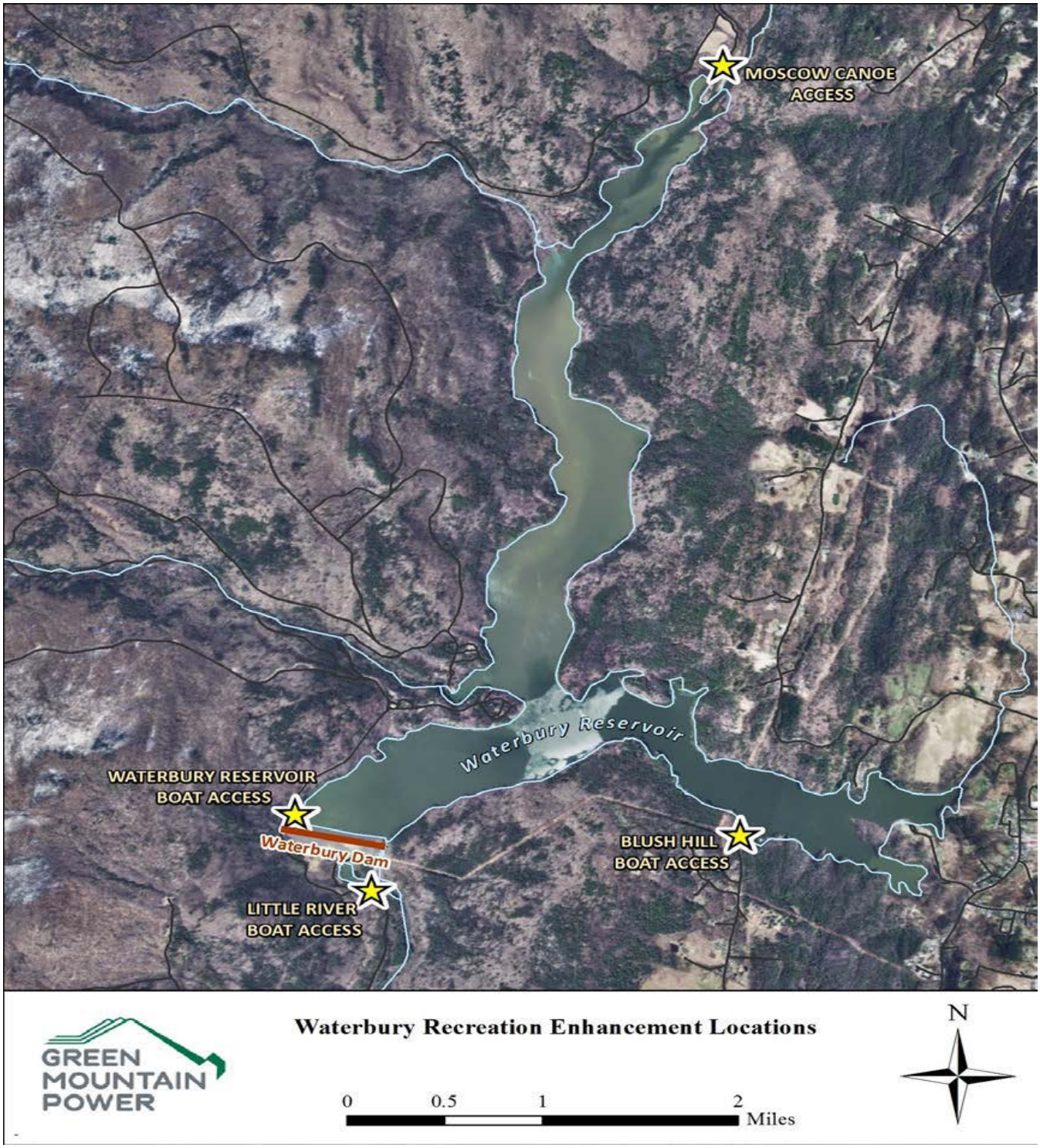


Figure 6 - Recreation Enhancements

In accordance with the RP, GMP was to complete construction of the recreation facilities at the Little River Boat Access and Moscow Canoe Access by December 31, 2017 and complete construction of the recreation facilities at the Waterbury Reservoir Boat Launch and Blush Hill Boat Ramp by December 31, 2019[56].

On December 13, 2017[57], GMP filed a request to extend the construction completion date for the Moscow Canoe Access Site and Little River Boat Access as GMP was working through the necessary environmental permits surrounding recreation enhancement construction. On December 20, 2017[58], FERC granted to extend the construction completion date for the Moscow Canoe Access Site and Little River Boat Access to December 31, 2019, to align with completion of the other recreation facilities.

GMP began recreation enhancements work in October 2018 and plans to continue improvements in the spring of 2019. GMP is scheduling completion of enhancements by the end of 2019. Once recreation updates are completed, continued operation and maintenance of the upgraded facilities will be the responsibility of the State of Vermont.

Within ZOE 2, the Little River below the Waterbury dam to the confluence with the Winooski River offers local canoeing/kayaking and angling opportunities. Hiking trails from Little River Road provide trout anglers access to the river, and beginner and intermediate boaters take advantage of flatwater and Class I/II whitewater. The Little River Boat Access is also located downstream of the Project and is part of the Mt. Mansfield State Forest. All recreational facilities in the ZOE 2 are located outside of the Project boundary.

The RP requires GMP to make the following improvements within the Downstream ZOE:

- Construct a five-vehicle gravel parking lot at the Little River Boat Access and stabilize nearby trails using footbridges or similar structures (See Figure 6);
- Clean and reconstruct an existing ditch and possibly install a culvert under the parking entrance for storm water management;
- Relocate the gate northwest of the entrance to the parking lot such that public access to the hydroelectric plant can be controlled without limiting access to the parking lot;
- Provide notification of flow conditions through the USGS gage located downstream of the Project and corresponding USGS website (See FERC Order dated May 3, 2017[59]);
- Post signs warning boaters of in-stream hazards and takeout areas in the Little River downstream of the Project. GMP plans to install the signs at the same time it improves the Little River Boat Access. Signage is planned to be placed downstream of the dam including at: the gate across driveway, the trailhead parking, the snowmobile access bridge, and USGS gaging station. Final sign locations will be determined in consultation with appropriate state agencies and stakeholders.

Similarly, as with ZOE 1, on December 20, 2017, GMP received an extension to complete the Moscow Canoe Access Site and Little River Boat Access construction by December 31, 2019 to align with completion of the other recreation facilities. Once recreation updates are completed, continued operation and maintenance of the upgraded facilities will be the responsibility of the State of Vermont. Given GMP provides LIHI updates on recreation enhancements still in progress within ZOE 1 and ZOE 2 until completion, it is my recommendation that the Project satisfies the recreational resources criterion with the following condition:

The Facility Owner shall provide updates in their annual compliance submittals to LIHI summarizing progress made toward completion of recreation enhancements until all required improvements have been made and approved by FERC.

[56] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14507078
[57] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14776567
[58] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14781347
[59] https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14581451

7. RECOMMENDATION

A review of the certification application and a search of the entire FERC docket shows GMP has been proactive in meeting the Project's FERC license articles. Most filings were on time without the need of time extension requests. No FERC compliance issues were found.

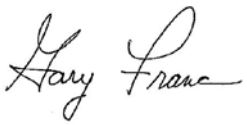
The TDOEMP employs advance technologies to enhance water quality. In addition, the TDOEMP is an adaptive management approach given that the plan may be altered over time in consultation with resource agencies should it be needed. Finally, GMP has proactively reduced licensed plant capacity for the purposes of environmental stewardship.

I recommend issuing to GMP a LIHI Certificate for five years with an option of another three years for the Project with the following conditions:

Condition 1: Upon completion of the current water year under Stage II operations (Oct. 1, 2018 – Sep. 30, 2019), the Facility Owner shall provide a report to VANR and LIHI that documents run of river compliance, adjustments made over the monitoring period, and recommendations for any additional refinement and/or monitoring needed to ensure compliance. The report shall be provided by December 31, 2019. Thereafter, the facility Owner shall provide annual status summaries of run-of-river operations in annual compliance submittals to LIHI.

Condition 2: The Facility Owner shall provide updates in their annual compliance submittals to LIHI summarizing progress made toward completion of recreation enhancements until all required improvements have been made and approved by FERC.

Condition 3 (optional): If at any time prior to six months before the expiration of the Certification term the Facility Owner provides evidence that the Project meets the Plus standard for water quality based on continued implementation of the Tailrace Dissolved Oxygen Enhancement and Monitoring Plan (TDOEMP); that results indicate that TDOEMP implementation measures are appropriate; and that VDEC concurs with continued implementation of the TDOEMP; LIHI will review that information and determine whether or not to award the Plus and extend the Certificate term for three additional years.



Gary M. Franc

FRANC LOGIC

Licensing & Compliance
Hydropower Consulting & Modeling

APPENDIX A
DOCUMENTS

From: Green, Benjamin
To: Katie Sellers
Cc: Greenan, John
Subject: RE: Waterbury Dam Timeline?
Date: Wednesday, February 21, 2018 10:58:12 AM

Good morning Katie,

It is hard to say. We will hopefully be entering into an agreement with the USACE to perform an Risk Assessment of the dam ($615k) and conceptual design for the project, to be completed next year. From there, it is not clear where the funding will come from to complete design, permitting, and construction. It will likely require modification of an existing act. Hopefully the project will become a reality in the next 5 to 10 years, but no one can say for certain.

On a side note, Ali is no longer in the Dam Chief position at the Corps. I will send along contact information for her replacement when I get it as I just learned they hired someone.

Best,

Ben

VERMONT
Benjamin T. Green, PE
Dam Safety Program
Facilities Engineering Division
1 National Life Drive
Montpelier, VT 05620-3510

Phone: 802-622-4093
Email: Benjamin.Green@vermont.gov

http://dec.vermont.gov/facilities-engineering/dam-safety

From: Katie Sellers [mailto:Katie.Sellers@KleinschmidtGroup.com]
Sent: Tuesday, February 20, 2018 2:08 PM
To: Ali.M.Bachowski@usace.army.mil; Green, Benjamin <Benjamin.Green@vermont.gov>
Cc: Greenan, John <John.Greenan@greenmountainpower.com>
Subject: Waterbury Dam Timeline?

Afternoon Ali and Ben – I am working with John Greenan/GMP to develop a Low Impact Hydropower Institute (LIHI) Certification Application for the Waterbury facility. Within the Application, we are hoping to include an approximate timeline for when the Waterbury Tainter gate work might begin and end. That said, would you be able to provide a preliminary start and end date for this work?

I understand the Tainter gate work is not currently scheduled or budgeted, so I understand if "TBD"

is the appropriate answer to this question for the time being.

Thank you
Katie Sellers

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*Providing **practical** solutions for **complex** problems affecting energy, water, and the environment*

APPENDIX E

DRAFT TUBE AERATION POSSIBILITY CFD STUDY

Waterbury GS
Draft tube aeration possibility
- CFD study -

Swiderski Engineering Inc.

For

NORCAN Hydraulic Turbine Inc.

April/2016

Table of content

Preamble

This work was undertaken as a result of discussions with the owner of the Waterbury G.S. on the subject of necessity to increase dissolved oxygen (D.O.) level in the river downstream of the powerplant. As there is a possibility of utilizing the turbine for this purpose, it was decided to study this issue further in order to determine a possible method to aerate the water flow as well as to attempt to determine what the expected D.O. level would be.

CFD domain and zone of interest

Entire turbine unit, as used in the previous phase (hydraulic design of the new runner) was used for the purpose of the flow simulations to determine possibility of flow aeration by injecting air into the draft tube flow.

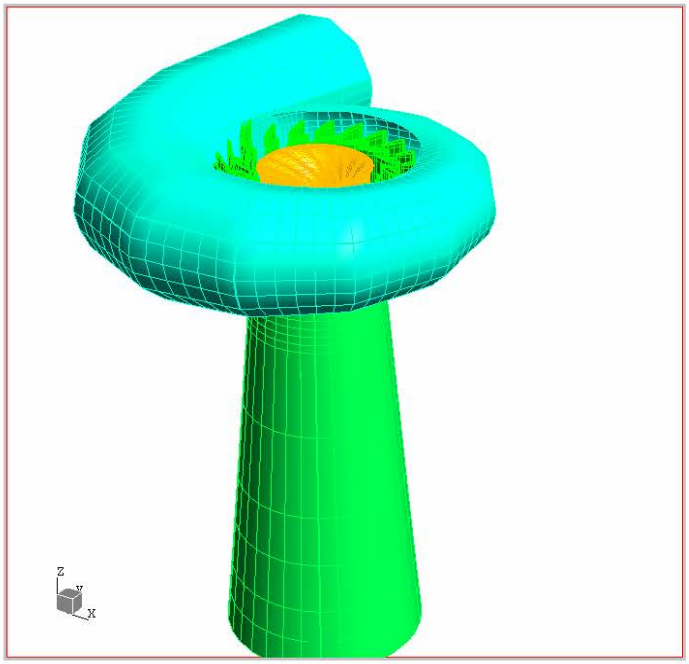

Fig. 1 Domain used for the CFD analysis

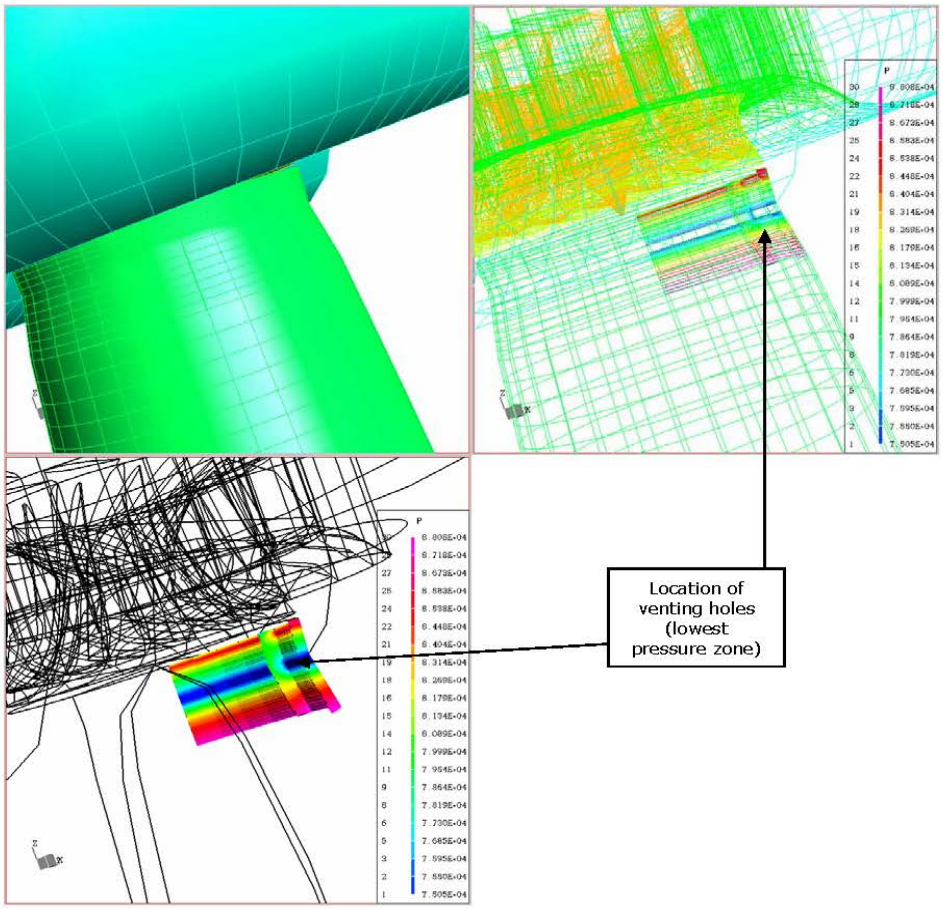

Fig. 2. Zone of interest; parameters monitored are: minimal static pressure and its location, water velocity at the same location.

The zone of interest is located just below the draft tube inlet flange at the shell of the draft tube.

Aerating structure - concept

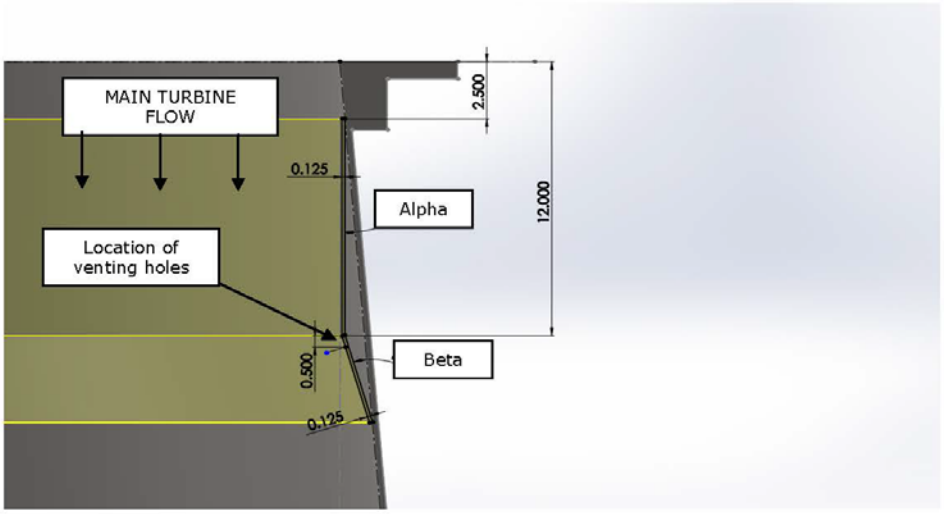

Fig 3. General parameterization of the aeration structure.

For the purpose of current studies, four tested configurations were defined by varying angles Alpha (from 10deg to 3deg) and Beta (12deg or 6deg)

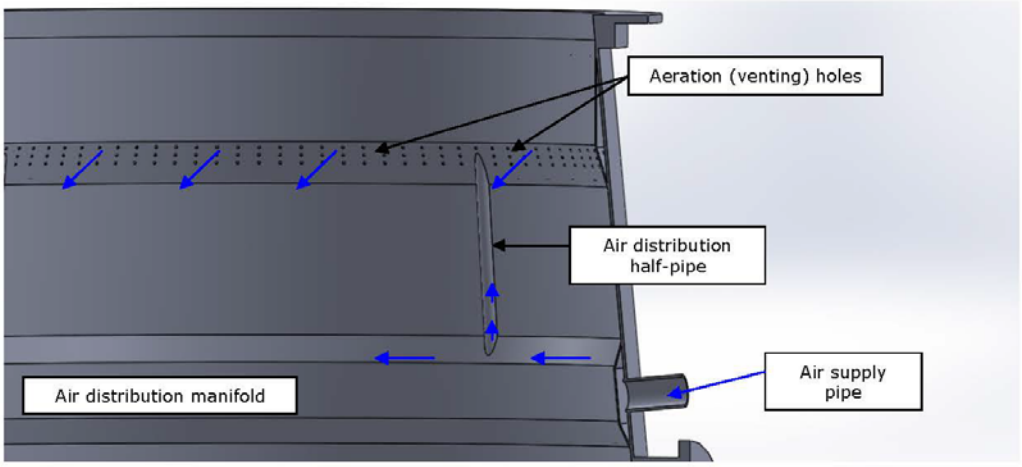

Fig. 4a General view of aeration structure (shown: 300, 0.25in dia holes); there should be total of 4 1.25in dia air supply half-pipes.

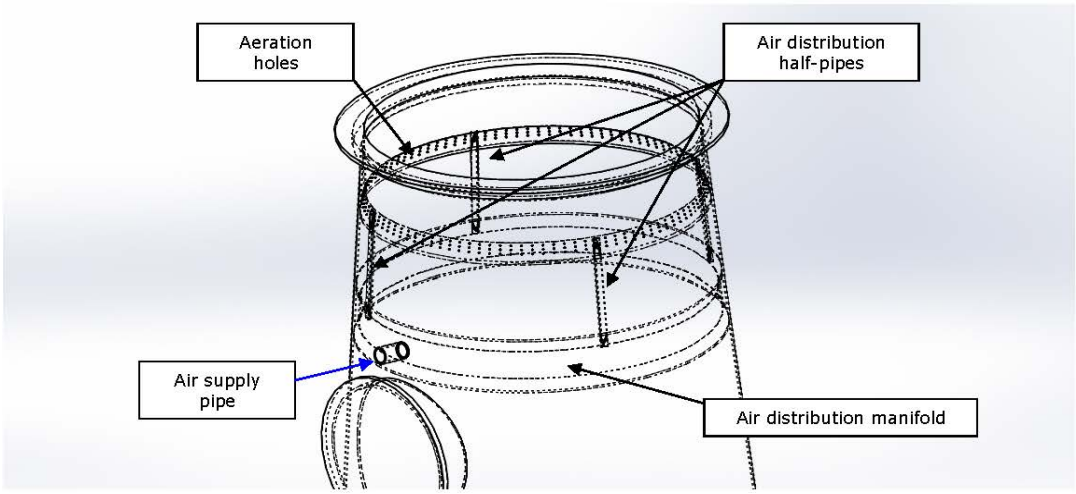

Fig. 4b General view of aeration structure – transparent view.

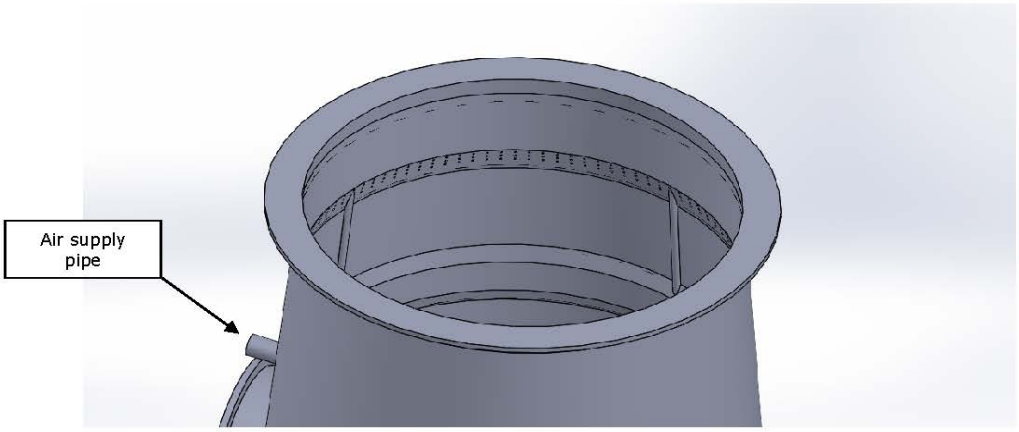

Fig. 4c General view of aeration structure – view 3.

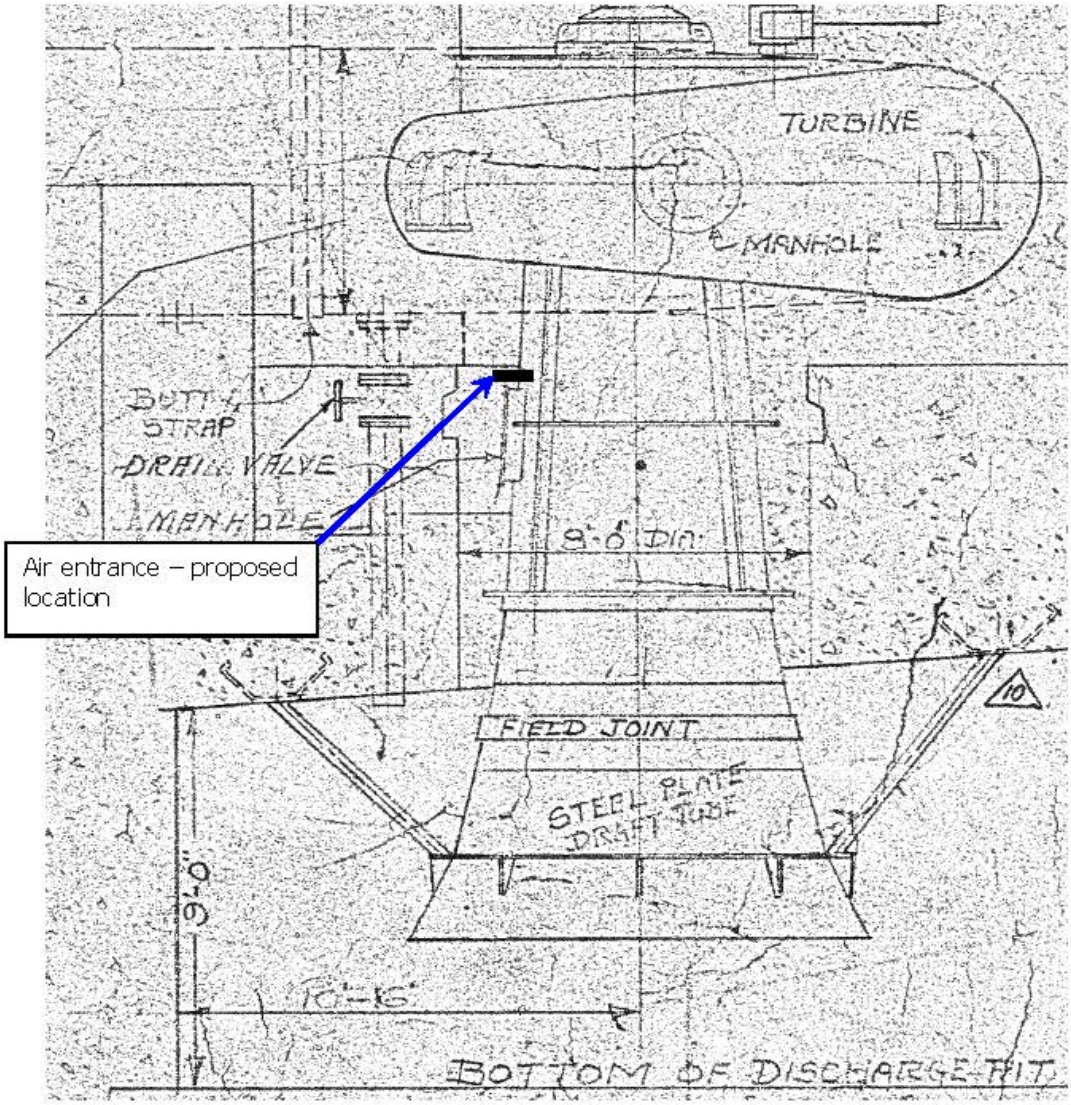

Fig. 4d Location of the proposed main air intake.

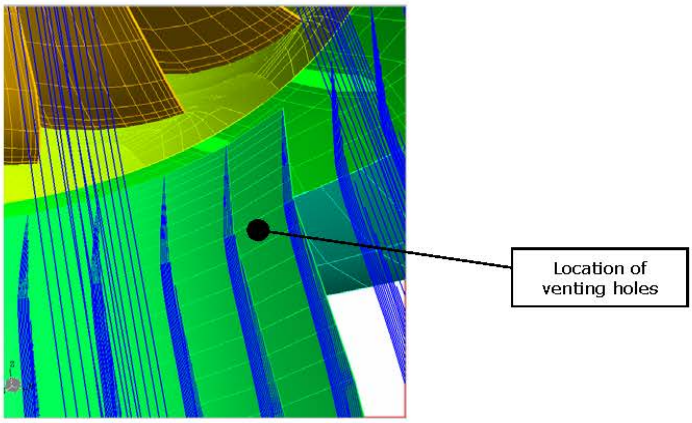

Fig. 5 Illustration of water flow at the zone of interest at full load

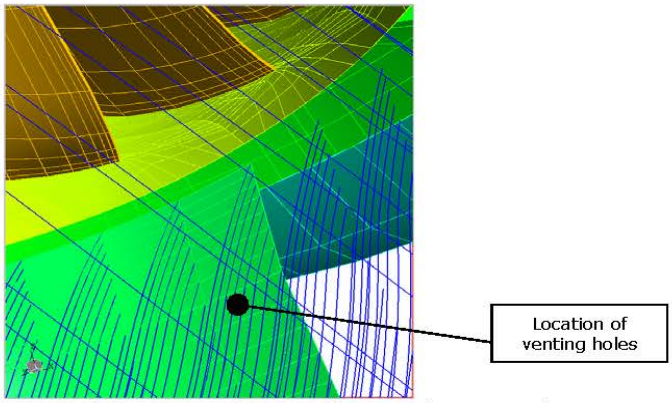

Fig. 6 Illustration of water flow at the zone of interest at best efficiency point

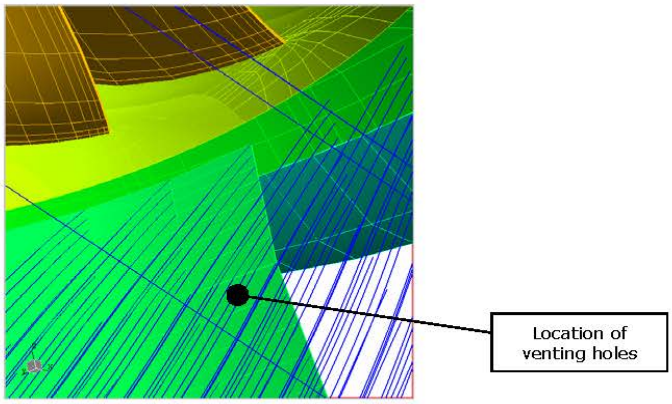

Fig. 7 Illustration of water flow at the zone of interest at 40% load

Calculation results

Four configurations of the aeration structures were tested at the CFD stage to determine:

1) what influence they would have on the overall turbine efficiency
2) where would the most effective suction conditions be located.

The results show very small, almost negligent (within a field measurement error) reduction of turbine efficiency. The effectiveness, measured by the differential suction pressure (amount of static pressure below the atmospheric pressure) also varies amongst the configurations and in the extreme options differs by approximately 10%.

In order to determine magnitude of the D.O. level it is proposed that the ratio of volume flow rates between water and the air be used;

D.O. FACTOR = Qair/Qwater

Where:
Qair [cms] – calculated anticipated volume of air, which enters the water stream
Qwater [cms] – water flow through the turbine

Calculated theoretical airflow through the assumed size of the aerating hole (0.25in dia) based on the differential pressure far exceeds ability of a water flow to evacuate the delivered volume of air, due to limited velocity of water flow. It was therefore assumed that maximum velocity of the airflow through the aerating holes is limited by the velocity of the water flow in the vicinity of the airflow entrance.

Tables showed on final pages show results of calculations at the recent stage of the design.

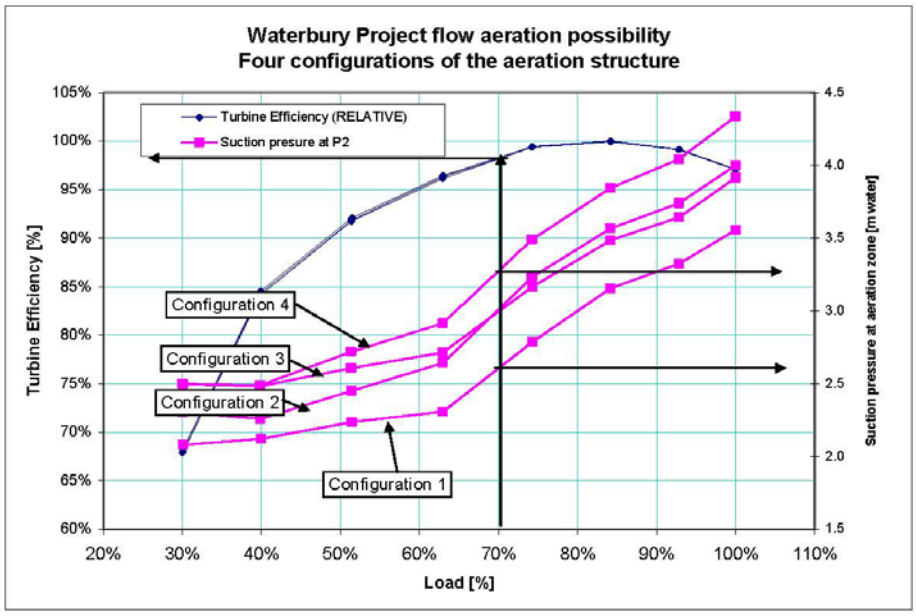

Fig. 8. Graph showing negligible influence of tested aeration structures on turbine efficiency, while the localised suction pressure varies by approx. 20% to 25%.

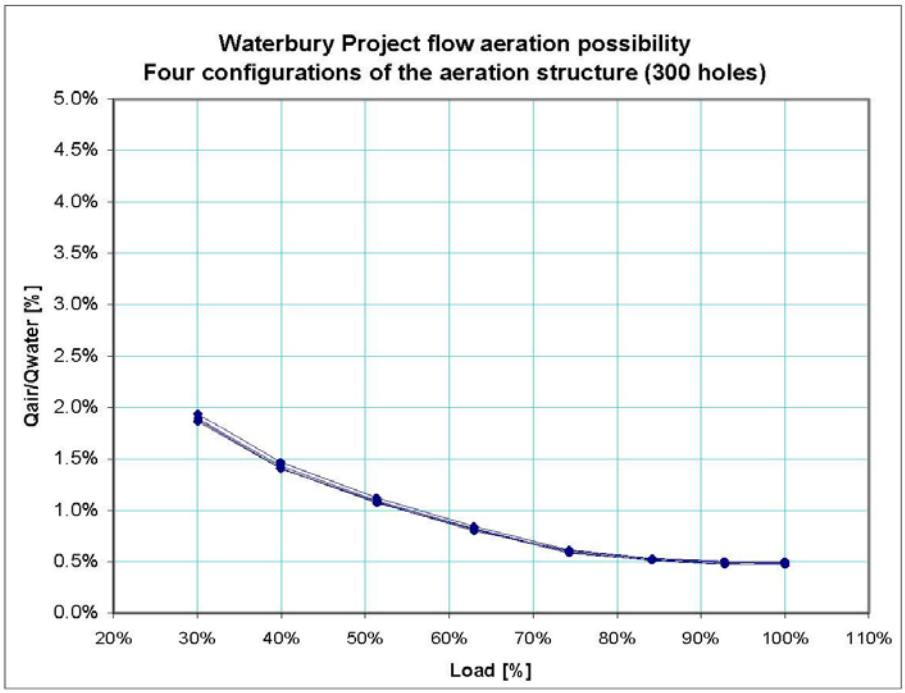

Fig. 9. Calculated proportion of the airflow to the main water flow at various turbine loads: 300 holes option (ref. Fig. 4 and TABLE 1)

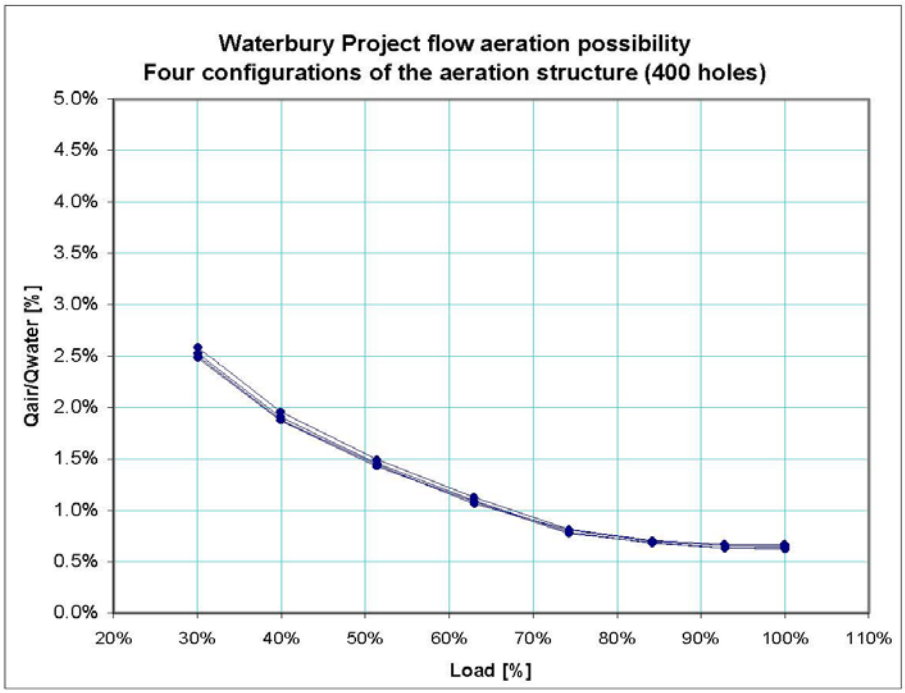

Fig. 10. Calculated proportion of the airflow to the main water flow at various turbine loads: 400 holes option (ref. Fig. 4 and TABLE 2)

	Turbine Power	Turbine Flow	Turbine Efficiency (RELATIVE)	Suction presure at P2	P1 (atm)	P2 (draft tube inlet)	dP	Vmax_air _possible	V_hole	Water Drift velocity (from CFD)	Actual air inflow velocity	Total expected air flow through n_holes	Qair /Qwater
	% of full power	[cms]	[%]	[m H2O]	[kPa]	[kPa]	[kPa]	[m/s]	[m/s]	[m/s]	[m/s]	[cms]	[%]
Configuration 1	30%	3.7	68.3%	2.079	101.33	76.90	24.42	202	100.9	7.53	7.53	0.0693	1.87%
	40%	4.9	84.5%	2.120	101.33	76.50	24.82	203	101.7	7.50	7.50	0.0690	1.40%
	51%	6.3	92.1%	2.235	101.33	75.38	25.95	208	104.0	7.41	7.41	0.0682	1.08%
	63%	7.8	96.5%	2.308	101.33	74.68	26.65	211	105.4	6.70	6.70	0.0617	0.80%
	74%	9.1	99.4%	2.788	101.33	70.01	31.32	228	114.2	6.00	6.00	0.0552	0.60%
	84%	10.4	100.0%	3.154	101.33	66.46	34.87	241	120.5	5.88	5.88	0.0541	0.52%
	93%	11.4	99.1%	3.325	101.33	64.80	36.52	247	123.4	6.10	6.10	0.0561	0.49%
	100%	12.3	97.1%	3.554	101.33	62.57	38.75	254	127.1	6.53	6.53	0.0601	0.49%
Configuration 2	30%	3.7	67.9%	2.497	101.33	72.84	28.48	218	108.9	7.48	7.48	0.0688	1.86%
	40%	4.9	84.1%	2.483	101.33	72.98	28.35	217	108.7	7.50	7.50	0.0690	1.41%
	51%	6.3	91.7%	2.607	101.33	71.77	29.55	222	111.0	7.35	7.35	0.0676	1.07%
	63%	7.7	96.2%	2.712	101.33	70.75	30.58	226	112.9	6.83	6.83	0.0629	0.81%
	74%	9.1	99.4%	3.167	101.33	66.33	34.99	241	120.7	5.75	5.75	0.0529	0.58%
	84%	10.4	100.0%	3.485	101.33	63.25	38.07	252	126.0	5.77	5.77	0.0531	0.51%
	93%	11.4	99.1%	3.643	101.33	61.72	39.61	257	128.5	5.88	5.88	0.0541	0.47%
	100%	12.3	97.1%	3.915	101.33	59.07	42.25	265	132.7	6.21	6.21	0.0572	0.46%
Configuration 3	30%	3.7	68.0%	2.301	101.33	74.74	26.59	210	105.2	7.61	7.61	0.0700	1.89%
	40%	4.9	84.3%	2.256	101.33	75.18	26.15	209	104.4	7.62	7.62	0.0702	1.43%
	51%	6.3	91.9%	2.449	101.33	73.31	28.02	216	108.0	7.50	7.50	0.0691	1.09%
	63%	7.7	96.4%	2.642	101.33	71.43	29.90	223	111.6	6.90	6.90	0.0635	0.82%
	74%	9.1	99.4%	3.233	101.33	65.70	35.63	244	121.8	5.85	5.85	0.0538	0.59%
	84%	10.4	99.9%	3.567	101.33	62.45	38.88	255	127.3	5.70	5.70	0.0525	0.51%
	93%	11.4	99.1%	3.739	101.33	60.78	40.54	260	130.0	5.86	5.86	0.0539	0.47%
	100%	12.3	97.1%	4.002	101.33	58.23	43.09	268	134.0	6.34	6.34	0.0584	0.47%
Configuration 4	30%	3.7	67.9%	2.500	101.33	72.81	28.51	218	109.0	7.77	7.77	0.0715	1.94%
	40%	4.9	84.3%	2.488	101.33	72.93	28.40	218	108.8	7.81	7.81	0.0718	1.46%
	51%	6.3	91.8%	2.720	101.33	70.68	30.65	226	113.0	7.70	7.70	0.0708	1.12%
	63%	7.7	96.3%	2.915	101.33	68.79	32.54	233	116.4	7.09	7.09	0.0652	0.84%
	74%	9.1	99.3%	3.489	101.33	63.21	38.11	252	126.0	6.04	6.04	0.0556	0.61%
	84%	10.4	99.9%	3.843	101.33	59.77	41.55	263	131.6	5.92	5.92	0.0545	0.53%
	93%	11.4	99.1%	4.040	101.33	57.86	43.47	269	134.6	6.21	6.21	0.0571	0.50%
	100%	12.3	97.0%	4.336	101.33	54.99	46.34	278	139.0	6.71	6.71	0.0618	0.50%

TABLE 1 Calculation results – 300 holes option (Fig. 9)

	Turbine Power	Turbine Flow	Turbine Efficiency (RELATIVE)	Suction pressure at P2	P1 (atm)	P2 (draft tube inlet)	dP	Vmax_air_possible	V_hole	Water Drift velocity (from CFD)	Actual air inflow velocity	Total expected air flow through n_holes	Qair /Qwater
	% of full power	[cms]	[%]	[m H2O]	[kPa]	[kPa]	[kPa]	[m/s]	[m/s]	[m/s]	[m/s]	[cms]	[%]
Configuration 1	30%	3.7	68.3%	2.079	101.33	76.90	24.42	202	100.9	7.53	7.53	0.0924	2.49%
	40%	4.9	84.5%	2.120	101.33	76.50	24.82	203	101.7	7.50	7.50	0.0920	1.87%
	51%	6.3	92.1%	2.235	101.33	75.38	25.95	208	104.0	7.41	7.41	0.0909	1.44%
	63%	7.8	96.5%	2.308	101.33	74.68	26.65	211	105.4	6.70	6.70	0.0822	1.06%
	74%	9.1	99.4%	2.758	101.33	70.01	31.32	228	114.2	6.00	6.00	0.0736	0.81%
	86%	10.4	100.0%	3.154	101.33	66.48	34.87	241	120.5	5.88	5.88	0.0722	0.70%
	93%	11.4	99.1%	3.575	101.33	64.80	36.52	247	123.4	6.10	6.10	0.0749	0.66%
	100%	12.3	97.1%	3.554	101.33	62.57	38.75	254	127.1	6.53	6.53	0.0801	0.65%
Configuration 2	30%	3.7	67.5%	2.497	101.33	72.84	28.48	218	108.9	7.48	7.48	0.0918	2.48%
	40%	4.9	84.1%	2.483	101.33	72.98	28.35	217	108.7	7.50	7.50	0.0920	1.88%
	51%	6.3	91.7%	2.607	101.33	71.77	29.55	222	111.0	7.35	7.35	0.0902	1.43%
	63%	7.7	96.2%	2.712	101.33	70.75	30.58	226	112.9	6.83	6.83	0.0838	1.08%
	74%	9.1	99.4%	3.167	101.33	66.33	34.99	241	120.7	5.75	5.75	0.0706	0.77%
	86%	10.4	100.0%	3.485	101.33	63.25	38.07	252	126.0	5.77	5.77	0.0705	0.68%
	93%	11.4	99.1%	3.643	101.33	61.72	39.61	257	128.5	5.88	5.88	0.0722	0.63%
	100%	12.3	97.1%	3.915	101.33	59.07	42.25	265	132.7	6.21	6.21	0.0762	0.62%
Configuration 3	30%	3.7	68.0%	2.501	101.33	74.74	26.59	210	105.2	7.61	7.61	0.0933	2.52%
	40%	4.9	84.3%	2.256	101.33	75.18	26.15	209	104.4	7.62	7.62	0.0935	1.91%
	51%	6.3	91.9%	2.448	101.33	73.31	28.02	216	108.0	7.50	7.50	0.0921	1.46%
	63%	7.7	96.4%	2.642	101.33	71.43	29.90	223	111.6	6.90	6.90	0.0847	1.09%
	74%	9.1	99.4%	3.233	101.33	65.70	35.63	244	121.8	5.85	5.85	0.0717	0.78%
	86%	10.4	99.9%	3.567	101.33	62.45	38.88	255	127.3	5.70	5.70	0.0700	0.68%
	93%	11.4	99.1%	3.729	101.33	60.78	40.54	260	130.0	5.80	5.86	0.0719	0.63%
	100%	12.3	97.1%	4.002	101.33	58.23	43.09	269	134.0	6.34	6.34	0.0778	0.63%
Configuration 4	30%	3.7	67.9%	2.500	101.33	72.81	28.51	218	109.0	7.77	7.77	0.0954	2.58%
	40%	4.9	84.3%	2.488	101.33	72.93	28.40	218	108.8	7.81	7.81	0.0958	1.95%
	51%	6.3	91.8%	2.720	101.33	70.69	30.65	226	113.0	7.70	7.70	0.0944	1.49%
	63%	7.7	96.3%	2.915	101.33	68.79	32.54	233	116.4	7.09	7.09	0.0869	1.12%
	74%	9.1	99.3%	3.489	101.33	63.21	38.11	252	126.0	6.04	6.04	0.0741	0.81%
	86%	10.4	99.9%	3.843	101.33	59.77	41.55	263	131.6	5.92	5.92	0.0727	0.70%
	93%	11.4	99.1%	4.040	101.33	57.86	43.47	269	134.6	6.21	6.21	0.0762	0.67%
	100%	12.3	97.0%	4.308	101.33	54.99	46.34	278	139.0	6.71	6.71	0.0823	0.67%

TABLE 2 Calculation results – 400 holes option (Fig. 10)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
22 Bridge Street, Unit #1
Concord, New Hampshire 03301-4986

RE: Green Mountain Power Corporation
Waterbury Hydroelectric Project
FERC No. 2090

August 30, 2000

Harriet Ann King
King & King
Prentis House, P.O. Box 879
Waitsfield, VT 05673

Dear Ms. King:

This responds to your July 27, 2000 letter requesting information on the presence of federally-listed and proposed, endangered or threatened species in relation to the Waterbury Hydroelectric Project license application. Our comments are provided in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

Based on information currently available to us, no federally-listed or proposed threatened or endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area.

Thank you for your cooperation. Please contact me at 603-225-1411 if we can be of further assistance.

Sincerely yours,

for Michael Amaral
Endangered Species Specialist
New England Field Office

RECEIVED
SEP 5 2000

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104
http://www.fws.gov/newengland

In Reply Refer To:
Consultation Code: 05E1NE00-2017-SLI-2535
Event Code: 05E1NE00-2017-E-05527
Project Name: Waterbury Hydroelectric Project FERC No. 2090

August 24, 2017

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 et seq.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the

human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Endangered Species Act Species

There is a total of 1 threatened, endangered, or candidate species on this species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

Mammals

NAME	STATUS
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Critical habitats

There are no critical habitats within your project area under this office's jurisdiction.

Project Summary

Consultation Code: 05E1NE00-2017-SLI-2535

Event Code: 05E1NE00-2017-E-05527

Project Name: Waterbury Hydroelectric Project FERC No. 2090

Project Type: DAM

Project Description: Certification for LIHI, The Waterbury Hydroelectric Project (FERC No. 2090) (Project) is located on the Little River in the town of Waterbury, Washington County, Vermont and is one of seven dams built on Winooski River and its tributaries. The Project's hydroelectric facilities are owned and operated by the Green Mountain Power Corporation. The existing project boundary encloses the project's hydroelectric generation related facilities including the intake, tunnel, penstocks, powerhouse, and transmission line. The Waterbury dam and reservoir are federal facilities, they are not included in the license.

Project Location:

Approximate location of the project can be viewed in Google Maps:
https://www.google.com/maps/place/44.380181655632211N72.77050992551659W

Counties: Washington, VT