PETERSBURG
MUNICIPAL POWER & LIGHT

Blind Slough Hydroelectric Project

Alternatives Development and Evaluation

DRAFT
Revision No. 0

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Executive Summary

McMillen Jacobs Associates (McMillen Jacobs) previously performed a Condition Assessment (CA) of the Blind Slough Hydroelectric Project (Project) for the Borough of Petersburg, Municipal Power and Light (Borough). The CA was performed by a multidisciplinary team of professional engineers who used their experience with other hydroelectric facilities and information provided by the Borough to assess the condition of the Project. The Project is performing as designed. Project operations and maintenance (O&M) staff are knowledgeable and have a long association with the Project. The CA concluded with a list of recommendations for work needed to keep the Project operating for the term of the current Federal Energy Regulatory Commission (FERC) license and future licenses.

The Project is a cost-effective source of energy for the Borough. As for any long-lived energy asset, periodic refurbishment and replacements are needed to allow continued operation. The Project, which was originally constructed in 1921 and rebuilt in 1955, has been in operation for nearly 100 years. While we understand it is not the Borough's plan, allowing equipment to run to failure will mean purchasing more replacement power from the Southeast Alaska Power Agency (SEAPA) in the future. The average cost of power for the Project is $0.012 per kilowatt-hour (kWh). Replacement power from SEAPA is currently $0.068 per kWh. A lengthy outage could easily cost the Borough several hundred thousand dollars.

McMillen Jacobs was also retained to use the CA to perform an analysis of alternatives for major maintenance (for life extension) and capital improvements for the Project. This report (Alternatives Development and Evaluation) documents and evaluates the alternatives developed to recommend major maintenance and capital improvements for the Project. Table ES-1 presents the alternatives evaluated as part of this work.

Table ES-1. Alternatives Evaluated

Alternative	Component	Issue
1	No Action	Sets the baseline alternative that estimates the remaining facility life and risk of no action. Alternative 1 represents the No Cost alternative for the purpose of comparing against other alternatives.
2	Planned small replacement / refurbishment projects performed over time with priority given to urgent items	This alternative provides replacements/upgrades to those components that are determined to have a high potential for failure within a 5-year operating window and provides up to a 20-year operating life. These small projects would include the following: **Powerhouse** Turbine repair/refurbishment Generator rewind Control system and protective relay replacement Governor replacement Generator excitation system replacement Generator lube oil set replacement Turbine inlet valve installation Balance of plant electrical improvements Powerhouse roof repairs

Alternative	Component	Issue
		Penstock Penstock remotely operated vehicle (ROV) inspection Penstock coupling refurbishment Penstock coupling hardware replacement Penstock support repairs
3	Powerhouse refurbishment / upgrade	This alternative involves a comprehensive powerhouse refurbishment that would be performed under a single contract. This approach would minimize outages and coordination by the Borough. This alternative could involve only equipment replacement (controls, protective relays, switchgear, etc.) and refurbishment of the turbine and generator (which will not result in any increased generation) or a new turbine with a higher efficiency and generator refurbishment / replacement that would result in increased generation.
4	Penstock repair / replacement	This alternative involves a comprehensive penstock refurbishment that would be performed under a single contract. This alternative could involve either a repair of the existing penstock or a new replacement penstock that would result in increased generation and a longer life.
5	Intake improvements	There is minimal active storage in the reservoir. This alternative investigates whether improvements could be made to utilize additional storage and increase generation or operating flexibility.

Alternative 1 – No Action Alternative

Alternative 1 would result in Project outages and continued maintenance cost increases over time. This alternative is the baseline situation, i.e., no alternative is selected for Project refurbishment. While the Borough is not advocating this alternative, this course of action would essentially mean that equipment would be run to failure. Such a course of action would not be prudent and could lead to long outages and safety concerns.

Alternative 2 – Planned Small Refurbishment / Replacement Projects

Alternative 2 would involve over a dozen different projects. These projects, done separately, would require significantly more coordination by the Borough and more outage time than if the work was consolidated into a single contract. The time required to perform work in this manner would likely stretch out into a number of years, thereby risking equipment failures.

Alternative 3 – Powerhouse Refurbishment

Given that the powerhouse major generating equipment is all equipment originally installed in 1955 (except for a new turbine runner in 1980 and some more recent controls improvements), refurbishment was considered as the minimum level of work. Among the major concerns noted in the CA are the following: the turbine efficiency appears to be very low and implies the need for a new runner, the generator is in need of a rewind, the governor is an antique with no available parts availability, the generator switchgear has exposed bus work with concerns for operating personnel safety, and the DC batteries are a concern for reliability.

Due to the age of this equipment, the potential for a failure and long outage are becoming a real concern. These issues and concerns suggest the need for a significant refurbishment program. Additionally, analysis of an option to replace the single-jet impulse turbine with a modern two-jet impulse turbine indicates that it would be cost effective and provide a significant boost (greater than 10%) in average annual generation. Our analysis indicates that the improvement in generation makes the turbine upgrade and replacement cost effective in comparison to installing a new runner. Based on discussion with one turbine vendor, a new runner for the existing turbine will not likely lead to increased generation. Furthermore, a rewind of the generator is not cost effective in relation to replacement. Replacement of the generator will allow the generator speed to be optimized for the new turbine.

Alternative 4 – Penstock Repair / Replacement

Because the penstock also dates to 1955, the installation was carefully inspected during the CA. The penstock has already had two failures due to problems with a penstock support and bypass valve malfunction. There were significant issues with the condition of some of the penstock supports, joint couplings and hardware, and lack of access for maintenance. This study also reviewed the economics of a complete penstock replacement and upgrade as an alternative to refurbishment/repair. An upgrade would optimize the size of the penstock to about a 22-inch outside diameter size, thereby reducing losses and increasing generation. Our analysis indicates that the increase in generation from a replacement/upgraded penstock is not cost effective in comparison to repair of the existing penstock. Recent 2018 penstock ultrasonic wall thickness testing (UTT) services carried out by QA Services Inc. revealed very minor apparent losses of steel wall thickness at approximately 15 different penstock locations. Further remote operated vehicle (ROV) camera inspection of the penstock interior is recommended to better understand the condition of the penstock liner and interior wall surface.

If no major problems are found with the ROV inspection, we believe that a penstock refurbishment/ repair project will allow the current penstock to remain in service for another 30 to 40 years. Based on the CA, the refurbishment project would include penstock interior ROV inspection, selected replacement of penstock couplings and hardware, selected concrete replacement/refurbishment of pedestals and steel supports, and maintenance trail improvement.

Discussions with the fish hatchery will be needed to address how to supply water to the hatchery during any outage of the penstock.

Alternative 5 – Intake Modifications

Presently, the Project has a narrow band of active storage (from Elevation [El.] 1,294 to 1,272 feet). An analysis was conducted of an alternative to increase the amount of active storage and withdraw water from a deeper point in the reservoir. During the site visit in 2018, McMillen Jacobs learned from the hatchery manager that problems with fish were experienced in the summer with warm water temperatures. Modifications to the intake to allow withdrawal from the deeper (and colder) part of the lake were studied as part of the evaluation of alternatives. However, because the Project rarely spills water over the spillway, additional storage has a limited economic benefit. Additionally, to access additional storage, a siphon arrangement would be required to pull water from below El. 1,270 feet (invert of the intake gate on the dam is at El. 1,266 feet).

This alternative studied adding a high-density polyethylene (HDPE) pipe that would be attached at the existing penstock intake on the upstream side of the dam and extended out into the reservoir up to 1,600 feet. The HDPE pipe would be weighted to sink to the bottom of the reservoir. At the inlet to the HDPE pipe, a wire screen would prevent large debris from entering the pipe. The reservoir would still only be able to be drawn down to about El. 1,240 feet due to practical limitations on the height the siphon could lift water. In addition, attempted use of a new siphon intake could create problems with air entrainment through the existing penstock sleeve style couplings inside the pump-back station building and just below the pump-back station building. This type of joint design is not typically used with any type of siphon intake design that creates negative pressures on portions of the penstock pipeline. The change in storage would increase from the current capacity of 5,200 acre-feet to 15,000 acre-feet. An operation model did not show enough economic benefit to justify the expense of construction.

Conclusions

Table ES-2 summarizes the results of the alternatives evaluation.

Table ES-2. Results of the Alternatives Evaluation

Alternative	Description	Recommendation	Cost
1	No Action	This is the baseline condition against which other alternatives are evaluated.	Not applicable.
2	Planned Small Refurbishment / Replacement Projects	This alternative is not recommended. There are too many small projects to coordinate effectively and complete in a timely manner.	Not applicable.
3	Powerhouse refurbishment and upgrade alternatives	The powerhouse equipment is past its service life. We recommend that a complete powerhouse refurbishment be performed under a single contract. A single contract will minimize the outage time and provide comprehensive refurbishment of all powerhouse equipment. Our analysis indicates that a replacement of the existing turbine with a two-jet impulse turbine is cost effective due to the increased generation. Replacement of the generator is also cost effective (compared to a rewind). We recommend an equipment procurement contract to select and purchase a new turbine-generator and auxiliary electric equipment followed by a construction contract to demolition the old equipment and install the new equipment.	$5,300,000

Alternative	Description	Recommendation	Cost
4	Penstock repair / replacement	The penstock needs repair to allow another 30 to 40 years of operation. An alternative to increase generation by replacing the penstock with larger diameter pipe to reduce losses is not cost effective compared to repair. We recommend detailed engineering and the development and execution of a penstock repair contract to fully refurbish the penstock. As part of the initial engineering, we recommend an inspection of the existing penstock interior with an ROV.	$2,000,000
5	Intake improvements	Modifications are not recommended because there is insufficient benefit in comparison to the cost.	Not applicable.