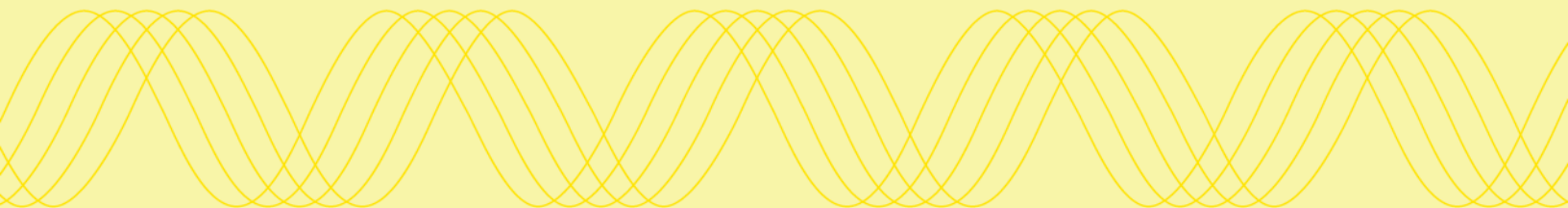


Portland General Electric



River Mill: A lasting legacy for the people of Oregon

An Oregon kind of energy



In 1905, Thomas Edison visited Portland, Oregon, and the Lewis & Clark Exposition. A big spectacle of the fair - championed by Portland's power company - was not a Space Needle or an Eiffel Tower.

It was a city lit up by electricity.

The fair helped fuel the growth of Portland and brought in more people wanting power; between 1900 and 1910, the city doubled in population, reaching 207,000 residents.

To help provide for the growing city, our company built a series of small thermal and hydro generation facilities, using a letter of the alphabet to sequentially name each plant. In 1910 the company began construction on the dam for its 12th generation facility - Station M, which years later was renamed River Mill.

Completed in 1911 on the Clackamas River, located on the western slope of the Cascade Mountain Range, River Mill remains the furthest downstream element of PGE's Clackamas River Hydroelectric Project.

The Jan. 4, 1913 edition of the "Journal of Electricity, Power and Gas" suggested that right from the start the project was unusual and

noteworthy ". . . for the rapidity of its construction, considering the exceedingly substantial manner in which it is built, and for the fact that it employs the first Ambursen type of dam for power plant work on the Pacific Coast."

"Our region's rich resources and the great facilities our predecessors built have left us with a strong legacy," said PGE President and CEO Maria Pope, who served as senior vice president of Power Supply and Operations and Resource Strategy at the time.

"We don't think of River Mill as an old project. We consider it a heritage project. It just shows that if you put the right work into a project, the project will last."

Today the dam is listed on the National Register of Historic Places for its rare design and the role its construction played in the development of the town of Estacada and electrification of area.



The site for the River Mill Dam in 1878.

In 2015, River Mill was inducted into the Hydro Review Hydro Hall of Fame during the HydroVision International Conference in Portland. This marks the second PGE hydro facility to be included in the Hall of Fame - PGE's T.W. Sullivan Plant, which began commercial operation on the Willamette River in 1895, was inducted in 1995.

The site is considered so interesting and historically important, in 2010, the Estacada Area Arts Commission collaborated with PGE on a multi-year project to explore these dams and powerhouses through the arts. Artists visited the site and created works showing the River Mill area in photography, paint and wood.

Plant design and construction



Panorama of the construction of River Mill (originally known as Station M), taken on Oct. 28, 1911.

River Mill was designed by Nils F. Ambursen (1876-1958), a Norwegian-American civil engineer and inventor known for his influential dam designs in the early-20th century.

River Mill is unique because of its construction. It was the first Ambursen dam on the West Coast, and today is one of the few original Ambursen-designed dams still operating in the country. Also known as buttress dams, Ambursen dams use relatively thin slabs to hold back the water, supported by buttresses along the length of the dam. This design marked a turning point toward more efficient use of raw materials in dam construction. This design required less concrete, which was heavy and expensive to transport to dam sites. They were also quicker to build.

Labor of the pick and shovel type was required. Workmen lived at the site in temporary housing; a sawmill on site provided lumber for construction purposes. Rail lines built to carry workers and materials to the site were also important because they

brought tourism to the region, which ultimately led to the birth of the city of Estacada, 35 miles from Portland.

“The River Mill dam is one of the more important projects in PGE’s hydroelectric fleet from a control perspective because it allows us to regulate the flow on the Clackamas River,” said Nick Loos, who served as plant manager of Westside Hydro when River Mill was inducted into the Hydro Review Hydro Hall of Fame. “It took a commitment from PGE and combined efforts from many agencies to make this facility outlast others.”

“It’s not big in the sense of comparing it to some of our other projects, but 20 megawatts is 20 megawatts,” said John Esler, a retired project manager in PGE’s Environmental Compliance & Licensing department. “It’s a nice contributor to our system. It’s also the last dam in the series of dams, and provides an underappreciated value regulating the flows from the projects above.”

Powerhouse dam



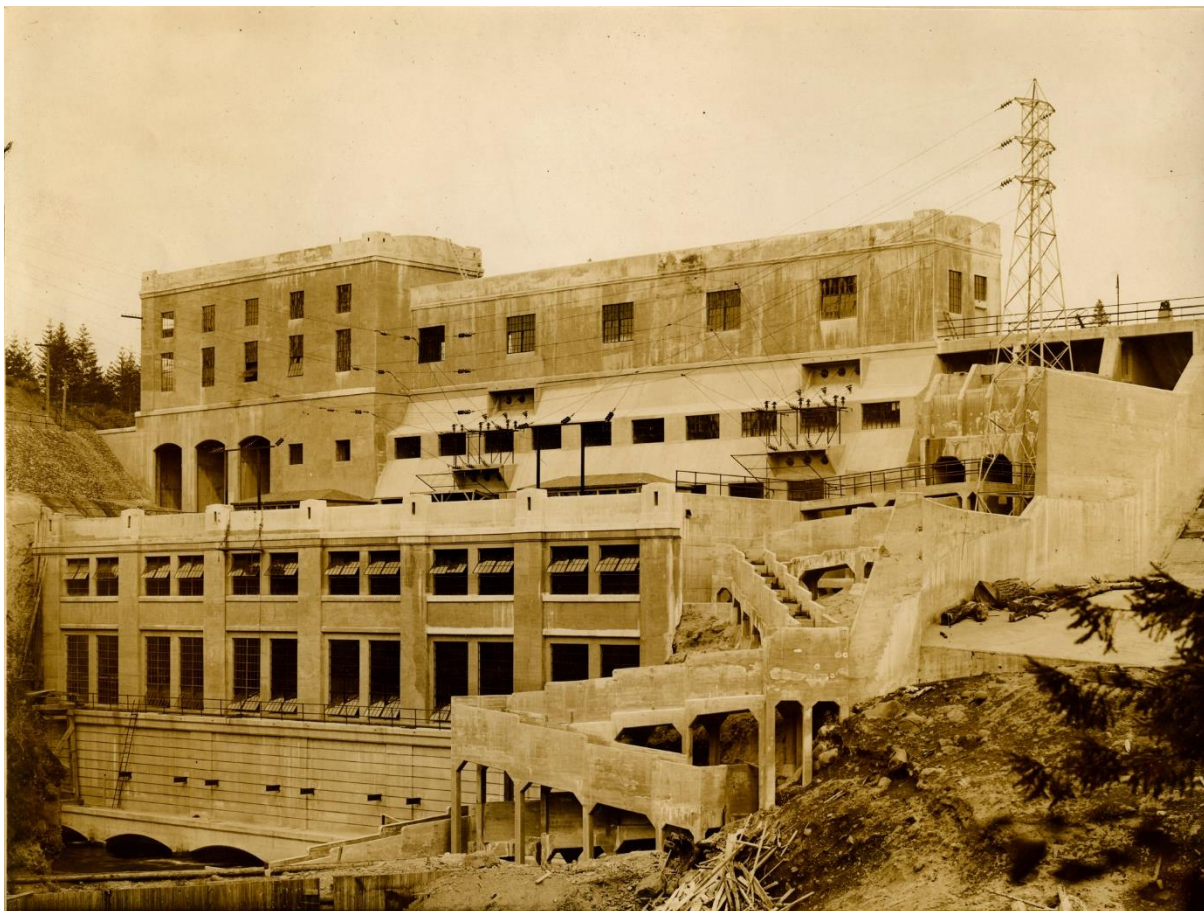
River Mill on April 15, 1931.

Located on the east bank of the Clackamas River, the powerhouse dam is approximately 173 feet in length, supporting the power and gate houses. Overall height at the downstream face is approximately 86 feet.

The hollow interior of the structure is composed of a series of poured-in-place buttresses spaced on 14- to 18-foot intervals, with horizontal supporting members of concrete slabs forming the up and downstream faces. Interior finishes include the rough form marks and put-log holes remaining from the false work of construction and the interior is accessed via a narrow, suspended walkway that runs the length of the dam.

In 2000-2001, as an element of the FERC-mandated seismic remediation, the hollow interior bays of the powerhouse dam were filled with concrete to rectify limitations of the original design.

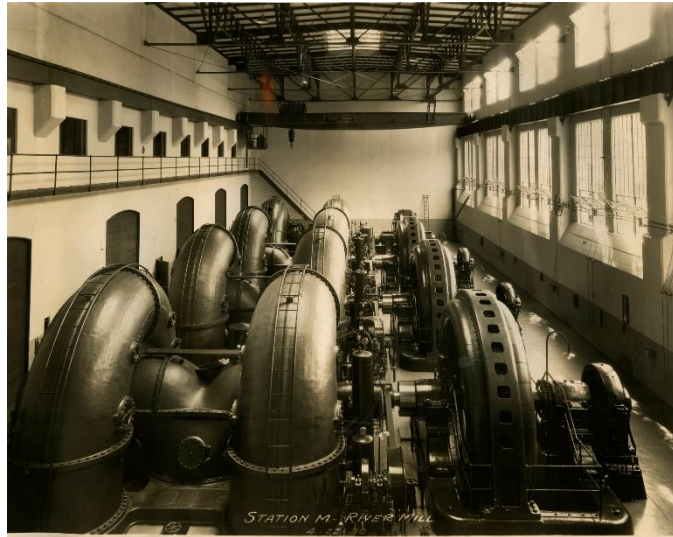
Powerhouse



Construction of the River Mill Powerhouse on July 12, 1919.

River Mill currently operates five generating units: Three of the units were up and running by the end of 1911. Peak capability in January 1924 was 13,800 kW. The fourth unit was installed in 1927 and a fifth in 1952. Those later additions helped raise the plant to its current peak capability of 23,000 kW.

The powerhouse itself is a large cast concrete structure built above the dam. A three-story rectilinear volume set perpendicularly across the river channel, the powerhouse is simply detailed with engaged cast stringcourse lines, sills and cornice. The interior power floor, holding the power generation equipment, is lit by two banks of original steel fixed and pivot sash multipaned windows.

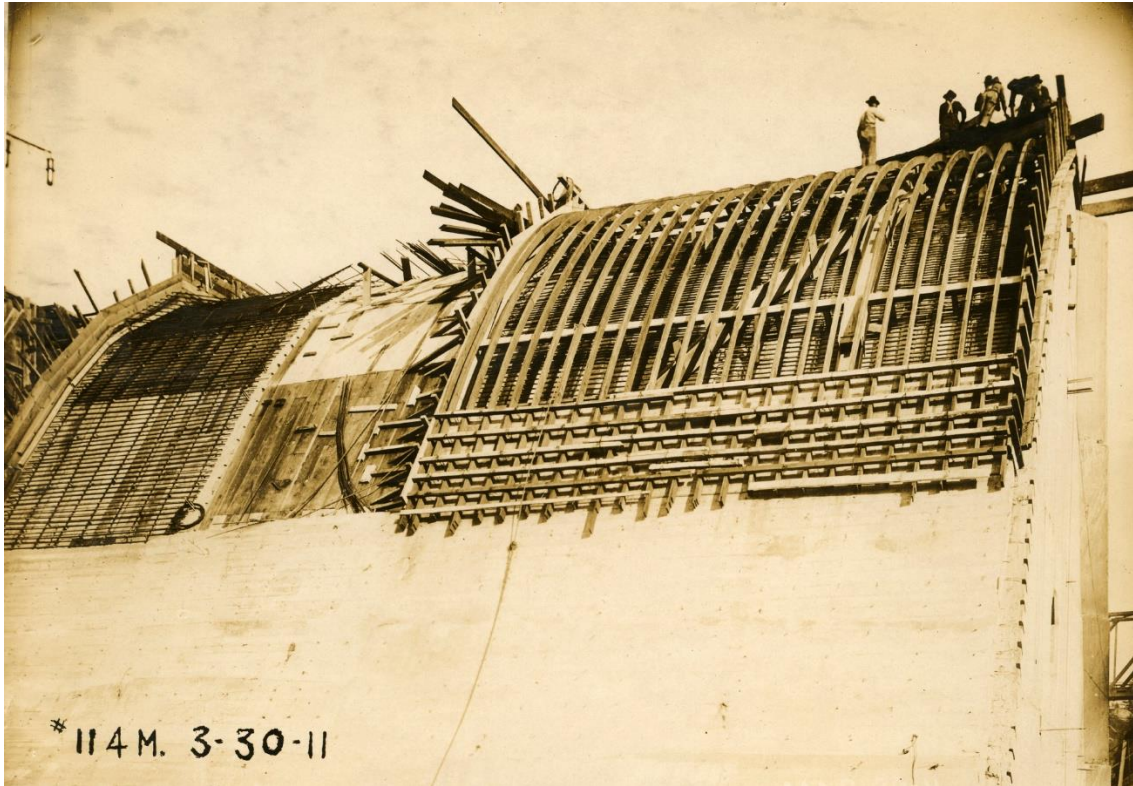


The interior of the River Mill Powerhouse on April 22, 1930. Three of the generating units were installed in 1911 during initial construction. A fourth unit was added in 1927, three years prior to the taking of this picture.

Spillway dam

Located between the powerhouse dam and the west bank of the Clackamas River, the spillway dam is 406 feet long and approximately 73 feet high. A 54-foot wide non-overflow section divides the spillway dam from the powerhouse dam.

The River Mill dam consists of 22 cast concrete buttresses, varying in width from 15 inches to 72 inches, depending on the location, set parallel to the river channel at intervals of 18 feet center to center, except for the 10-foot spacing between buttresses A and B. Cast concrete slab sections form both faces of the spillway, with interior cast concrete corbels and lateral cast concrete struts providing additional support.



Construction of the River Mill Spillway on March 30, 1911.

River Mill Substation

Located on the east bank, the outdoor River Mill substation consists of transformers and early metal latticework supports along two 57kV lines.

The forebay for the River Mill powerhouse, Estacada Lake/River Mill reservoir, is a three-mile long, 150-acre portion of the Clackamas River channel behind the River Mill dam.

Upgrades

A significant improvement made at River Mill in 1954 was the modernization of control of the generating units, making the plant semiautomatic.

In 1966, spillway capacity of the River Mill dam was increased 50 percent (to 150,000 cfs) to match that of the spillway at North Fork Dam, a few miles upstream. A December 1964 flood had pointed to the need for provision to pass floods of greater magnitude.

Due to the excellence of the construction methods and materials originally used in the dam, the reinforced concrete and strength of the sections were found to be

adequate to withstand the additional pressure of an even greater flood. Because of higher flood elevations, abutments and wing walls were topped with eight feet of concrete and a compacted-earth dike was built across the lowlands at the south end of the dam.

Helping fish

Because it is the first structure encountered by salmon migrating up the Clackamas River, River Mill's fish ladders play an important role in upstream migration.

The ladder was originally built in 1911 - 1913 and was serially modified to improve its function.

When first built, the fish ladder was a square-sided concrete structure that rising from the downstream elevation through a series of "switchback" turns to allow upstream migrants to bypass the River Mill Dam. The ladder is box-shaped with an open, wire-mesh protected top.

"There's still a piece of the original fish ladder from when the project was built - and that fish ladder was literally a ladder," said Esler. "It's impressive that fish got up it, but they did." The replacement fish ladder is a modern Half Ice Harbor weir and orifice design that migrating fish can use easily. A recent improvement on the upriver side of the powerhouse includes the new state-of-the-art juvenile salmon surface collector completed in 2012. This system moves fish safely to the tailrace of the dam so they can continue migrating downstream.

"Replacing the fish ladder before we relicensed the project was a demonstration of PGE's commitment to River Mill Dam" said Esler. "Retrofitting into existing projects is never easy. You are so constrained on where you can build. But putting in a new fish ladder with the best modern design was our way of saying this dam is important to us and worth the investment to keep it operating into the future. It was a really cool construction effort." One fish reaping the benefits is the lamprey.

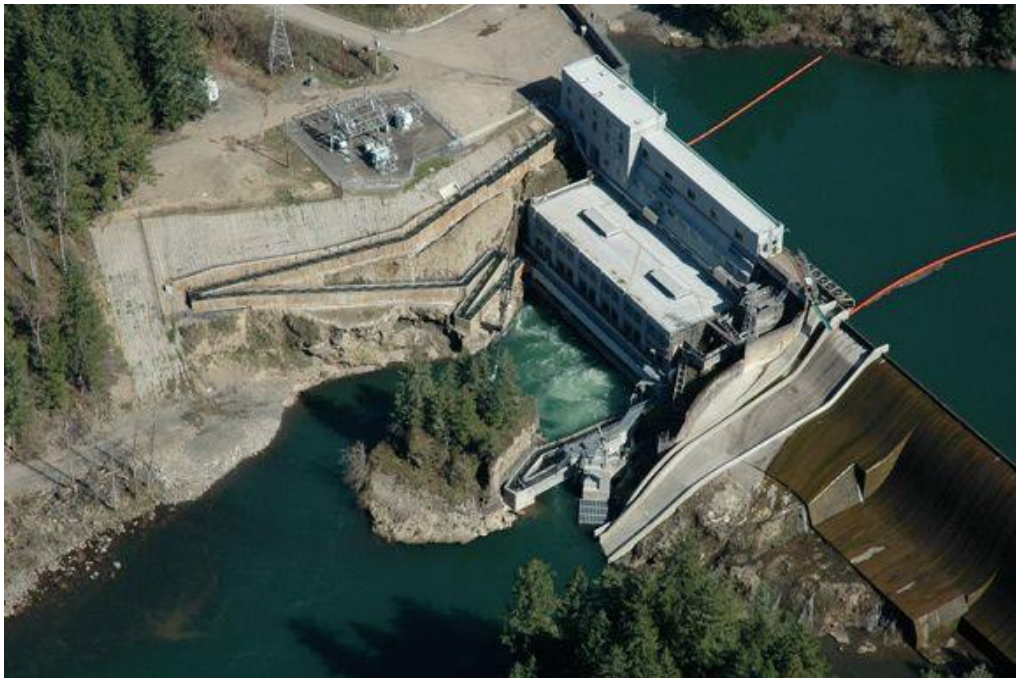
"The cultural significance of lamprey, especially to the tribes, is great," said Esler.

"Pacific Lamprey passage needs are unique. They are not strong swimmers. You need to really manage flows in terms of velocity and turbulence. A lot of effort went into the design and construction of the ladder to ensure the concrete surfaces of the ladder are to their liking. This ladder appears to have some of the highest passage success in the NW for Pacific Lamprey."



West Side Hydro biologists celebrate the 4,000th Chinook to pass through the adult fish sorter in 2021. Surface collectors at River Mill and North Fork dams allow juvenile salmon to move safely downstream past our hydropower facilities. More juveniles reaching the ocean means more adults returning to the Clackamas to spawn, repeating the cycle.

Looking forward



A 2011 aerial photo of River Mill.

Between 2005 and 2010, PGE obtained new operating licenses from the Federal Energy Regulatory Commission for all of its hydro facilities.

PGE is reinvesting in its legacy facilities with \$35 million slated for seismic and related upgrades at the Clackamas and Willamette hydro facilities and over \$25 million in new hydro IT and communications systems.

“Over the last decade, with our new FERC licenses in hand, PGE has invested well over \$200 million dollars in fish passage and water quality,” Pope said. “And we’re not alone in this. Other hydro operators and government agencies in the Northwest are collectively spending billions of dollars on programs and improvements to reduce the environmental impact of hydro facilities. We’re excited about the future, as we continue to develop resources to meet our customers’ need for reliable, affordable, clean energy.”

ON THE COVER: The River Mill Powerhouse and Dam from down river on Jan. 25, 1912.



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