COLUMBIA BASIN PROJECT, GRAND COULEE
PUMP-GENERATING PLANT
Grand Coulee
Grant County
Washington

HAER No. WA-139-C

HAER
WASH
13-GRACO
1C-

BLACK & WHITE PHOTOGRAPHY

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
National Park Service
Cultural Resources
1849 C Street, N.W., Room NC 300
Washington, D.C. 20240

ADDENDUM TO:
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
PACIFIC WEST REGIONAL OFFICE
National Park Service
U.S. Department of the Interior
333 Bush Street
San Francisco, CA 94104

HISTORIC AMERICAN ENGINEERING RECORD

COLUMBIA BASIN PROJECT, GRAND COULEE PUMP-GENERATING PLANT

HAER No. WA-139-C

Location:	Grand Coulee Grant County Washington The Grand Coulee Pump-Generating Plant is located at ~~latitude: 47.8014, longitude: -123.2092. The latitude and longitude coordinates were converted from the UTMs via Montana State University and Yellowstone National Park RCN Utilities and Tools web site on November 19, 2013.~~ latitude: 47.953622, longitude: -118.989672 (Google Earth, August 2016).
Dates of Construction:	1938-79
Engineers:	Bureau of Reclamation
Original Owner:	Bureau of Reclamation
Original Use:	Pumping plant
Present Owner:	Bureau of Reclamation
Present Use:	Pump-generating plant
Significance:	This facility was first known as the Pumping Plant. It was an essential component of the irrigation system of the Grand Coulee Project, and irrigation was a primary justification for the project's inception. Hydroelectricity, however, became a driving force by the time that construction began, and progress on the Pumping Plant was slow after the foundation was completed as part of the dam's creation. Six pumping units were initially installed, going into service between 1951 and 1953. By the early 1970s, Reclamation began making plans to add more pumping units. Because the demand for electricity was also rising, Reclamation installed pump-generating units that generated power as well as pumping, serving as an important source of electricity during peak periods. The plant was renamed in 2008 in honor of John W. Keys III, who headed Reclamation from 2001 until he died in a plane crash in 2006.
Project Information:	This documentation study was initiated by the Bureau of Reclamation's Pacific Northwest Regional Office in Boise, Idaho. Joseph Pratt was the

contracting officer; Derek Beery, Mike Flowers, Sean Hess, Pei-Lin Yu, and Lynne MacDonald served as contracting officer representatives. Hess, Roise and Company, a historical consulting firm based in Minneapolis, Minnesota, was the prime contractor for the project, with photography and delineation completed by subcontractor Clayton Fraser of FraserDesign, Loveland, Colorado. Charlene Roise, principal of Hess Roise, was the project manager and historian, with research assistance from staff historian Elizabeth Gales and staff researcher Penny Petersen. CH2M Hill's Boise office provided editorial and other assistance, under the supervision of Mark Bransom, as a subcontractor to Hess Roise.

The facility was first known as the Pumping Plant. It was an essential component of the irrigation system of the Grand Coulee Project, as irrigation was a primary justification for the project's construction. Reclamation's mission was to develop irrigation works that would sustain farming on the rich but arid lands of the western United States. Reclamation initially included hydroelectric facilities in its projects to support pumping and other needs related to agriculture. Over time, however, hydroelectricity became a driving force behind new developments. Such was the case at Grand Coulee, where construction of the first hydroelectric plant was concurrent with the construction of the dam starting in the mid-1930s.

The Pumping Plant lagged for a number of years, although the feasibility of developing the plant was a critical factor in the debate over the initial height of the dam. In addition, excavation for the plant's foundation started along with work on the dam, the western end of which angled upstream to hold the intakes for the Pumping Plant. The plant had provision for twelve pumps, although Reclamation anticipated that only ten would be required to serve the project's needs. The pumps were responsible for taking water from Lake Roosevelt and pushing it some 280' up the steep west wall of the Columbia River Valley. Siphon breakers at the ridge would stop the water from rushing back down the pipes when the pumps shut down. A canal would transport the water from the pipes to a reservoir formed by the damming of a large natural canyon—the Grand Coulee—and the reservoir would feed a series of canals and laterals distributing water to an irrigation district the size of the state of Connecticut.[1]

The water entered the base of a vertical-shaft pump. The pump runner had to be below minimum water level, but Reclamation wanted to minimize costly rock excavation. Operating at 60,000 horsepower at a 295' head with capacity of 1,600 cubic feet per second (cfs) , the single-stage pumps would be exponentially larger than the 27,000-horsepower, 350' head, 423-cfs units at the Black-and-White-Sea pump storage plant in France, the world's largest at that time. The Coulee pumps would easily best the 11,000-horsepower, 444' head, 200-cfs pumps at the Hayfield Plant on the Colorado River Aqueduct, the country's largest. A contemporary journal provided a down-to-earth illustration of the facility's power: "The total output of ten pumps, 16,000 cu. ft. per sec., if discharged into the Yale Bowl, would fill that structure to overflowing in less than twenty minutes!"[2]

World War II further delayed work on the Pumping Plant, but there was progress as a result of a housing shortage when military personnel returned to the United States after the war: the land irrigated by the Columbia River could support homes for many veterans. In 1946, Reclamation ordered pump motors for six units, planning to install only half of the units until

[1] John O. Holland, "The Columbia Basin Project," information prepared by chief guide at Grand Coulee Dam, November 22, 1949.
[2] Bureau of Reclamation, "Grand Coulee Pumping Plant," July 25, 1940, 1, at Record Group (RG) 115, Engineering and Research Center, Project Reports, 1910-55, 8NN-115-019, Box 329, National Archives and Records Administration- Rocky Mountain Region, Denver (hereafter cited as NARA-RMR); D. P. Barnes, engineer, Bureau of Reclamation, "Grand Coulee Pump Tests at California Institute of Technology: Summary," July 13, 1940, 3, at RG 115, Engineering and Research Center, Project Reports, 1910-55, 8NN-115-85-019, Box 1043, NARA-RMR; A. A. Merrill and J. R. Murphy, "Some Engineering Features in the Construction of the Grand Coulee Dam," *General Electric Review* 41 (November 1938): 471.

enough demand justified putting in the remaining six. Westinghouse Electric Corporation provided four of the motors and two more came from the General Electric Company. The pumps were produced by a joint venture of the Byron-Jackson Company of Los Angeles and the Pelton Water Wheel Company of San Francisco. [3]

In 1948, Reclamation awarded a $13.3 million contract to a joint venture of the Morrison-Knudsen Company and Peter Kiewit Sons' Company to produce concrete; complete the Pumping Plant; excavate the Feeder Canal; install the pump discharge pipes; erect the Siphon Breaker Building; and other activities. This work was essentially finished by June 1951. A month earlier, Unit P-1 was placed in service, with P-2 following in July. All six pumps were working by May 1953.[4]

Accommodations for visitors were limited during construction of the Third Powerplant. Reclamation established a new parking lot at the south end of the Pumping Plant so that the facility could be reopened to the public in June 1969. Exhibits and murals were installed in conjunction with a self-guided tour program, which included access to the pump motor room with the assistance of a programmed automatic elevator. The plant proved a popular attraction, drawing 250,000 guests by the end of the year.[5]

As more land was irrigated, the six pumps strained to supply sufficient water to the reservoir, which had been named Banks Lake in honor of long-time project administrator Frank Banks. At the same time, Banks Lake was becoming a popular recreational destination, so wide fluctuations in the level of its surface were less acceptable. By the early 1970s, Reclamation began making plans to add more pumping units. Because the demand for electricity was also rising, engineers considered installing pump-generating units that could generate power as well as pump. Even though the pump-generating units were about 35 percent more expensive than standard pumping units, this was easily offset by the value of their electrical production. Reclamation engineers asserted "that these units would be among the most economical sources of peaking power available in the area."[6]

The units had to fit within the existing bays in the building. After considering alternatives, the engineers selected units that were "single-impeller-runner, Francis type with spiral case, fixed stay vanes, and wicket gates." The capacity of the units "when pumping at a speed of 200 rpm was not less than 1,700 cubic feet per second when operating under a total dynamic head of 292 feet, and not less than 800 cfs when operating under a total dynamic head of 365 feet. The maximum power required for pumping at 200 rpm when operating over the total range of heads

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[3] Bureau of Reclamation, "Description of the Power Plant at the Grand Coulee Dam," April 1952, 16, in "Appendices to Substantiating Materials, Columbia Basin Project-Washington, Coulee Dam Field Division, Third Power Plant, Grand Coulee Dam," May 1953.

[4] Bureau of Reclamation, Annual Project History, Columbia Basin Project, Vol. 16, 1948, 39-41; Bureau of Reclamation, Annual Project History, Columbia Basin Project, Vol. 19, 1951, 13; Bureau of Reclamation, Annual Project History, Columbia Basin Project, Vol. 21, 1953, 61.

[5] Bureau of Reclamation, Columbia Basin Project History, 1969, 6.

[6] C. B. Brown and E. M. Tomsic, "Pumping-Generating Units for the Grand Coulee Pumping-Generating Plant," *IEEE Transactions on Power Apparatus and Systems* 92 (May 1973): 1057.

could not exceed 67,500 horsepower. Rated capacity specified when operating as a turbine a speed of 200 rpm was not less than 63,500 horsepower when operating under an effective head of 266 feet."[7]

For the generator/motors, engineers specified a "vertical shaft, direct-coupled type," with "each rated 50,000 kva/67,500 hp, unity power factor, 200 rpm, 13.8/13.2 kV, 3-phase, 60°C temperature rise with 25°C maximum cooling temperature." Space did not allow for a thrust bearing below the rotor, so the units were suspended below adjustable-shoe-type thrust bearings. An engineer from Westinghouse, manufacturer of the generator/motors, noted that "the high torque required to start the unit in the pumping mode with the turbine watered, necessitates starting at full voltage. . . . The combination of relatively high pull-in torque and full voltage starting does present unique problems due to abnormal thermal stresses in the damper winding and stator coil vibration. Thermal stresses in the damper winding are accommodated through the use of high strength steel for the damper bars. Stator coil vibration is minimized by particular care in bracing the end turns of the armature winding."[8]

Location of the transformers was a challenge given the limited space around the plant and the area's high visibility. To minimize the amount of equipment, engineers specified three-phase transformers that could be connected to three generator/motors. "Initial studies considered termination of the cables in outdoor potheads, connected to lightning arresters, and exposed transformer bushings. The space limitations would permit the installation with minimum electrical clearances; however, because of these minimum clearances to a traveling crane, consideration of personnel safety and esthetics the decision was made to terminate the cable in terminal tanks adjacent to the power transformer." Although gas-filled terminal tanks were considered, oil was used.[9]

Power was transmitted from the transformers to the Consolidated Switchyard through a high-pressure oil cable circuit. This was tied into the circuits installed for the Right and Left Powerplants when the Third Powerplant was developed. A single circuit was sufficient to handle the transmission of power from all six of the planned pump-generating units. Like the circuits from the main plants, the circuit comprised three single-conductor cables, each about 3.5" in diameter, contained in a 10"-diameter steel pipe.[10]

As with the original six units, the new units could be operated manually or automatically through individual control panels. Unit control was also being incorporated into the programmable

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[7] C. B. Brown and E. M. Tomsic, "Pumping-Generating Units for the Grand Coulee Pumping-Generating Plant," *IEEE Transactions on Power Apparatus and Systems* 92 (May 1973): 1059.
[8] C. B. Brown and E. M. Tomsic, "Pumping-Generating Units for the Grand Coulee Pumping-Generating Plant," *IEEE Transactions on Power Apparatus and Systems* 92 (May 1973): 1061, 1063-1064. The comments from K. C. Kosiba, the Westinghouse engineer, were printed as commentary at the end of the article.
[9] C. B. Brown and E. M. Tomsic, "Pumping-Generating Units for the Grand Coulee Pumping-Generating Plant," *IEEE Transactions on Power Apparatus and Systems* 92 (May 1973): 1061.
[10] C. B. Brown and E. M. Tomsic, "Pumping-Generating Units for the Grand Coulee Pumping-Generating Plant," *IEEE Transactions on Power Apparatus and Systems* 92 (May 1973): 1059-1061.

master supervisory control system overseen from a dispatch center in the Left Powerplant. This system was not in service, though, by the time that units 7 and 8 (designated "P/G" to distinguish them from the first six "P" units) began pumping in 1973. A year later, the generators went into use. It was not until 1979 that all the pump-generating units were in service.[11]

In 2008, the plant was named in honor of John W. Keyes III, who had died in a plane crash that year. The formal dedication ceremony was held the following May. Keyes had headed Reclamation's Pacific Northwest Region from 1986 to 1998 and was the Bureau's commissioner between 2001 and 2006.[12]

A more detailed discussion of the construction and capacity of the Pump-Generating Plant is provided in the project overview; see "Columbia Basin Project, Grand Coulee Dam," HAER No. WA-139-A.

[11] C. B. Brown and E. M. Tomsic, "Pumping-Generating Units for the Grand Coulee Pumping-Generating Plant," *IEEE Transactions on Power Apparatus and Systems* 92 (May 1973): 1062; Bureau of Reclamation, Annual Project History, Grand Coulee Third Powerplant-Columbia Basin Project, 1980, Vol. 6, 33-34.
[12] "John W. Keys III Pump-Generating Plant," fact sheet prepared by Bureau of Reclamation, n.d., revised April 2009.

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Secondary

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