# The Columbia Basin Project

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Prefatory Note

Established in 1902, the Bureau of Reclamation is one of the major Federal water development agencies. Historically Reclamation developed water projects to "reclaim" arid Western lands for irrigated farming. The concept of "homemaking" was integral to Reclamation's early projects, i.e., homes would be made for settlers on new, irrigated farms. Over the years Reclamation's responsibilities expanded to multiple uses including water development for municipal and industrial uses, generation of hydroelectric power, flood control, and recreation.

Reclamation built about 180 projects and is currently completing the last authorized major construction on those projects. The bureau is now concentrating on management of its existing water development projects.

In the summer of 1993 Reclamation's history program began a multi-year research project. The intention is to develop a basic narrative history of each Reclamation project. Each narrative will outline the historic/prehistoric setting, the reasons for authorization, basic construction history, the aftermath of project development, and a rudimentary bibliography. These brief narrative overviews are not intended to be definitive or deeply interpretive. Each narrative is expected to be further edited for inclusion in a publication, about 2002, on the history of Reclamation projects.

In the meantime, we plan to distribute these narrative essays both to make the basic information available, and to encourage independent research in Reclamation's history.

This essay is in second draft. It is not Reclamation's final product. It is distributed in the hope it will make basic information available and stimulate further interest in Reclamation's history. We encourage the reader to do supplemental research and arrive at their own interpretive conclusions. The final edited version of this narrative likely will vary widely from this draft.

If you would like additional information about Reclamation's history program or about other narratives available, please contact:

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# The Columbia Basin Project

On a hot July day in 1918, a lone newspaper man named Rufus Woods was wandering the dry, arid regions of central Washington State looking for a story. What he found turned out to be the story of a lifetime and one that would capture the imagination of the entire country: the story of Grand Coulee Dam and the Columbia Basin Project. It would be the largest thing ever built by mankind, and thousands came from all over North America to be a part of its construction. Its canals would water more than 1,000,000 acres of land, helping to feed thousands, and its power lines would reach out, bringing light not only to the lives of those in the Northwest, but throughout the western United States.

## Project Location

The Columbia Basin Project is located in the central part of Washington State in the counties of Adams, Douglas, Franklin, Stevens, Okanogan, Grant, Lincoln, and Walla Walla. The primary feature of the project is Grand Coulee Dam, which is located on the main stem of the Columbia River about 90 miles west of Spokane. The project area extends southward from the dam for more than 120 miles to Pasco, Washington, where the Columbia and Snake Rivers meet. Other project features include the Grand Coulee Power Complex and pump-generating plant; Banks Lake and Feeder Canal; the Main, West, East High and East Low Canals; O'Sullivan Dam and Potholes Reservoir; and Potholes East Canal. Construction of the East High and portions of the East Low Canals has been deferred. The project was designed to provide irrigation water to just less than 1,100,000 acres of land within the project area, but full development of the project has been delayed. Currently, just over 500,000 acres of project lands have been developed.[1]

## Historic Setting

By Toni Rae Linenberger

Archeologists believe the first habitation of the Columbia Basin, specifically along the Columbia River, occurred around 11,000 years ago. These early Native American residents avoided much of the Columbia Plateau because of its dryness. They also felt that the Grand Coulee harbored spirits, so they circumvented that area as well. These ancient peoples left traces of their existence throughout the basin, providing clues as to their lifestyles and habits.

One such site, situated near one of Reclamation's irrigation waterways, is the oldest known location of human habitation in Northwestern America, probably dating between 9,000 and 11,000 years ago. In recognition of the importance of the site, it was placed on the *National Register of Historic Places*, in 1974, as the Lind Coulee Archaeological Site. The site contained an unusually complete inventory of stone and bone tools, projectile points, and other objects, it was the location of the first discovery of a bison skull in the state of Washington.

Various other nomadic native bands resided in the valley including the Sinkiuse, Isle De Pierre, Columbia, Kawachken, and Moses. These tribes hunted throughout the area, returning to the River each year to fish for migrating salmon.

Kettle Falls, a second *National Register of Historic Places* site, lies within Franklin D. Roosevelt Lake. Archeologists believe the site, submerged at full pool by the waters of the reservoir, was a preferred fishing area on the River. The oldest artifacts from this site date back 7,000 years.

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1. United States Department of the Interior, Water and Power Resources Service, *Project Data*, (Washington: U.S. Government Printing Office, 1981), 375.

The first Anglos began to enter and explore the area in the late eighteenth century. In 1792, Captain Robert Gray crossed the bar of the Columbia River, naming it for his ship. Meanwhile, a British expedition explored the lower one-hundred miles of the river. Thirteen years later, in 1805, Meriwether Lewis and William Clark descended the Columbia to the Pacific Ocean. Exploration of the river basin was sporadic until 1811, when map maker David Thompson, in the employ of the Northwest Company, traversed the length of the river, the first European to make the trip. Following Thompson’s expedition, the Northwest Company established several posts throughout the area.

The first major Anglo settlement began in 1835, when Samuel Parker settled on the Columbia plain. Though Parker noted the fertile upper prairies, few settlers made the trek. However, the area proved to be potent ground for missionaries. The Whitman and Spaulding missions were established a year later in 1836. In 1847, relations with the local Native Americans came to a head with the Whitman Massacre and the Cayuse War. Both events served to discourage settlement.

The British and Americans coexisted in Oregon Country until 1846, when the boundary between the United States and Canada became the Forty-ninth Parallel by mutual agreement. Previously the land had been jointly held by both countries. Congress established the Oregon Territory in 1848. Oregon Territory was split in 1853, with creation of the Washington Territory, which included all of present day Washington, and portions of Montana and Idaho.

Just one year later, in 1854, a prospector discovered gold near Fort Colville, Washington Territory. The discovery set off a second wave of the Gold Rush, this one to the Pacific Northwest. Sporadic settlement followed until the 1880s.

The 1880s saw a rise of settlement in and around the Columbia Basin. In 1883, the Northern Pacific Railroad crossed the region. James J. Hill's Great Northern Railroad followed ten years later, reaching Portland and Tacoma in 1893. A series of hard winters in the 1880s also shifted the economic base of the region from cattle ranching to wheat farming. As the years progressed, residents began to eye the Columbia River for irrigation development. Into this mentality stepped Rufus Woods in 1918, promoting an idea for a dam at Grand Coulee.

Though the local residents probably contemplated ideas similar to the one Woods published in his *Wenatchee Daily World* in 1918, William "Billy" Clapp originated the idea that ultimately took root and developed into a plan to build Grand Coulee Dam. A local Ephrata lawyer, Clapp together with Paul Donaldson and Warren Gale Matthews also of Ephrata, and A.A. Goldsmith of Soap Lake, lamented the loss of a 1914 bond measure to irrigate land and augment the war effort. A series of ongoing discussions ensued, at the conclusion of which Clapp proposed a dam across the Columbia River. After deciding that the idea had some merit, the men approached deputy Grant County engineer Norvall Enger, and later the Grant County commissioners. They asked Enger to measure the distance from the Columbia up to the mouth of the Grand Coulee and determine how high a dam diverting the river would need to be. The arrangements to measure the river remained confidential.

The guise of confidentiality held up until a hot July afternoon in 1918. Editor, owner, and reporter of the *Wenatchee Daily World* Rufus Woods, wandered into town and approached Gale Matthews looking for news. Too busy to talk to the newspaperman, Matthews brushed him off, playfully sending Woods off to talk to Billy Clapp about a dam on the Columbia River. The resulting headline buried on page seven of the July 18, 1918, issue, read, "FORMULATE

BRAND NEW IDEA FOR IRRIGATION GRANT, ADAMS, FRANKLIN COUNTIES, COVERING MILLION ACRES OR MORE."

While Woods was printing articles, somewhat in jest, about a dam at Grand Coulee, Elbert Blaine developed his own plan to irrigate the valley. Blaine, in his capacity as chairman of the Washington State Railroad Commission, often traveled through eastern Washington and knew of the arid condition there. Credited with developing what became known as the "gravity plan," Blaine developed a plan to irrigate most of the land east of the Columbia River with water diverted from Idaho. The gravity plan would irrigate with water diverted from the Pend Oreille River at Albeni Falls on the Idaho border, after being channeled through some 130 miles of canals, tunnels, aqueducts, and reservoirs to the Big Bend. Blaine earned the support of the Spokane Chamber of Commerce, Governor Ernest Lister, and Seattle Mayor Ole Hanson, while Clapp's plan remained largely unnoticed by the more powerful governmental officials.

As Blaine gained support for the "gravity plan," Woods rekindled interested in a dam at Grand Coulee. Local engineers proposed instead of the huge dam originally proposed, that the river generate power to pump water uphill from a reservoir behind a more modest dam. The revised plan became known as the "pumping plan." A dam would be built across the Columbia River thus raising the level of the river behind the dam; water could then be pumped out of the resulting reservoir and into the distribution system, using electricity generated at the dam. Water had to be pumped out of the reservoir due to the height of the irrigable lands in relation to the river.

Each plan had its own following of dedicated supporters. Spokane's Chamber of Commerce backed the gravity plan. People scattered in small towns throughout the valley generally favored the pumping plan. Various factors influenced the protracted debate between the two sides. Among them was local pride which automatically pitted Spokane against Wenatchee. The development of power in the pumping plan would compete directly with the Washington Water Power Company, Spokane's largest employer and most influential supporter of the Chamber of Commerce. The Company wanted to protect their economic interests, despite any inherent benefits of the pumping plan. On the other hand, the diversion of irrigation water into the Spokane River during the off-season would directly benefit the Company's power generation by increasing output. Other mitigating factors arose from the general hesitation toward any large scale government project in light of the "Red Scare" which developed after World War I, and the general decline in irrigation development nationally.

In 1919, the Washington Legislature formed the Columbia Basin Survey Commission and appropriated $100,000 to study the two irrigation plans. Louis Hart, acting governor, appointed state hydraulic engineer Marvin Chase to head the committee. Chase then appointed the remaining committee members: Osmar Waller; Spokane investor and real estate promoter Arthur Jones; Elbert Benson, state commissioner of agriculture; and Peter McGregor, wheat and stock rancher and Spokane Federal Reserve Bank director. The U.S. Reclamation Service reluctantly named engineer and consultant David Henny of Portland and James Munn of Denver as its representatives. The staff, with one exception, all consisted of former and present engineers from the Washington Water Power Company. The obvious bent of the commission toward Spokane and its private power concerns, ensured that the pumping plan would receive little consideration.

The Commission released its report in July of 1920. The report contained few surprises, except for the commission's cost projections, declaring a dam at Grand Coulee infeasible and favoring the gravity plan which benefitted the Washington Water Power Company. Cost projections for both plans awed even members of the Reclamation Service who then decided to disengage from any involvement with either project, a decision which proved to be harder to implement than anticipated.

Proponents of both plans tried various maneuvers to convince the State Legislature and Federal entities to adopt their plan. In 1921, a Seattle engineer, Willis Batcheller, after studying both proposals, released a report favoring a dam at Grand Coulee. The gravity plan backers countered the report by hiring Major George Goethals, who built the Panama Canal, to study the situation. Not surprisingly Goethals returned with a report favoring the gravity method, after a cursory examination of the pumping plan. Meanwhile, James O'Sullivan, a strong supporter of the pumping plan, continued to write articles for Woods' *Wenatchee Daily World*, promoting the idea.

A milestone in the continuing struggle occurred in 1926, when two senators from Washington, Republican Wesley Jones, and Democrat Clarence Dill joined forces and attempted to secure an appropriation of $600,000, for a comprehensive study of the two irrigation schemes, during the 1926 session. Though they were unable to get the support of Congress, Jones, a member of the Commerce and Appropriations Committee, inserted the appropriation into a rivers and harbors bill where it went undetected. After passage of the measure, Major John Butler of the Army Engineers began the survey in 1928, completing it in 1931. His report favored building a large dam at Grand Coulee, the pumping plan.

By this time the dust bowl had reached the Pacific Northwest. Beginning in 1929, a drought robbed the small streams of Puget Sound of water resulted in crippling power shortages throughout the Pacific Northwest. In addition, the topsoil of the region began to blow away. In April of 1931, a huge cloud of fine dust engulfed passengers aboard an ocean liner 600 miles off the coast of Seattle headed for Honolulu. Despite the renewed public outcry for additional irrigation projects, Congress still could not stomach an irrigation project of the magnitude of Grand Coulee.

The tide turned a year later when Franklin D. Roosevelt was elected President. A practitioner of Keynesian economics, Roosevelt planned large public works programs designed to increase expenditures and promote economic growth. A few weeks after election, FDR included Grand Coulee Dam in his new Public Works Administration program.[2]

**Project Authorization**

In mid-April 1933, supporters of the project met with President Roosevelt to outline the project and recommend he allocate the $400,000,000 needed for construction. The President balked at the suggestion and suggested a smaller dam that could be enlarged at a later date. The President advised that the project be constructed in stages using relief money and encouraged them to seek the assistance of the Bureau of Reclamation in designing and building the dam. Supporters of the irrigation scheme were disappointed: a low dam could be used to generate power, but would not allow water to be pumped for irrigation. Still, the drive to get the dam built continued.

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2. William Dietrich, *Northwest Passage: The Great Columbia River* (New York: Simon & Schuster, 1995), 403-8; Robert F. Ficken, *Rufus Woods, The Columbia River, & The Building of Modern Washington* (Pullman: Washington State University Press, 1995), 59-73, 95-121; Paul C. Pitzer, *Grand Coulee: Harnessing a Dream* (Pullman: Washington State University Press, 1994), 1-95, 115-26; United States Department of the Interior, Bureau of Reclamation, *The Story of the Columbia Basin Project* (Washington, D.C.: U.S. Government Printing Office, 1964), 47-56.

Senator Dill approached Elwood Mead, Commissioner of Reclamation, to see if a low dam that could be enlarged at a later date could be constructed. Mead assigned the task of investigating the project to John Lucian "Jack" Savage, Reclamation's Chief Design Engineer and designer of Hoover Dam, which was under construction at the time. Soon, Mead was able to report to Dill that Reclamation could do the job for around $60,000,000. Dill reported to the press that the project would move forward and that funding would be provided by Washington State unemployment relief funds and the Reconstruction Finance Corporation (RFC), which provided money to the states for large, self-liquidating projects.

The State of Washington and the Bureau of Reclamation negotiated a contract whereby Reclamation would prepare plans, conduct surveys, and begin preliminary work on the project. The estimated cost was $377,000. Washington State Governor Clarence Martin and the Columbia Basin Commission, an independent commission formed by Martin to secure federal funding and oversee construction of the project, debated over allocating monies from relief funds or approaching the RFC. Martin and the Commission elected to use relief funds, hoping that the pending National Industrial Recovery Act (NIRA) with its Public Works Administration (PWA), would provide the needed federal funding for the project.

The NIRA was signed in June 1933, and the Columbia Basin Commission immediately applied for funds. On June 30, it was announced that the State Relief Commission had allocated the $377,000 for preliminary work. The contract between Reclamation and the State of Washington was signed in early July, and on July 16, 1933, groundbreaking ceremonies took place at the site. A few days after the groundbreaking, news came to the Northwest that caused project supporters significant concern. On July 23, it was announced that the President had approved $31,000,000 for the construction of Bonneville Dam, a Corps of Engineers project on the lower Columbia River between Oregon and Washington. Many interpreted this development as indicating that any hope of federal support for Grand Coulee was dead, seriously jeopardizing the project. But on July 28, President Roosevelt announced that the $63,000,000 needed to construct the low dam had been appropriated by the Public Works Board and that the project would move forward.

By approving construction of the project through the NIRA, the President avoided having to obtain the approval of Congress, a situation that would soon return to haunt the project. In April 1935, the Supreme Court ruled in the case of the *United States v. Arizona*, that the construction of Parker Dam on the Colorado River had been illegally authorized. Under the Rivers and Harbors Bill of 1899 and subsequent legislation in 1910, construction of dams across navigable rivers was not permitted excepting with the authorization of Congress. The Court further ruled that the NIRA, under which Grand Coulee and several other dams had been approved, did not repeal the previous legislation. The Court ruled that, unless Parker Dam was approved by Congress, construction must stop. Concerned about the effects of the ruling of Grand Coulee and other projects, the Roosevelt Administration began to look for ways to legitimize the many projects that had been approved under the NIRA.

In May 1935, the Administration pushed legislation that approved the twenty-some federal dams then under construction. The Senate held hearings in late May and passed the bill without debate on May 27. In the House, the bill was sent to Committee where it died. Senator Roy Samuel Copeland of New York proposed adding the contents of the bill to the Rivers and Harbors Bill, previously passed by the House, and sending it back to the Senate. The Senate adopted the measure and returned it to the House where the amendment containing authorization for Grand Coulee met stiff opposition. On August 19, after a long and heated debate, the Grand Coulee amendment was passed by the House. The Rivers and Harbors Bill, as amended was then passed by the House, and two days later, the Senate. The President signed the bill on August 30, 1935, legitimizing the Grand Coulee Project.[3]

On March 10, 1943, the Columbia Basin Project Act was signed. This act reauthorized the project and set forth certain conditions regarding repayment of project costs, bringing the project in line with the Reclamation Project Act of 1939. The 1943 act also repealed a 1937 act which was designed to prevent land speculation within the project. Authorization for construction of the third powerplant was signed into law on June 14, 1966, and amended September 7, 1966.[4]

## Construction History

### Grand Coulee Dam and Power Complex

When it was announced that a great dam would be constructed on the Columbia River, hundreds of men, many with families, traveled to the region in search of jobs and relief from the economic devastation of the depression. For many, the relief was long in coming because a significant amount of preparatory work had to be carried out before construction of the actual dam could begin. In keeping with the Government's Public Works Administration policy of putting as many people to work as possible, several contracts were issued prior to letting the contract for the dam. These early contracts included excavations of overburden, investigative

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3. Pitzer, 61-80, 115-26.
4. *Ibid.*, 240, 273: United States Department of the Interior, Bureau of Reclamation, *Federal Reclamation and Related Laws Annotated*, *Volume II*, 1943-1958, (Washington: U.S. Government Printing Office, 1972), 728-39.

diamond drilling along the dam foundation, construction of piers for a bridge downstream from the dam, railroad construction, and work at the government townsite.

The contract for excavations was awarded to David H. Ryan Company of San Diego on November 20, 1933. Work under this contract consisted of excavation of more than 2,000,000 cubic yards (cy) of overburden and some 40,000 cy of rock from sites at either end of the dam. Much of the work was sublet to other contractors. The contract for foundation drilling was awarded to Lynch Brothers of Seattle, while the contract for construction of the bridge piers was awarded to Western Construction Company, also of Seattle. Crick & Kuney, of Spokane received the contract for construction of about 1.5 miles of railroad from the head of Grand Coulee to the damsite. Work under these contracts began in early to mid-1934. Excavations on the east side of the river were completed in early June, with completion of work on the west side coming just as bids for construction of the dam and power plant were being opened.[5]

Bids for construction of the first phase of the dam and power plant were opened in Spokane on June 18, 1934. In the days leading up to the opening, the town took on an almost carnival-like atmosphere as hundreds of people descended upon the town in anticipation. The grapevine was ripe with rumors about the number of bidders and who would be awarded the contract. It was generally believed that Six Companies, Inc., the builder of Hoover Dam on the Colorado River near Las Vegas would be a front runner in the bidding process.

The bid opening took place at the Spokane Civic Building in front of a crowd of nearly 1,000 and was broadcast over the radio to much of the Pacific Northwest. Those in attendance at the opening included Elwood Mead, Commissioner of Reclamation, Raymond F. Walker,

5. G. E. Bjork, "Bids Opened at Spokane for Grand Coulee Dam and Power Plant, " *Western Construction News*, July 1935, 224-9.

Reclamation Chief Engineer, Governor Clarence Martin of Washington, members of the many federal and state consulting boards, and Rufus Woods, publisher of the *Wenatchee Daily World* and a longtime champion of the Columbia Basin Project. The proceedings were presided over by Reclamation Construction Engineer Frank A. Banks. Four bids were received. Two bids were rejected: one did not contain the required bid bond or unit prices, and the other, from Mae West, advised the engineers that, if trouble arose, they should "come up and see me sometime." The two accepted bids were from Six Companies, Inc., and a joint venture of Silas Mason Company, Inc., Walsh Construction Company, and Atkinson-Kier Company (MWAK), whose bid of $29,339,301 proved to be more than $5,000,000 less than the Six Companies bid.[6]

The contract for construction of the low dam was officially awarded to MWAK by Secretary of the Interior Harold Ickes on July 13, 1934. The contract limited MWAK to 1,650 days and also had an option to switch to a high dam with thirty days notice. Even though the contract called for construction of the low dam, at 350 feet high, it would be second only to Hoover Dam as the highest dam in the world.[7]

Immediately following receipt of the contract for construction of the dam, MWAK began preparing for the work of building the dam. On a large, flat plot of land on the east side of the river, MWAK built Mason City. Named for Silas Mason, founder and head of the Silas Mason Company, the town would house MWAK employees and officials. Designed to be the world's first "all electric city," MWAK hoped to use the town to demonstrate the convenience of electricity and promote its use to the states and region, helping to secure a firm market for the power that would be generated at the dam. MWAK contracted with the Washington Water

6. *Ibid*.
7. Pitzer, 101.

Power Company, which had fought against construction of the dam fearing the loss of its markets, to supply power for the town. The lights first went on in Mason City in October 1934. Mason City cost more than $1,000,000 to build and included more than 300 houses, several dormitories, a 1,000 seat cookhouse, and a 33-bed hospital. Rent for a three-bedroom house, if one was lucky enough to get one, was $32 a month, with rent for a four-bedroom house running $38 a month.[8]

Other towns sprung up in the area, ready to provide for the needs of the workers and their families, those who sought to profit from them, and those who simply wanted to be a part of it all. Not far from Mason City, Reclamation built Engineers Town to house Reclamation officials, engineers, and their families. Tightly controlled by the government, Engineers Town was a model community. In contrast, other towns that sprung up were wide open and rough, reminiscent of early frontier towns. One of the more famous of these was the town of Grand Coulee, which sprang up in 1933, and soon became the center for sin and vice. Its dirt streets were lined with taverns and gambling halls while down dark alleys prostitutes plied their trade in tents and shacks. Bootlegging, common in the early days, was replaced by dozens of taverns following the end of prohibition. In the summer the dust from the streets choked the air while in the winter, those same streets became a mire of mud and slush. The town soon earned several nick names, among them “The Cesspool of the New Deal” and the “Toughest Town in North America.”[9]

Thirty miles south of Mason City, workmen for the David H. Ryan Company and its subcontractor, Crick & Kuney, both fresh from the successful completion of the contract to

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8. *Ibid*., 104.
9. *Ibid*., 103-4,181-5.

excavate overburden at the dam site, began to build the construction railroad thirty miles from Odair to the head of Grand Coulee. Work on the railroad began in mid-1934, with the first rails laid in early September. The rails reached Grand Coulee in early December, and by July 1935, the project, which included construction of a 200-foot tunnel, installation of switches, and the acquisition of engines, cars, and all equipment necessary for a railroad, was complete. Rail service between Odair and the head of Grand Coulee began in late July 1935.[10]

Immediately after receiving the notice to proceed, MWAK began removing the remaining overburden from the dam site. Instead of using trucks to remove the material, MWAK elected to use a conveyor, an innovation that had previously never been used on such a large scale. Sixty inches wide and ¾ of an inch thick, the belt would eventually extend over two miles, carrying over 50,000 cy of rock and earth each day. By the end of 1934, the system had moved over 1,000,000 cy of material. As more and more material was excavated from the area of the west abutment, earth slides began to become a serious problem. In November 1934, the hillside above the west abutment gave away, dropping 2,000,000 cy of material into the excavations. Luckily no one was injured. A few days later, another 750,000 cy of material slid into the excavation. This time, 15 men were carried along with the slide, but again, no one was injured. Slides would be a problem throughout the construction period forcing the relocation of roads and railroads and creating a significant amount of additional work.[11]

As the end of 1934 approached, MWAK was facing a deadline that had to be met. It was necessary to construct the first coffer dam during the low water period in the winter of 1934-35. If this could not be done, high waters during the spring would cause insurmountable delays. To

10. *Ibid*., 105; G. E. Bjork, “Bids Opened at Spokane for Grand Coulee Dam and Power Plant,” 228.
11. Pitzer, *Grand Coulee*, 106-7.

assist in the design of a suitable structure, Reclamation engineers designed and built models in Reclamation's experimental laboratory at the University of Colorado in Boulder, testing different plans for diverting the river. The design chosen consisted of a 3,000-foot long, U-shaped, steel pile coffer dam which would extend from the west bank of the river, enclosing the western portion of the dam site. The steel piles would form interlocking cells which would be filled with rock and earth from the excavations. Once in place, the dam would keep the river at bay during excavations and construction of the dam's foundation. A similar design was to be used on the east side of the river as well. Construction of the west coffer dam began on January 1, 1935, with placement of the first of more than 7,000 sheet steel pilings that would make up the bulk of the structure. Harsh winter temperatures, sometimes reaching well below zero, and large boulders caused significant problems during pile driving operations. But on March 23, 1935, less than 90 days following placement of the first pile, the last sheet steel pile was driven into place, bringing to a close the main work on the coffer dam. Within days following completion of the coffer dam, the river began to rise, reaching a peak of more than 30-feet above normal in mid-June. MWAK's coffer dam, raised an additional 5-feet to provide a greater margin of safety, held its ground. Behind the coffer dam, more than 100-feet below the surface of the river, crews worked removing the overburden and exposing the bedrock foundation.[12]

The plan for the coffer dam on the east side of the river was similar to that on the west, but MWAK determined that it would be too difficult to duplicate the task, instead opting for a lower dam and concentrating their efforts on excavating the eastern portion of the foundation during low water. Beginning on May 1, 1935, MWAK started a small earth dam to protect

12. *Ibid.*, 107-10; "Cofferdam 3,000 Ft. Long Built at Grand Coulee," *Western Construction News*, June 1935, 162-4.

excavations on the east shore of the river. As the water receded, the dam was extended, and the area enclosed was pumped clear of water. In September, MWAK began construction of a timber crib dam to further protect work on the east side. The timber dam was 1,130 feet long and consisted of piles driven into the ground and backed by earth and stone. The east side coffer dam successfully protected the excavations during the winter of 1935-36, allowing MWAK crews to excavate several million cubic yards of material in preparation for construction of the eastern section of the dam.[13]

On June 5, 1935, Secretary of the Interior Harold Ickes, signed Order for Change No. 1 providing for construction of the base for the high dam. This change meant the MWAK would not construct the low dam as specified under the original contract, but the foundation for the high dam which would be completed under a second contract at a later date. The change from the low dam to the high dam was not a surprise to many. As early as December 1934, Reclamation engineers were looking at the possibility of successfully placing a high dam upon the low dam. Reclamation's chief design engineer, "Jack" Savage, cautioned that joining new concrete to old might be difficult, and recommended against it. In addition, it was noted that if work under the existing contracts were to continue without changes or modifications, the construction of a high dam at a later date would be difficult. Although the technical problems associated with raising the low dam at a later date served as primary reasons for switching to the high dam, other factors contributed. The low dam under construction at the time would only be useful for power generation, and there was little need for extra power at the time. In addition, the low dam would provide no relief for irrigators as the cost of pumping water upward over 500 feet would prove

13. Pitzer, *Grand Coulee*, 110.

too great.  The potential problems posed by attempting to raise the low dam at a later date proved to be overwhelming, prompting the move to the high dam.[14]

MWAK began preparations for concrete operation in the summer of 1935.  In June, construction of the west side batch plant began, followed soon after by construction of the east side plant.  The two plants combined to produce 640 cy of concrete each hour.  Aggregate for the concrete was located on the east side of the river about 1½ miles northeast of the dam.  MWAK constructed a large aggregate plant to wash and sort the material before transporting it to the batch plants.  At the peak of operations, the aggregate plant produced 12,000 cy of aggregate each day.  Aggregates were transported to the batch plant by a series of forty-three conveyor belts.  To transport materials to the west side of the river, a suspension bridge with two, 1,500 foot spans, was constructed to carry the conveyor belt.  The system was capable of delivering 700 tons of material to the batch plants each hour.

As workmen exposed the bedrock foundation, test holes were drilled to depths from 30 to 200 feet, and men were lowered into the hole to inspect the quality of the rock.  Grout holes between 20 and 30 feet deep were drilled, and grout was pumped into the holes to provide a secure seal beneath the dam.  Grouting operations began in November 1935.

On December 6, 1935, Washington Governor Clarence Martin pulled the handle on a four cubic-yard bucket of concrete, releasing it into the waiting form, marking the first "official" concrete placement in the dam.  The first actual placement of concrete in the dam took place on Thanksgiving Day, as Reclamation engineers and officials from MAC tested the delivery system, placing about 250 cy of concrete.  By the time the first official pour took place, more than 1,500

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14. *Ibid*., 115-121; United States Department of the Interior, Bureau of Reclamation, *Dams and Control Works*, Second Edition, (Washington: U.S. Government Printing Office, 1938), 31.

cy of concrete had been placed. Before construction would be completed, more than 11,000,000 cy of concrete would be placed in the dam.

With the start of concrete operations, work at the dam began to move at an accelerated pace, and the workforce grew to meet the demand. On December 20, the first concrete was placed in Block 40, the eastern most block then under construction and the block that would connect with the future cross-river coffer dam. Operations continued through December and into January 1936. As temperatures dropped, and placement became increasingly difficult, heated water was used in the concrete, steam was circulated through pipes to keep the bedrock warm, and electric heaters were used to keep newly poured concrete from freezing. As a result of the cold weather, several concrete pours froze and had to be blasted away and replaced. Finally, on January 31, cold weather halted concrete operations until spring, idling more than a thousand men.[15]

Spring weather brought the annual floods, and in April 1936, high water overflowed into the east side excavations, halting all work there. But on the west side, concrete operations resumed, and by midsummer, more than 5,000 men were employed on the project, mostly working on concrete crews on the west side. Construction of the dam was carried out in blocks, with each block built according to a set routine. Each block was raised five-feet at a time, with 72 hours between placement of each five-foot lift. Prior to placement of each lift, the surface of the previous lift was sandblasted clean, and a layer of grout was spread evenly over the surface. Just before the next lift was placed, cooling pipes were laid out over the previous lift. Concrete, as it cures, produces heat. In a structure as large as Grand Coulee, natural cooling would take

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15. Pitzer, *Grand Coulee*, 129-34.

hundreds of years. In addition, as it cools, concrete shrinks and cracks. To help cool the concrete more rapidly and control shrinking and cracking, more than 2,000 miles of 1-inch cooling pipe was embedded in the dam. In a process first tested at Owyhee Dam in Oregon and used extensively during the construction of Hoover Dam, chilled water was circulated through the pipes, drawing off heat as it moved though the dam. When the dam cooled sufficiently, grout was pumped into the spaces between the blocks, creating a single monolithic block across the river.

Concrete operations moved swiftly through the summer of 1936, as workmen rushed to complete the west foundation in preparation for diversion of the river across the completed section, exposing the center and eastern portions of the foundation. By early June, 500,000 cy of concrete had been placed. The figure reached 1,000,000 cy by early August. In addition to concrete placement in the dam foundation, crews worked placing concrete in the foundation for the powerhouse and the pump station that would one day pump water up the hillside to project lands.

As work continued on the east side, an old problem resurfaced. Winter rains soaked the earth creating a constant slide danger. Compounding the problem was the discovery of a long, narrow trench, 120 to 150 feet deeper than the surrounding bedrock. Excavating the trench proved difficult. As workmen removed the overburden from the trench, more slid in. The only solution appeared to be the removal of all overburden for a considerable distance on all sides of the trench. But engineers came up with a novel solution. Six miles of pipe were driven into the muck, and super-cooled salt brine was pumped through the pipes, causing the surrounding earth to freeze. Soon, a dam of frozen earth, 100-feet long and 40-feet high, prevented any further movement of the slope, holding back more than 200,000 cy of earth.[16]

As work on the west side of the dam continued, engineers from MWAK and the Bureau of Reclamation turned their attention to the second river diversion. The original plans had called for the construction of the dam in three sections beginning with the west side, then the east, and finally the center section. But after studies conducted at Reclamation's hydrologic laboratory in Fort Collins, Colorado, it was decided to construct the dam in two sections. After completion of the west side, two coffer dams would be constructed from the east side to meet the end of the completed west section, enclosing the east and center sections of the foundation and forcing the river through several 32-foot wide channels left in the west section of the dam.

Work began in mid-February 1936 with construction of the down stream portion of the second coffer dam. The timber crib dam was believed to be the largest ever constructed and consisted of 3,000,000 board feet of lumber, a significant amount of sheet-steel piling, and rock and gravel. Work on the upstream portion of the coffer dam began in August. Aiding in the construction effort was an unusually low river flow, only 26,000 cfs, one of the lowest levels in many years. In mid-August, workmen began dismantling the west side coffer dam, and on November 5, water began to flow into the western section, backing up against the completed portion of the dam. A few days later, water began to flow through the channels left in the western section of the dam.

Work on the eastern section of the dam began without ceremony, and the first concrete was placed on November 28, 1936. The final closure of the downstream coffer dam was accomplished in mid-December, with the final closure of the upstream coffer dam following

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16. Ibid., 138-9.

soon after. Pumps worked for almost a week to drain the area between the dams, exposing the river bed on January 11, 1937.

As was the case in early 1936, cold weather once again plagued construction efforts in early 1937. On December 31, 1936, the concrete plants shut down due to freezing weather, idling several thousand men. The entire river froze in early January, and MWAK took advantage of the conditions to put the finishing touches on the coffer dams. But on January 29, almost a foot of snow fell, and work was halted until March, idling most of the more than 6,000 men who had been on the payroll in December.[17]

Warm weather returned in March, and all of the idled men, and several hundred new hires went to work on the east section of the foundation. At first, the diversion appeared to be completely successful, then in early March, men working in the area between the two dams noticed that one of the cells in the down stream section was leaking. Within a few weeks, the leak had increased to a point that 15,000 gallons per minute was entering the area. Suddenly, the inside face of the bad cell burst, and water flooded into the area. Workmen rushed to plug the leak, throwing anything they could find into the gap. The leak was slowed, but workmen were unable to completely stop the flow of water into the area between the dams. For several months, pumps strained to keep the area free of water while work continued on the foundation. Eventually, MWAK was forced to reinforce the entire coffer dam using sheet steel piles driven deep into the river bed.

Concrete placement in the foundation moved ahead at a dizzying pace, and several records for concrete placement were set during the summer of 1937. As the end of the year

17. *Ibid*., 139-41; "Program for Grand Coulee's Second Coffer Dam," *Engineering News-Record*, (October 1, 1936), 464-6.

approached, the two sections of the foundation came together, forming a solid block that covered more than thirty acres. In early November, MWAK shut down the east side concrete plant, its work complete. The final concrete pour in the western section of the foundation took place on December 27, and MWAK officials announced that work under their contract would be completed on February 1, 1938, fourteen months ahead of schedule.

In completing the contract for the foundation, MWAK's record was remarkable. Almost 11,000 men had worked more than 27,000,000 man-hours diverting the river, excavating the foundation area and placing more than 4,500,000 cy of concrete. During that time, several records for concrete placement and materials hauled were established; records that would prove to be short lived. Forty-five men died in accidents while in the employ of MWAK; a number then considered to be acceptable for a project the size of Grand Coulee.[18]

During the summer of 1937, Reclamation officials worked on the specifications for the second stage contract which would include completion of the dam and west powerhouse, the foundation for the east powerhouse, and the foundation for the pumping plant. One significant difference between the first contract and the second was the Government's decision to supply all of the materials needed for completion of the contract. The successful bidder would primarily be required to supply labor. The American Federation of Labor (AFL) and the Congress of Industrial Organizations (CIO) demanded that the Government negotiate a contract with the unions and set wages before awarding the contract. The Departments of Interior and Labor worked with the unions to set wages at a reasonable level that would not be burdensome to prospective bidders.

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18. Pitzer, 141-54.

In early December 1937, Henry Kaiser, principal of Six Companies and the builder of Hoover Dam, met with MWAK principal Guy Atkinson. The two men discussed the merger of the two construction giants to bid on the second Grand Coulee contract. They both agreed that no single company could manage the contract within the limits set by the government and still pay the wages demanded by the unions. By merging the two giants, they could reduce their costs by 20% and stay within Reclamation's estimate. The two firms joined forces as the Interior Construction Company and negotiated an agreement with the AFL that guaranteed wages at about the minimum set by the government. The merger of MWAK and Six Companies brought together the three MWAK companies; the Kaiser Construction Company, and the General Construction Company of Seattle; the Morrison-Knudsen Company of Boise; the Utah Construction Company of Ogden; and the J.F. Shea, the Pacific Bridge, and the McDonald and Kahn Companies of San Francisco. Their bid of $34,442,240 proved to be more than $7,000,000 less than the next bid.[19]

Bids for completion of the dam were opened on December 10, 1937, and the contract was awarded to Interior Construction on January 28, 1938. In late February, at the request of Secretary of the Interior Harold Ickes, the name Interior Construction was changed to Consolidated Builders Inc., or CBI. This was done to avoid any confusion between the Department of the Interior and the primary contractor. The Bureau of Reclamation received the completed foundation from MWAK on March 12, 1938, and issued the notice to proceed to CBI on March 18.[20]

When CBI began work under the contract, several thousand men, many idle since late

19. *Ibid*., 195-7; "Two Bids Offered on Coulee Dam," *Engineering News-Record*, (December 9, 1937), 963.
20. Pitzer, 197; "Contract Let For Coulee High Dam," *Engineering News-Record*, (February 3, 1938), 164.

1937, stood by, eager to return to work. But most were disappointed when it was announced that CBI would only hire a few hundred men to do preliminary work until the fall of 1938. Among the tasks undertaken by CBI in the first few months was removing the west side concrete plant and joining it with the east side plant, constructing a new railroad bridge to provide better access to the east side of the dam, and replacing MWAK's construction trestle with a new one at a higher level. In addition, CBI built a new high school in Mason City and refurbished dormitories and houses. By mid-May, more than 1,650 people were working on the project.[21]

Concrete placement began in late July, but after only a few days work, operations were halted to make changes in the delivery system. Placements resumed in late August, and CBI increased from two shifts per day to three. CBI concentrated their efforts on mixing and pouring concrete, electing to subcontract much of the other work. By the end of July 1938, twenty-one subcontractors were involved in different tasks around the site. The contract for the manufacture and installation of the penstocks and pump-inlet pipes was let to the Western Pipe and Steel Company (Western). As at Hoover Dam, the penstock pipes were too large to be shipped to the site, and the contractor was required to build a fabrication plant at the site. Western fabricated 18 penstocks each 290-feet long and 18-feet in diameter. In addition, three other penstocks, each 290-feet long and 6-feet in diameter were manufactured. The 12 pump-inlet pipes were each 14-feet in diameter and comparatively short. Fabrication of the huge pipes required more than nine miles of heavy welds.[22]

Work at the dam moved at a breakneck pace, with the blocks of the dam quickly rising

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21. Pitzer, 197-8.
22. Ibid., 202; "Penstock Contract Let For Grand Coulee," *Engineering News-Record*, (February 10, 1938), 196.

toward their final height. Concrete operations followed much the same pattern as with the MWAK contract. To control the flow of the river through the channels in the dam (actually blocks constructed to a lower height than those on either side), CBI fabricated several large portable gates, each 52-feet wide and 35-feet high and weighing 150,000 pounds. The gates would be placed against the upstream face of the dam, blocking flows through the slots while workmen poured concrete into the openings. As the dam rose, CBI began to divert the river through the first of thirty pairs of outlet tubes. The tubes, arranged in groups of ten pairs at three different levels, were installed in the spillway section of the dam to control the outflow during normal operations. Each 8½-foot wide tube is controlled by a high pressure gate located at the upstream end of the tube. By the end of 1938, the lake forming behind the dam was 60-feet deep and extended upstream more than 20 miles.[23]

Like MWAK before, CBI experienced difficulties due to freezing weather and was forced to shut down concrete operations during January 1939, idling more than 1,000 men. Operation resumed in late February and by April, more than 5,500 men worked placing concrete in the ever growing mass. CBI and Reclamation selected May 25, 1939 as a special day. Concrete operation during the previous week had been reduced, and most of the dam's surface was ready for a new layer of concrete. Beginning at midnight on the 25th, workmen began placing concrete at an enormous rate. Working nonstop for 24 hours, workers placed an average of one cy of concrete every four seconds. By the end of the day, more than 20,680 cy of concrete had been placed, surpassing the previous record for concrete placement in a 24-hour period. While CBI normally never approached that volume of placement, all involved felt the effort worthwhile

23. Pitzer, 202-4; *Dams and Control Works*, Second Edition, 35-6.

considering the magnitude of the project. But the “great pour” would come back to haunt the project.

Cement had been in short supply, and the activities of May 25 depleted most of the government’s stockpile. Unable to secure additional supplies, CBI was forced to lay off several hundred workmen. By mid-June, the situation had grown so bad that concrete operations stopped almost entirely. Reclamation began looking for new sources of cement outside of Washington State, angering local suppliers who had been promised exclusive rights to supply all cement. But the unions contended that Reclamation should do whatever was necessary to keep the project going and men working. In mid-July, shipments of cement from California began arriving, augmenting those from local suppliers. But by that time, the river had risen, inundating the spillway section and preventing further work in that part of the dam. By the end of August, CBI had more cement than it could use.

Even given the shortages, construction moved forward at a rapid pace. In September 1939, CBI placed 400,000 cy of concrete, breaking the previous record set by MWAK. In 1939, the contractor placed 3,650,000 cy of concrete, almost four times the amount placed in 1938. At the end of 1939, the west powerhouse was essentially complete and ready for installation of the generators and turbines. Because of the fast pace of construction, Reclamation placed orders for the first turbines and generators a year earlier than originally anticipated. Westinghouse received the contract to provide the first three, 108,000 kilowatt generators - at that time, the largest ever constructed. Each generator cost over $2,625,000. The contract for the record-sized turbines to drive the enormous generators was awarded to the Newport News Ship Building and Dry Dock Company. The turbines cost $1,500,000.

During the winter of 1939-1940, the flow of the Columbia River fell to a level where the entire flow could be diverted through the lowest bank of outlet tubes, allowing unrestricted work in the spillway section. As in previous winters, cold temperatures plagued the project. A barge with nine oil feed boilers was anchored to the dam, pumping steam into tents which covered newly poured concrete. And on the river banks, workmen removed another 1,000,000 cy of earth that threatened to slide into the construction area. Despite the continued efforts to control the slides, the problem persisted.

Full scale concrete operations resumed in late February 1940, beginning with the pumping plant and the final pours in the west powerhouse. Throughout 1940, workers concentrated their efforts on completing the dam crest, the bridge piers for the roadway across the dam, and installation of the drum gates that would control flows over the spillway. Workmen placed the ten-millionth cubic yard of concrete on June 21, and CBI announced that only 500,000 cy remained to be placed. By the first of August, a third of the almost 100 blocks that make up the dam had reached their final height, and by the end of the summer, concrete placement was essentially complete.

In September, CBI began reducing their workforce, and many men left to work on Friant Dam in California's Central Valley. Through the winter, the reduced workforce completed installation of the drum gates, and worked completing small projects around the site. The first generator to go into service was one of the small service units, designed to provide power for operation of the dam. It began service on January 21, 1941, followed by the second service unit on February 15. The official start of the two units took place on March 22, amid much pomp and ceremony. The start of the first large unit was still almost six months away.

On September 28, 1941, the first 108,000 kW unit, unit L-3 (L is for the left, or west powerhouse), then the largest in the world, began testing. On October 4, the unit was officially placed into service. With the start of the first generator, construction of the dam was virtually complete, with only a few minor tasks and cleanup remaining. On December 12, CBI announced that the last concrete had been placed, bringing the total to almost 11,000,000 cy. On January 1, 1942, the Bureau of Reclamation accepted the dam from CBI.[24]

Grand Coulee Dam, as originally constructed, was 4,173 feet long and 550 feet high. The volume of concrete placed in the original dam was over 10,500,000 cy. The outlet works consist of twenty, 8½ diameter steel-lined conduits each controlled by ring seal gates. The capacity of the outlet works is 265,000 cfs. The spillway consists of an overflow section at the center of the dam. It is controlled by eleven, 138-foot long drum gates. The capacity of the spillway is 1,000,000 cfs. Franklin D. Roosevelt Lake extends upstream more than 150 miles to the US/Canadian border. It has a maximum storage capacity of 9,652,000 acre-feet and a surface area of more than 80,000 acres.

### Irrigation Facilities

Construction of Grand Coulee Dam was an example of civil construction on a scale never before seen, surpassing many of the records set during construction of Hoover Dam. But construction of the dam was only the first step in the development of the Columbia Basin. To bring the more than 1,000,000 acres of project land into production would require an enormous construction program that called for the construction of several storage and equalizing reservoirs, dozens of pumping plants, and hundreds of miles of primary and secondary canals with

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24. Pitzer, 204-12.

associated wasteways, turnouts, siphons, and control structures. Construction of the distribution system would prove to be no less daunting than that of the dam itself.

**Pumping Plant**

Construction of the irrigation facilities began in 1945, with the beginning of work to complete the pumping plant and construction of the feeder canal and equalizing reservoir. The feeder canal and equalizing reservoir consist of three primary features: the feeder canal, which extends from the pumping plant discharge to the equalizing reservoir, about 1.6 miles; and the North and South Dams, located at opposite ends of the Grand Coulee, creating a reservoir 27-miles long.

Completion of the pumping plant began in 1945 when government forces began work to stabilize the hillside behind the pumping plant structure and the back wall of the excavations. This work was completed in August 1947. The contract for completion of the pumping plant was awarded to a joint venture of Peter Kiewit Sons and Morrison-Knudsen Company on October 7, 1948. The contract also included portions of the feeder canal. The contractor received the order to proceed in late November 1948, and immediately began work. By the end of 1949, the contractor had placed nearly 40,000 cy of concrete in the pumping plant structure, completed trimming of the discharge tunnels and excavations for the outlet structure, and begun placement of the twelve discharge pipes, completing one, most of three others, and portions of the remaining eight. Installation of the outlets pipes was sublet to the Western Steel Corp. The sections of pipe installed in tunnels are encased in concrete while the exposed sections are anchored and supported by concrete blocks.[25]

Construction activities continued into 1950. The last concrete was placed in the substructure in April. The contractor completed assembly and erection of the twelve discharge pipes on May 31, and the embedded parts for pumping units No. 1 and 2 were set in place in October. Assembly of the motors for units 1 and 2 began in November, and concrete placement in the intermediate structure was completed on December 1. Two of the pump motors were supplied by General Electric and four by Westinghouse Electric. The pumps were supplied by a joint venture of the Byron-Jackson Pump Company and the Pelton Waterwheel Company. Assembly of the first unit was completed in early May 1951, and operated for the first time on May 7, 1951. The pumping plant was dedicated on June 15, 1951, when the first unit was "officially" started by Secretary of the Interior Oscar L. Chapman via long distance signal from Washington, D.C. Unit N. 2 began operation in July 1951. Assembly of units 3, 4, 5, and 6 began in August 1951. The last of the first six units went into operation in 1953.

**Dry Falls Dam (South Coulee Dam)**

Construction of the Dry Falls Dam (originally known as the South Coulee Dam) began in 1946. The contract for construction of the dam was awarded to the joint venture of Roy L. Blair and Company and James Crick and Sons, whose bid of $2,771,887 proved to be the lowest of six bids received. The contract was awarded on June 18, 1946, and notice to proceed was given to the contractor on August 28, although actual construction began in mid-July. The contract called

25. National Archives and Records Administration, Rocky Mountain Region. Record Group 115, Records of the Bureau of Reclamation. Annual Project Histories - Columbia Basin Project. Part 1, "Coulee Dam Division," Vol. XIV, 1946: 223; Vol. XV, 1947: 168-175; Vol. XVII, 1949: 203, 205, 213, 223; United States Department of the Interior, Bureau of Reclamation, *Technical Record of Design and Construction, Equalizing Reservoir Dams and the Feeder Canal*, (Denver: U.S. Government Printing Office, 1954), 50.

for construction of the dam across the south end of the Grand Coulee, and construction of the approach channel, the headworks and control structure, and the initial reach of the main canal.[26]

Excavations for the canal approach channel, headworks structure, and main canal began in August 1946. Rock excavations began in the early fall of 1946, and continued essentially without delays until mid-1948. A cutoff trench was excavated to bedrock along the entire length of the dam. The minimum width of the trench was 30-feet. A continuous concrete cutoff wall was constructed on the center line of the trench. The footings for the wall extend into the bedrock for at least three feet. The wall, which is designed to prevent seepage of water under the dam, varies in height from 5 to 10 feet. Concrete placement in the footings of the cutoff wall began in November 1946. The wall was completed in October 1947. Concrete placement in the canal headworks structure began in March 1948, and was completed in June 1949, after a short delay due to weather during the winter. A total of 15,640 cy of concrete were used in the cutoff wall, headworks structure, and associated features.[27]

The dam was designed as a zoned earth embankment structure with an impervious central core, a semi-pervious layer on either side of the core, and a layer of rockfill over the semi-pervious layer. The impervious core, zone 1, runs the entire length of the dam, from the bottom of the cutoff trench upward to the crest of the dam. Zone 1 material was placed in horizontal layers and compacted into six-inch layers by several passes of a sheepsfoot roller. A total of 579,747 cy of zone 1 material was placed. The semi-pervious layer, zone 2, was placed in one-foot layers and compacted with a sheepsfoot roller. Zone 2 material placed amounted to just under 120,000 cy. Zone 3, the rockfill layer, was placed in three foot layers without compaction.

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26. *Technical Record of Design and Construction, Equalizing Reservoir Dams and the Feeder Canal*, 137.
27. *Ibid.*, 142-4, 161-2.

The amount of zone 3 material placed came to almost 930,750 cy. Construction of the embankment took three construction seasons beginning in mid-1947, and was completed in June 1949. The contract was accepted as complete by the Government on September 9, 1949.[28]

## Feeder Canal

Construction of the Feeder Canal began in early 1946, and was carried out in three stages. Stage 1 consisted of general excavations; stage 2, rock excavations; and stage 3, final excavations, concrete work, and construction of appurtenant works. Stage 1 was carried out by Government forces between January 1946 and July 1947. A rider to the 1948 appropriation bill restricted expenditures for force-account work, requiring Reclamation to complete construction of the canal by contract.

The contract for stage 2 work was awarded as part of a larger contract which included construction of the pumping plant. The low bidder for this work was a joint venture of Morrison-Knudsen Company, and Peter Kiewit Sons' Company, which was awarded the contract on October 7, 1948. The contract for stage 3 was included in schedule 2 of a larger contract which included the construction of the North Dam (schedule 1), the remaining portions of the feeder canal including the cut-and cover conduit, relocation of the construction railroad, and construction of access roads. J. A. Terteling and Sons, Inc., submitted the low bids for all schedules advertised and was awarded the contract for both schedules on April 21, 1949.[29]

Excavations by Government forces began in January 1946, and continued until April 1947, when recurring slides in a section of the canal forced the Government to discontinue operations until a solution to the slide problem could be developed. To combat the slide

28. *Ibid.*, 126, 137, 151-3.
29. *Technical Record of Design and Construction, Equalizing Reservoir Dams and the Feeder Canal*, 49-51.

problem, the design of the canal was altered, substituting a two-barrel, cut and cover conduit in place of the concrete-lined, open cut section through the affected area. Construction of the conduit was included in the Terteling and Sons contract.[30]

Rock excavation was required at all stages of construction of the canal. Rock excavations for stage one were carried out by Government forces and consisted of removal of 410,000 cy of material in addition to 620,000 cy of common excavation. Second stage excavations were carried out by the Morrison-Knudsen/Peter Kiewit joint venture and began in mid-October 1948. The contractor initially proposed carrying out the excavations in single lifts of up to 28 feet, but this proved unsatisfactory. The plan was modified and the work was then carried out in two lifts, the first to a depth of about 18-feet with the second lift to a depth of about 6-inches below the final grade. Materials excavated were stockpiled for use in other parts of the project including rip-rap, slope protection, and backfill. Stage two excavations consisted in the removal of 27,400 cy of common material and 208,000 cy of rock. Work under the Morrison-Knudsen/Peter Kiewit contract, which included completion of the pumping plant as well as stage two excavations, was completed in early August 1948.[31]

Rock excavations for stage three (the Terteling and Sons contract) were carried out in conjunction with the common excavations for the canal and associated structures. As with other excavations, suitable materials were stockpiled for use in other aspects of the construction. When excavations were complete, the canal embankments were constructed. The embankments were constructed in much the same manner as earth embankment dams. The foundation areas were striped and prepared, and embankment material was spread out over the foundation and

30. *Technical Record of Design and Construction, Equalizing Reservoir Dams and the Feeder Canal*, 49-59.
31. *Ibid*., 50, 58-62.

rolled with a sheepsfoot roller until properly compacted.  The embankments were over built by several feet to ensure complete compaction of the entire embankment after it was trimmed to the final grade prior to lining with concrete.  In areas where the canal runs through rock, the canal grade was prepared by placement of gravel and earth which was compacted by several passes of a roller.  Areas where there was seepage or springs were given special treatment to allow drainage.[32]

Feeder Canal lining operations began in mid-September 1949, with lining of both side slopes, followed by lining of the canal bottom, which began in early August.  Concrete placement followed closely behind placement of reinforcement steel on the side slope and bottom of the canal.  The side slopes were placed in 14-foot panels, and when the concrete had set, a crew filled the joints and applied a curing compound.  The bottom lining was placed in a similar manner.  The lining thickness varies from 7½-inches in the base and tapers to 5-inches at the top of the side slopes.  Some of the problems encountered included slippage of the side slope linings prior to placement of the bottom panels, and sagging of freshly placed concrete in the side slopes.[33]

Construction of the cut-and-cover conduit began soon after Terteling and Sons received the contract.  Placement of concrete in the first section took place in late August 1949.  Because of the unstable nature of the ground, construction activities were confined to limited areas at all times and required close coordination.  Sub-grade preparation followed closely behind excavation, and placement of the invert, or lower, sections of the conduit followed close on the heels of the sub-grade preparation.  Placement of the upper sections of the conduit closely

32. *Ibid.*, 61-5.
33. *Ibid.*, 35, 73-6.

followed placement of the invert. The rigid schedule was followed throughout the operation. The final section was completed on September 5, 1950.[34]

The Feeder Canal discharges into the equalizing reservoir via a 410-foot long concrete chute. The chute was constructed on a compacted earth cushion placed over a foundation of bedrock and boulders. Concrete placement began in late April 1950, and the structure was completed in early October. At the junction of the feeder canal and discharge chute there is a concrete control structure consisting of three, 24-foot by 25-foot radial gates. This control structure is unique in that the gates are designed to resist pressure from either side. They are designed to control the pressures of a full reservoir against an empty canal, or a full canal against an empty reservoir. Concrete placement in the control structure began in mid-May 1950, and was essentially complete by late November. The three radial gates were supplied by the Yuba Manufacturing Company, and were installed by Terteling and Sons crews. The hoisting machinery was furnished by Western Gear Works and was also installed by Terteling and Sons crews. Work under schedule 2 of the contract was accepted as complete on March 25, 1951.[35]

**North Dam**

Construction of the North Dam was carried out under schedule 1 of the larger contract that was awarded in April 1949 and included construction and finishing of the feeder canal and control structure. Stripping of the foundation area began in early May 1949, and was completed in June, at which time crews began excavations for the cutoff trench. The cutoff trench runs the full length of the dam. Except for minor clean up, the excavations were completed by October. Cutoff walls were constructed on both abutments.

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34. *Ibid.*, 76-82.
35. *Ibid*., 35, 42, 48, 81-2, 87.

Like the Dry Falls Dam, the North Dam is a zoned earth embankment structure with an impervious central core covered by a semi-pervious layer. The outer layer of the embankment consists of rocks up to one cubic yard in diameter. In addition, a fourth zone was placed on the reservoir side of the dam to provide additional stability for the embankment. Placement of zone 1 material began in late October 1949, and by the time embankment placing operation were halted for the season on November 26, much of the cutoff trench had been backfilled. Zone 1 material was placed in 10-inch layers that were compacted to 6-inches by several passes of a sheepsfoot roller. Zone 1 placement resumed in the spring of 1950 and continued until completed in early September. A total of 504,271 cy of zone 1 material was placed. Placement of zone 2 material began in late November 1949, but only a small amount was placed before the end of the construction season. Zone 2 placement resumed in June 1950, and followed along behind zone 1 placement. Zone 2 material was spread out into 12-inch layers and compacted by four passes of a heavy crawler tractor. The zone 2 embankment was completed in October 1950, and contains just under 172,650 cy of material.

Work on zone 3 and 4 began in June 1949. Zone 3 material totaling just under 340,450 cy was spread out over the competed portions of zone 2 in layers not greater than 3-feet in thickness. Zone 3 material was not compacted or rolled. A total of 208,695 cy of zone 4 material, dumped fill, was placed in the dam embankment between June 1949 and August 1950. In addition to the zoned earth fill, 24,500 cy of rip rap was placed in a 3-foot thick layer over the reservoir side of the embankment. Work under schedule 1 on the contract was accepted by the government as complete on January 9, 1951.[36]

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36. *Ibid*., 51-2, 89-120.

All work under contracts for construction of the Feeder Canal and equalizing reservoir dams was accepted by the government as complete by April 1951. The feeder canal, as constructed, is 1.6 miles long including the conduit. The canal has a base width of 50-feet and is 25-feet deep. The conduit is 2,100-feet long and has two 25-foot diameter barrels. The control structure has three, 24-foot by 25-foot radial gates. The capacity of the canal is 16,000 cfs. The equalizing reservoir is formed by the North Dam and the Dry Falls Dam. The North Dam is an earthfill structure located at the north end of the Grand Coulee. It is 145-feet high and 1,450-feet long, and contains 1,473,000 cy of material. The discharge chute for the feeder canal runs through the north abutment of the dam. Dry Falls Dam is located at the south end of the Grand Coulee, about 25 miles southwest of the North Dam. Dry Falls Dam is an earthfill structure containing 1,658,000 cy of material. It is 123-feet high and 9,800-feet long. The outlet works are the headworks for the main project canal and consist of a rectangular shaped, 6-barrel conduit. Each barrel is controlled by a 12-foot by 18-foot radial gate. The total discharge capacity of the headworks is 13,200 cfs. The equalizing reservoir has a maximum capacity of 1,275,000 af and a surface area of 27,000.[37]

## Main Canal

The Main Canal begins at Dry Falls Dam and extends southward to Long Lake Dam, then west to the East Low and West Canal bifurcation structure. The canal has a total length of about 21 miles including about 5½ miles in Long Lake which was formed by the construction of Long Lake Dam. By constructing Long Lake Dam, later renamed Pinto Dam, Reclamation utilized the existing channel and avoided costly construction of 5½ miles of expensive and

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37. Ibid., 33, 35, 89, 121; *Project Data*, 386-7.

difficult canal construction. The canal was originally constructed with a capacity of 13,200 cfs. This was later enlarged to 19,300 cfs. Along the canal there are several major structures. Most notable are the 1,000 -foot long Bacon Siphon and 2 -mile long Bacon Tunnel.

Construction of the Main Canal began in 1946 and was completed in 1951. Several major contracts were let in association with construction of the Main Canal. The contract for construction of Long Lake Dam was awarded to J. A. Terteling and Sons, Inc., which also received a contract for excavating and lining a portion of the canal. Work under those contracts began in late 1946. A contract for canal lining and structures was let to Western Contracting Corporation in October 1948. The contract for construction of the Bacon Siphon and Tunnel was awarded to T. E. Connally, Inc., with work beginning in August 1946. The contract for excavation of the initial reach of the canal, from the Dry Falls headworks to the Bacon Siphon, was let to the Morrison-Knudsen Company. Work under the Morrison-Knudsen contract began in May 1946 and was completed in July 1947.[38]

Work on the Main Canal and associated structures continued through 1947 and 1948, with some delays due to lack of funds. Workers holed through Bacon Tunnel on August 18, 1948, and completed the barrel section of the siphon in late November leaving only the transition to be completed. Work under the Terteling & Sons contract for canal excavation and lining was completed in November 1948, and Long Lake Dam was completed by the end of the year. Crews for Western Contracting began trimming the canal section in March 1949. Lining operations began in mid-May, and were completed in late August. All structures were finished

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38. National Archives and Records Administration, Rocky Mountain Region. Record Group 115, Records of the Bureau of Reclamation. Annual Project Histories - Columbia Basin Project. “Irrigation Division, Vol. XIV, Part II, 1946: 18, 38, 76, 87-89; Vol. XV, 1947: 99.

by early December, and the contract was accepted as complete on December 6, 1949.

T. E. Connally crews began testing the Bacon Siphon in the spring of 1949. Backfilling over the siphon barrel began in May. The siphon was essentially complete by the end of the year. Excavation of the Bacon Tunnel to its full diameter was completed in April 1949, and trimming was finished in early May. Lining of the arch and sidewalls began on June 9, and was completed in early November. Placement of the invert section began on November 14 and was finished in mid-December. All work under the Connally contract was completed in early 1950.[39]

**West Canal**

The West Canal is one of two canals formed by the bifurcation of the Main Canal, the other being the East Low Canal. The West Canal is 88 miles long and was constructed between 1946 and 1955. The canal runs west for about 2½ miles, then southwest to Quincy where it turns south. The canal has an initial capacity of 5,100 cfs and is both concrete and earth-lined. Along its route, the West Canal passes through several major structures, including the 12,820 -foot long Soap Lake Siphon, one of the longest siphons in the world, the 9,150 -foot long Frenchman Hills Tunnel, Dry Coulee Siphon No. 1 (4,500 -feet long), Dry Coulee Siphon No. 2 (1,100 -feet long), and the Winchester Wasteway.

As with the Main Canal, the West Canal was constructed under several major contracts. One contract, for earthwork, lining and structures (1st section), was let to a joint venture of Utah Construction Company and Winston Brothers Company in June 1946. Morrison-Knudsen Company also received a contract for earthwork, lining and structures (2nd section) in March 1949, as did Marshall, Haas & Royce, and Haas & Rothschild, and Minnis & Shilling (3rd

39. *Ibid.*;1946, Vol. XIV: 18, 76, 85, 87-89, 94-96; 1947, Vol. XV: 14-15, 84, 86-99; 1948, Vol. XVI: 13, 15, 76, 83, 86; 1949, Vol. XVII: xxiv, 47-48, 57, 89-90.

section) in January 1950, and J. A. Terteling & Sons Inc. (4th section), in October 1950. The contract for construction of Soap Lake Siphon was let to Utah Construction and Winston Brothers in February 1949. Winchester Wasteway was constructed under contract by J. A. Terteling and Sons, Inc. In addition, numerous smaller contracts for equipment and supplies were let.[40]

Winston Brothers and Utah Construction began work under their contract for the 1st section in September 1946 with excavations for Dry Coulee Siphon No. 1. First concrete was placed in the siphon in late May 1947. Canal lining began in early July 1947, and was completed in late August. The barrel section of Dry Coulee Siphon No. 2 was completed in June 1949, and the barrel of Siphon No. 1 in early July. Backfill over both siphons was completed in October, and the contract was accepted as complete on October 28, 1949. Crews for Winston Brothers and Utah Construction began work under the contract for Soap Lake Siphon in March 1949, with concrete placement beginning in July. The siphon was completed in April 1951, Work under the Morrison-Knudsen contract began in March 1949, and was completed in January 1951. Construction of the Winchester Wasteway began in late June 1949 when Terteling and Sons crews began excavations for the wasteway chute. Work on the wasteway was completed in July 1951.

Work on the 3rd section of the West Canal by crews for Marshall, Haas & Royce, and Haas and Rothschild, began in late February 1950. By the end of 1950, the contract was about 80 percent complete, with final acceptance coming in mid-June 1951. J. A. Terteling & sons

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40. Annual Project Histories - Columbia Basin Project. "Irrigation Division, Vol. XIV, Part II, 1946: 39-42, 49, 98; "Notes For Contractors" *Reclamation Era*, August 1946, p. 186; February. 1949, p. 49; May 1949, p.116; March 1950, p.65; December 1950, p.244.

began work on the 4th section of the West Canal in September 1950. Construction of the Frenchman Hills Tunnel was carried out under contract by United Concrete Pipe Corporation and Ralph A. Bell. Work on the tunnel began in January 1951 and was completed in 1953. All work on the West Canal was completed by the end of 1955.[41]

### East Low Canal

The East Low Canal also begins at the bifurcation of the Main Canal, and has an initial capacity of 4,500 cfs. As with the West Canal, the East Low Canal is both earth and concrete lined. It runs generally southward for about 87 miles, ending just east of Scooteney Reservoir. The original design called for the canal to continue southward another 30 miles past Connell, Mesa, and Eltopia, but construction of that portion has been indefinitely deferred. Major structures along the canal route include Crab Creek Siphon No. 1 (3,330 -feet long), Crab Creek Siphon No. 2 (1,400 -feet long), Broken Rock Siphon (1,800 -feet long), and Rocky Coulee Wasteway. Three major contracts were let for construction of the East Low Canal. The first contract was for earthwork, canal lining, and structures, and was let to Winston Brothers Company and Utah Construction Company on October 25, 1946. The second contract was awarded to J. A. Terteling and Sons, Inc. on May 20, 1949, and included earthwork, canal lining, structures, and construction of Rocky Coulee Wasteway. The third contract was for earthwork and structures, and was awarded to Western Contracting Corporation in early 1951.[42]

Crews for Utah Construction and Winston Brothers began work in early January 1947

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41. Annual Project Histories - Columbia Basin Project. "Irrigation Division," Part 2, Vol. XIV, 1946: 104; Vol. XV, 1947: 142; Vol. XVII, 1949: xxii-xxiv, 90, 111-112, 133, 143-144; "Ephrata Division," Vol. XVIII, 1950; xii, 28; Vol. XIX, 1951: 34-35; *Project Data*, 387.

42. *Project Data*, 379, 388; "Annual Project Histories - Columbia Basin Project: Irrigation Division," Part 2, Vol. XIV, 1946: 39; Vol. XVII, 1949: 35; "Notes for Contractors" July 1949: 161; April 1950: 85.

with excavations for Crab Creek Siphon No. 1. Work on Crab Creek Siphon No. 2 began in June. All work under the Utah Construction/Winston Brothers contract was completed and accepted on December 16, 1949. Crews for J. A. Terteling and Sons began work under their contract in late May 1949, with excavations for the Rocky Coulee Wasteway beginning in September. Work under the contract continued through 1950 and into 1951. Canal construction was completed in late November 1951, and the Rocky Coulee Wasteway was completed in early December. Western Contracting began work under their contract in April 1950, finishing in September 1951. All work on the canal was complete by the end of 1954.[43]

**Pasco Pumping Plant**

The first deliveries of water for irrigation did not come from one of the project's enormous, river-sized canals, but from a small pumping plant drawing water directly from the Columbia River near Pasco. The Pasco Pumping Plant was a temporary plant constructed to supply water to about 5,400 acres of land northwest of Pasco. These lands would later receive water from Potholes Reservoir via Potholes East Canal.

Construction of the Pasco Pumping Plant began in late-1946, and was undertaken by the James Construction Company. Excavations for the plant began in early-August and were completed in late-September, at which time, excavations for the intake tunnel began. Concrete placement in the plant began in mid-November. Construction of the unit's lateral system and associated structures was let to J. A. Terteling and Sons, Inc. in mid-1946. Excavations for the lateral system began in mid-July, and were completed in early February 1947. The canal

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43. "Annual Project Histories - Columbia Basin Project: Irrigation Division," Part 2, Vol XV, 1947: 13, 129; Vol. XVII, 1949: xxiii, xxv, 175, 230, 234: "Ephrata Division," Part 2, Vol. XVIII, 1950: xiii; Vol. XIX, 1951: 35; *Project Data*, 388.

structures and concrete lining were completed in mid-July 1947. On May 15, 1948, two pumps, supplied by the Worthington Pump and Machinery Corp., began lifting water 167-feet from the Columbia River, delivering it to the first farms to receive project water. All work on the Pasco Pump Unit was completed by mid-January 1949.[44]

**Potholes Dam (O'Sullivan Dam)**

Potholes Reservoir captures irrigation return flows from the northern portions of the project area and stores those flows for re-use in the southern region. In addition, the reservoir captures and stores excess flow from the West and East Low Canals via the Winchester and Rocky Coulee Wasteways. Potholes Reservoir is formed by O'Sullivan Dam[45], one of the largest earthfill dams in the United States. O'Sullivan Dam was constructed between 1947 and 1949, and is 19,000 -feet long, and 200 -feet high. The total volume of the embankment exceeds 8,750,000 cubic yards. Potholes Reservoir has a total capacity of 511,700 af with a surface area of 27,800 acres. The original spillway was an uncontrolled concrete crest with a rock-cut chute. The spillway was modified in 1973-75 by construction of a new spillway structure, the addition of four, 24 -foot wide radial gates and a reinforced concrete discharge chute. The outlet works, which consisted of a concrete conduit through the dam, were abandoned and plugged in 1983. The headworks for the Potholes East Canal are located near the left abutment of the dam.

The contract for construction of the dam and reservoir was awarded to a joint venture of C. F. Lytle Company, Amis Construction Company, and Green Construction Company, on October 24, 1946. Work on the project began in January 1947 when crews began excavations

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44. Annual Project Histories - Columbia Basin Project. "Irrigation Division, Vol. XIV, Part II, 1946: 42, 108, 122-127; Vol. XV, 1947: 13-15; Vol. XVI, 1948: 13; Vol. XVII, 1949: xxi; Pitzer, 281-282.

45. O'Sullivan Dam was originally called Potholes Dam, but was renamed in honor of project supporter and booster James O'Sullivan on September 28, 1948.

for the outlet works and stripping the foundation area. Excavated materials were stockpiled for construction of the embankment, which began in April. The outlet tunnel was holed through in mid-July 1947, and concrete lining began in early August. By the end of 1947, the project was almost 50 percent complete. Work continued though 1948 and into 1949. The embankment was completed on June 3, 1949, and the final concrete was set in place on June 30. The dam was accepted as complete by Reclamation on August 16, 1949, almost five months ahead of schedule.[46]

## Potholes East Canal

The Potholes East Canal extends from O'Sullivan Dam and runs generally southward for a distance of about 70 miles and is one of the primary canals for supplying water to lands in the southern part of the project. Along with the canal, there are numerous associated structures including headworks for branch canals, checks, wasteways, bridges, drainage inlets and control structures. Where possible, natural channels were utilized, which eliminated the need to construct canal sections through those areas. Two such areas are Soda Lake and Scooteney Reservoir, both of which were formed by the construction of dikes. In addition to the canal and associated structures, numerous pumping plants were constructed to supply water to areas above the canal. The largest plant is the Ringold Relift Plant with a capacity of 118 cfs.[47]

Construction of Potholes East Canal began in late 1949 and was completed in early 1955. Most of the work was carried out under six major contracts. One contract for earthwork was

46. "Annual Project Histories - Columbia Basin Project, Irrigation Division," Part 2, Vol. XIV, 1946: 106; Vol. XV, 1947: 13, 147, 161, 165, 168; Vol. XVII, 1949: xxi, xxiii, 35, 206, 218; *Project Data*, 386; United States Department of the Interior, Bureau of Reclamation, "SEED Report on O'Sullivan Dam, Columbia Basin Project, Washington," (Denver: Dam Safety Office).

47. United States Department of the Interior, Bureau of Reclamation, *Technical Record of Design and Construction, Potholes East Canal*, (Denver: U.S. Government Printing Office, 1958), 2, 51.

awarded to the Guy F. Atkinson Company in October 1949. Four contracts for earthwork and structures were let. The first was awarded to Scheumann and Johnson of Seattle. The second contract, which included construction of the North Scooteney Dike, was awarded to J. A. Terteling and Son, Inc., as was the third contract. The fourth contract was awarded to Peter Kiewit Sons Company. Schedule 2 of the Scheumann and Johnson Contract covered construction of Soda Lake Dike was awarded to the Guy F. Atkinson Company. The sixth major contract was for earth lining of sections of the canal and was let under five separate schedules. Two schedules were awarded to the L. D. Shilling Company, Inc., one to Otis Williams and Company, one to Riverbend Contractors, Inc., and one to Cherf Brothers Construction Company, Roy F. Johnson, and Sandkay Contractors, Inc. In addition to the primary construction contracts, numerous supply contracts were let including contracts for control gates and mechanical installations.[48]

Soda Lake Dike was constructed between July 1950 and June 1952. The dike is a zoned earthfill structure, 1,680 feet long and 59 feet high. The entire face of the dike is covered with a layer of rockfill which provides slope protection. A sluiceway consisting of a 4½- by 4½- foot concrete conduit controlled by a slide gate is located at one end of the dike. The sluiceway is used to drain water that accumulated behind the dike when the canal is not in operation. The accumulated water is usually highly saline and would contaminate the water in the canal if not removed.[49]

North Scooteney Dike is an earthfill dike 3,700 feet long and originally constructed to

48. *Ibid*., 67-69, 75.
49. *Ibid*., 31, 83-90; United States Department of the Interior, Bureau of Reclamation, *Statistical Compilation of Engineering Features on Bureau of Reclamation Projects*, (Denver: U.S. Government Printing Office, 1994), 21.

16- feet high. The Scooteney headworks are located at the south end of the reservoir formed by the dike and controls flows out of the reservoir. The headworks consist of a concrete structure set in a rock cut and controlled by a 20- by 10- foot radial gate. The capacity of the headworks is 1,800 cfs, equal to the capacity of the canal downstream from the headworks. In addition to regulating the flows in the canal and storing excess water, Scooteney Reservoir captures water from the Scooteney Wasteway which drains excess water from the East Low Canal. The reservoir has a capacity of 15,250 af.[50]

In addition to the main canals, there are a number of secondary canals. The Royal Branch Canal branches from the West Canal just south of the outlet of the Frenchman Hills Tunnel. Constructed in 1956-57, it is 8½ miles long and serves lands to the south of Frenchman Hills. The Wahluke Branch Canal runs southwest from a turnout on the Potholes East Canal about 6 miles south of Othelo. It is 41 miles long and has a capacity of 2,000 cfs. It was constructed between 1957 and 1967. The first 3 miles of the canal consist of the Wahluke Siphon, which was constructed between 1956 and 1959. The Eltopia Branch Canal begins at a turnout from the Potholes East Canal and runs southeast 8 miles to Eltopia, then south for another 17 miles. It was constructed between 1953 and 1954 and has a capacity of 555 cfs. Additional project facilities include more than 1,900 miles of laterals, more than 200 pumping plants ranging in capacity from 3 cfs up to more than 150 cfs, and more than 1,300 miles of drains.[51]

## The Third Powerhouse

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50. *Technical Record of Design and Construction, Potholes East Canal,* 41, 90-3; *Statistical Compilation of Engineering Features on Bureau of Reclamation Projects,* 66.
51. *Project Data*: 385, 387-9.

## Authorization

Even before the last of Grand Coulee's original 18 generators went online in 1951, Reclamation officials and engineers began looking at the possibility of adding a third and even a fourth powerplant. The problem facing Reclamation engineers was not one of demand for power (the postwar Northwest was hungry for power), but the unreliable flows of the Columbia River. During the spring and early summer, the river flows deep and fast, but during the late summer and winter, the flows diminish to a relative trickle. The key to the success of additional power developments was balancing out the flows to provide a consistent supply all year. The answer was construction of large storage reservoirs upstream to store excess water for release during periods of reduced natural flows. Hungry Horse Reservoir on the Flathead River, a tributary of the Columbia River, provided some degree of relief following its construction in the 1940s, but it was not enough. To truly regulate the flow of the river, storage of as much as 20,000,000 af would have to be constructed. This could only be accomplished through construction of several new dams, and since Roosevelt Lake reaches almost to the Canadian border, these new dams would have to be built in Canada, requiring complicated agreements between the governments of Canada and the United States. Those agreements took almost two decades to develop.

From the beginning, planners realized that construction of additional storage in Canada would provide significant benefits in the United States. One problem was determining how to credit Canada with its share of those benefits. One of the many benefits that the United States would receive was flood control. This was underscored in 1948, when flooding caused widespread damage throughout the Columbia Basin. The other major benefit was increased power production, and Canada wanted to share in that benefit as well. Politics also played a large role in delaying the necessary agreements. In Canada, disputes between the provincial government in British Columbia and the federal government in Ottawa caused many delays, as did shifting political forces in the United States. Driving the issue forward though, was the need for electricity, flood control, and a new factor, pride. In 1955, the Soviet Union completed construction of the Kuibyshev Powerplant on the Volga River, the first of three Soviet power plants that would outproduce Grand Coulee's generators, knocking it from the top spot as the world's largest powerplant.

In 1962, the United States and Canada finally reached agreement and signed the Columbia River Treaty. But the political jealousies that existed between the provincial government in Victoria and the federal government in Ottawa threatened to undo the treaty. The debate in Canada raged for two years, delaying ratification of the treaty. In 1963, a national election in Canada brought about a shift in the federal government that favored opponents of the treaty in British Columbia. The new government in Ottawa, with the support of the provincial government in Victoria, called for a renegotiation of the treaty. Negotiations resumed in December 1963, and resulted in a new, though little changed, treaty. The new treaty was ratified by the Canadian House of Commons on June 10, 1964, and soon after by the American Congress. President Lyndon Johnson and Prime Minister Lester Pearson signed the Columbia River Treaty and Protocol on September 16, 1964, ending one of the most heated debates ever waged between the two nations and clearing the way for construction of the Third Powerplant.[52]

With ratification of the Columbia River Treaty, plans for the Third Powerhouse moved forward. In February 1965, Secretary of the Interior Stuart Udall approved Reclamation's

52. Pitzer, 333-41.

tentative plans for the project. The initial plans called for the construction of a new powerhouse at the east end of the existing dam housing twelve, 300,000 KW units. The plan went before the Senate's Interior Committee in mid-April, and with Committee Chairman Henry Jackson (D-WA) pointing out that construction of the Third Powerhouse would restore Grand Coulee to the top spot as the world's largest power plant, little opposition to the plan was encountered. The plan was approved by the entire Senate on June 16, 1965. Final approval of the plan was delayed by political maneuvering for almost a year before the final appropriation bill was signed by President Johnson on June 14, 1966.[53]

## Construction

Work on the project began in early 1967, with excavations and preliminary work. Among the tasks that had to be completed before work on the actual structure could begin was relocation of the original switchyard and major portions of the town of Coulee Dam. As in the 1930s with construction of the main dam, construction workers flooded the area looking for jobs, and within a few months, several hundred families arrived, many with mobile home which they organized into small settlements.

The construction schedule was closely linked to the seasonal fluctuations of the river. A coffer dam placed during the spring of 1968 enclosed the upstream portion of the east end of the dam, providing access to areas normally under water. To assist construction crews in placing the cells for the coffer dam, dam operators lowered the level of the lake as much as possible. With the coffer dam in place, workmen began excavations for the powerhouse forebay and the removal of about 250 feet of the east end of the existing dam. In mid-October 1968, the first

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53. *Ibid*., 341-2.

blast of dynamite began removal of the east end of the thirty-year old dam. Blasting continued though the later part of 1968 and into early 1969, stopping due to cold weather from late-November through early-January. The concrete of the old dam proved to be much harder than anticipated, and removal of the old section took longer than expected. On February 28, 1969, one final blast brought down an enormous 11,000 ton section as workers neared the end of their task.

The original design for the powerplant called for the installation of twelve, 300,000 KW generating units, but Secretary of the Interior Udall announced that the powerhouse would hold 600,000 KW units, the largest in the world, producing more than 9,000,000 KW. Some controversy surrounded the decision to install the larger units. At the time of the announcement, no domestic manufacturer was building such large units. Indeed, few had ever been constructed. The most notable units of the period were being constructed by the Soviet Union, which had constructed several 500,000 KW units for their powerplants, and offered to bid for the contracts to build the units for Grand Coulee. The idea of placing Russian generating units in the Third Powerhouse was one that did not go over well in the United States, and the Interior Department soon announced that only domestic bids would be accepted.

Construction activity moved according to schedule though most of 1969. In the spring, operators again reduced the level of the lake to allow excavation of the forebay approach channel. The level of the lake was reduced until, for the first time in over twenty years, Kettle Falls was exposed. For six weeks, people came to see a sight that had been hidden for almost three decades and would likely never be seen again. Construction continued until September 1969, when President Richard Nixon announced that all government construction would be reduced by 75%. Within a month, the work force at Grand Coulee had been reduced by half. The announcement came just as Reclamation was preparing to advertise for bids for the construction of the powerhouse, and rumors indicated that the budget cuts would postpone construction of the powerhouse indefinitely. But in February 1970, the Administration announced that $68,000,000 had been set aside for the third powerhouse and that Grand Coulee would be exempt from budgetary constraints.

Bids for the construction of the third powerhouse were opened on February 11, 1970. The low bid, $112,525,612, was submitted by a joint venture of four firms: the Vinnell Corporation of Alhambra, California; Dravo Corporation of Pittsburgh; Lockheed Shipbuilding and Construction Company of Seattle; and the Mannix Construction Company of Calgary, Alberta. The contract, the largest ever issued by Reclamation, covered construction of both the powerhouse and forebay dam. Although slightly over Reclamation's estimate, the bid was accepted and the contract awarded on February 26.

On October 21, 1970, the first bucket of concrete was placed in the powerhouse. More than 2,500 people attended the event, including Reclamation Commissioner Ellis Armstrong and Senator Henry "Scoop" Jackson. By January 1971, more than 700 workers were employed at the powerhouse, and that number was expected to reach more than 2,000 before the project was complete. Among those working at the site was a twenty-three-year-old civil engineer named Toby Ann Levy, the first female engineer to be employed by Reclamation on a heavy construction job and one of three women employed by Reclamation at the site.

Reclamation had planned to lower the level of the lake in early 1972 to remove the coffer dam, but delays, including labor slowdowns and strikes, postponed that operation until

December, requiring the raising of the coffer dam ten feet to accommodate the spring runoff. Construction on the powerhouse also experienced significant delays and by January 1973, the project was well behind schedule. All was not well with the primary contracting organization and officials of the four firms frequently argued among themselves. In May 1973, Vinnell withdrew as the primary contract sponsor, replaced by Dravo. Reclamation was forced to push back the estimated date of completion by a year, from 1974 to 1975.

The last concrete placement in the forebay dam took place in the summer of 1973, joining the forebay dam to the main dam. Labor problems and strikes caused further delays, but in December 1973, the level of the lake was lowered 120-feet and removal of the coffer dam began. In March 1974, as work to remove the coffer dam continued, Kettle Falls once again emerged from the lake. Throughout April and into May, tourists made what was certain to be their final visit to the falls. Downstream, workers continued removing earth and rock from the forebay and on April 25, the dike between Roosevelt Lake and the forebay was breeched allowing the first water to flow into the newly constructed forebay. On May 11, the gates at Grand Coulee Dam were closed and Roosevelt Lake began to refill.

Work on the powerhouse continued though 1974 and into 1975, with one final labor strike shutting down the project during the summer of 1974. On December 3, 1975, the contract for the construction of the forebay dam and powerhouse was complete, one year and two days behind schedule.

As the powerhouse structure neared completion, attention turned to installation of the generators and turbines. As early as 1968, the Westinghouse Corporation and General Electric inquired about specifications for the giant generators. Because of restrictions imposed due to the

Soviet Union's interest in bidding on the generator project, General Electric withdrew from consideration. Because of fears of foreign bidding, the Department of the Interior established a policy permitting that no more than 49% non-domestic parts be used in the units. This presented a significant problem because the American firms relied heavily on parts from Japan, Canada, and Sweden, and Westinghouse wondered if it could build the units with enough domestic parts to meet the requirements of the contract. The problem eventually solved itself as construction delays on the powerhouse postponed the generator bidding and allowed the concern over foreign involvement to fade. The requirements were revised and Westinghouse was awarded the contract for the first three units, numbers 19, 20, and 21, each rated at 600,000 KW. The Willamette Iron and Steel Company of Portland was awarded the contract for the first three turbines. The contract for the three, 700,000 KW units, numbers 22, 23, and 24, was awarded to Canadian General Electric Company, Limited, on August 13, 1973.

Even by the standards of the day, the generators in the third powerhouse were huge. The 108,000 KW units installed in the first two powerhouses had been considered giants in their day, but were dwarfed by the new units. The 108,000 KW units are just over thirty feet in diameter and each weighs 556 tons. Each unit is fed by a penstock 18-feet across. By comparison, the 600,000 KW units are sixty-eight feet across, weigh 1,900 tons, and require penstocks forty feet across. To install the generating units, the world's largest gantry crane was constructed, capable of lifting and moving 2,000 tons.

On August 26, 1975, testing of the first unit, number 19, began. On October 11, Senator "Scoop" Jackson and Reclamation Commissioner Gilbert Stamm pushed a button that placed the new generator into service. Unit number 20 followed in April 1976, and unit number 21 in

December 1976. The first of the 700,000 KW units, number 22, went on-line May 23, 1978, followed by unit number 23 on November 14, and unit number 24 on April 1, 1980. The completion of the third powerhouse once again placed the Grand Coulee Power Complex at the top of the world's largest powerplants.[54]

**Post Construction History**

The completion of Grand Coulee Dam did not signal the end of construction. Even though the dam was finished, significant work remained, including completion of the powerhouses and installation of the remaining generators. America's entry into World War II created demands for power that no one could have anticipated, and the program to complete Coulee's powerplants was pushed forward. The second unit to go online was unit L-2, which was placed into service on January 29, 1942, followed by unit L-1, which began service on April 7. At the same time, the completion of the next six units was given a high priority. Congress immediately approved the second set of three units, followed by approval of the third set of three. But approval for the third set was later withdrawn after the War Production Board elected to increase production from existing powerplants rather than build new ones.

While work on units L-4, L-5, and L-6 continued, the Reclamation and the War Production Board developed an unusual plan to boost power output. Reclamation was constructing Shasta Dam in California, and two of Shasta's 75,000 KW generators were in storage awaiting completion of the dam. Reclamation proposed installing the units from Shasta at Coulee, which would bring more power on line sooner. The plan was approved, and Reclamation moved forward. The units from Shasta were installed in the spaces for units L-7, L-

54. *Ibid*., 343-51; United States Department of the Interior, Bureau of Reclamation, *The Story of the Columbia Basin Project*, (Washington DC: U.S. Government Printing Office, 1978), 21-2.

8, and L-9.  The generators at Coulee were designed to rotate clockwise, but the Shasta units were designed to turn counterclockwise.  To overcome the problem, the first Shasta unit was installed in the pit for unit L-7, but received water from the penstock for unit L-8.  The second Shasta unit was placed in the pit for unit L-8, and received water from unit L-9's penstock.  The plan required cutting through several feet of concrete to make the penstock connections.  The first Shasta unit went into service on February 25, 1943, followed by the second unit on May 7.

Unit L-6 went into service on August 9, 1943, followed by unit L-5 on November 8. Unit L-4, the last unit to be installed during the war, entered service on February 12, 1944.  The electricity provided by Grand Coulee powered the Boeing Aircraft Works near Seattle, and shipyards in Vancouver, Washington, and Portland, Oregon.  At the shipyards, scrap steel, salvaged following construction of Grand Coulee, was turned into ships destined for combat in the Pacific.  The aircraft industry was reliant upon aluminum, and in 1940, the Pacific Northwest had no aluminum manufacturing capacity.  But by the end of the war, more than ⅓ of the Nation’s aluminum was manufactured in the Northwest with power supplied, in part, by Grand Coulee’s generators.  In January 1943, a large block of power began to flow into an isolated area in southern Washington, seemingly disappearing into the desert.  It would be later revealed that the power was going to the Hanford Reservation where research on the atomic bomb was being carried out.  Grand Coulee’s contributions toward securing a victory in World War II were great. While it is likely that the war could have been won without Grand Coulee’s contributions, the impacts on the American public in the form of shortages and restrictions would have been much greater.

Following the end of the war, the economy in the Northwest continued to boom, and when Reclamation shut down the two Shasta units in July 1945, the loss of their energy created a significant power shortage in the region. In addition, the need to shut down units L-1 through L-6 for repairs and maintenance compounded the situation. Generator L-7, the first unit placed into service following World War II, went online on October 20, 1947. During 1948, units L-8 and L-9 were placed into service, and workmen began assembling unit R-1, the first unit in the right, or east, powerhouse. In 1948, the left powerhouse at Grand Coulee established several new records for power production. Even so, the region still suffered from power shortages as the economy continued to boom and new industries moved to the region. During the winters of 1948, 1949, and 1950, unusually cold temperatures placed an even greater burden on the power system, and the units at Grand Coulee often ran over capacity, producing as much as 135,000 KW, well over their 108,000 KW rating.

Unit R-1 began production in May 1949, followed by units R-2 and R-3 in July and September. Units R-4, R-5, and R-6 were placed into service during 1950. The dam was officially dedicated on May 11, 1950. President Harry S. Truman, accompanied by his wife and daughter, delivered the dedication address from Mead Square, at the center of Mason City. Commenting on the bitter fight that the project's opponents had waged against construction of the dam and the contributions made by the dam during the war, President Truman christened the dam and flipped the switch to officially start generator R-4.[55]

Units R-7 and R-8 began service in April and June 1951. The last unit, R-9, began service on September 14, 1951, just two weeks short of the tenth anniversary of the start of the first unit, L-3, in 1941. With the start-up of the last unit, Grand Coulee was finally operating at

55. *Ibid.*, 256.

full capacity. The two powerhouses held a total of 21 generating units. The left, or west powerhouse, contained 12 units; three, 10,000 KW station service units, and nine, 108,000 KW units. The right, or east, powerhouse contained nine 108,000 KW units. The total installed capacity of the Grand Coulee Power Complex was 1,9774,000 KW, making it the largest powerplant in the world.[56]

On June 1, 1942, water reached the crest of the spillway and began flowing over for the first time, creating a waterfall higher than Niagra Falls. Soon after, it was discovered that rocks and gravel washed into the spillway bucket were eroding the concrete at an alarming rate. In addition, fluctuations in the rivers flow caused significant erosion along the river bank downstream from the dam. The problems increased, and Reclamation engineers estimated that repairs might cost as much as $5,000,000 over ten years. To solve the problem, Reclamation engineers designed an enormous floating caisson that could be moved from place to place in the spillway bucket and pumped clear of water to provide access for repairs. The base of the caisson was shaped to match the contours of the bucket so a tight seal could be achieved.

On January 14, 1949, Reclamation awarded a $2,000,000 contract to the Pacific Bridge Company to carry out the repairs. The company worked throughout 1949 to make repairs to the spillway face and bucket, and placed riprap along the river bank to reduce erosion. A second contract for $2,500,000 was awarded to Pacific Bridge in 1950, for additional repairs. Even with the additional work, the situation was not fully resolved, and spillway and river bank erosion continues to be a problem.[57]

Completion of the major project features did not mean the end of construction activities.

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56. Pitzer, 248-57.
57. *Ibid*., 209, 211-2, 257-8.

Hundreds of miles of laterals to deliver water to individual farms, and many hundreds of miles of drains to remove excess irrigation flows remained to be built, a process that would take many years as settlement increased and more farm units went into production. Pumping plants to serve lands above the canal were also constructed. Construction of minor project features would continue for several decades.

In March 1952, an incident occurred at Grand Coulee which threatened to plunge the entire northwest into turmoil. The problem centered on the outlet tubes which run through the dam. Each tube has a control gate located at either end. Manholes allow access to the interiors of the tube for inspection and maintenance. Early on the morning of March 14, two workmen were preparing to perform routine maintenance on one of the tubes. The subject tube was dry, the gates at either end closed. This fact was overlooked by the workmen. Also unknown to them was the fact that the inspection cover had been left open during a previous inspection. The workmen inadvertently opened the upstream gate, flooding the tube. With the downstream gate closed, the water had nowhere to go except out the loosened manhole, and water began flooding into the interior of the dam at a rate of more than 50,000 gallons per minute. Confused and unsure what was happening, the workmen were forced to abandon the gate controls and seek assistance.

Water continued to flood the interior passageways of the dam, flowing down stairwells and shafts and moving toward the lowest point in the dam, the turbine pits in the powerhouses. Attempts to keep the water out of the powerhouses failed, and before long water flowed into the pits for L-8 and L-9, washing away the lubricating oil that kept the turbine bearing from burning up. In the control room, the power plant operator considered his options - take the units off-line and plunge the region into an instant power crisis, or keep them running and risk serious damage that might take months to repair. The operator made the decision to continue operation, keeping an eye on the bearing temperatures, ready to shut the units down at the first sign of overheating. As workmen attempted to close the gate, the word when out that there was a problem at Coulee. Industries throughout the region prepared to shut down at a moments notice, and operators of coal and oil fired powerplants rushed to bring their units up to steam.

Almost two hours after the flood began, workmen were able to make their way to the gate control panel and close the gate. While the flood had been controlled, the problems in the powerhouse grew worse. Unit L-9 was the first unit to be shut down, followed in short succession by units R-9, L-8 and R-8. In all, seven units were removed from service. As each unit went off-line, the regional power shortage grew worse. Industries were forced to halt operations, and a plea went out for all citizens in the northwest to cut down on electrical usage. By mid-afternoon, the situation was critical, but other powerplants throughout the region began to go on-line, picking up the slack and helping to relieve the pressure on Coulee's remaining units. Surplus power from other parts of the west was routed to the northwest, further alleviating the situation.

Meanwhile, at Coulee workmen pumped water from the flooded turbine pits, drained and flushed the turbine bearings, replaced the oil and prepared to place the units back into service. By early evening, the first unit to be restarted, L-7, was placed on-line, just in time for the peak power demand that occurred each evening. By 7:00 P.M., all units had been restored to operation and were functioning at full capacity. Later that night when the demand for power dropped as it did each night, the units were taken off-line and inspected for damage. No significant damage had occurred to any of the units, and by the next morning, Grand Coulee was operating at full power.[58]

Over time, a number of major project features would be modified. These changes included construction of a new spillway and sealing of the outlet conduit at O'Sullivan Dam; enlargement of the Feeder Canal and the replacement of the cut-and-cover conduit section by an open flume section; and the addition of second barrels for both the Bacon Siphon and Tunnel to meet increased demand for water. Beginning in 1964, Reclamation began a program to upgrade the 18 original generators from 108,000 KW to 125,000 KW. The first upgrade was completed in December 1964, with the last unit upgrade completed in August 1980. The three, 720,000 KW units in the third powerhouse were upgraded to 805,000 KW between 1995 and 1997.[59] A number of name changes occurred as well. Potholes Dam was renamed in honor of project supporter James O'Sullivan. The lake formed by the North Dam and Dry Falls Dam was renamed Banks Lake in honor of Frank Banks, district manager during much of the early construction period. The Feeder Canal was renamed Banks Lake Feeder Canal as well. Other name changes included renaming Long Lake Dam as Pinto Dam, and the reservoir Billy Clapp Lake, in honor of project booster Billy Clapp.

In the 1960s and into the 1970s, area farmers pressured Reclamation to bring water to more and more land within the project. Two things stood in the way of further development. When originally constructed, the Bacon Siphon and Tunnel were constructed to half their design capacity with provisions for enlargement by construction of a second siphon/tunnel at a later

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58. *Ibid*., 261-3; Murray Morgan, *The Dam*, (New York: Viking Press, 1954), 83-162.
59. Information on generator upgrades provided by the Bureau of Reclamation's Power Resources Office (D-5400), Denver, Colorado.

date, but the cost of modification was far beyond what planners had anticipated during the project planning stage. In addition, only six pumps were originally installed in the pumping plant, and as with the siphon and tunnel, the costs of installing the six remaining pumps threatened the feasibility of expanding the project. The problem of the cost of additional pumping units was solved in a unique manner. Instead of installing pump units, Reclamation would install pump/generating units that could be used in reverse to generate power when not being used as pumps, a technology that Reclamation pioneered on the Colorado-Big Thompson Project in the 1950s. The power generated by the units would help defray their cost and relieve the growing power shortage in the region. The first two units were supplied and installed in 1971 by Nohab Incorporated, a Swedish company. As pumps, these units have a capacity of 1,600 cfs. As generators, each unit produces 50,000 KW. Installation of the remaining four units was completed in 1984. These units have a generating capacity of 53,500 KW, and a pumping capacity of 1,600 cfs.

The change from pumps to pump/generating units required significant changes in the feeder canal. The need for modification was discovered during testing of the first two pump/generating units. During load-dump testing of two units in generating mode, a wave was created that overtopped sections of the canal and the cut-and-cover conduit section. Reclamation engineers realized that if such a wave was created by the rapid shut-down of two units, an even more damaging wave would be created if all six units dropped off at once. To compensate, Reclamation widened the canal bottom from 50 -feet to 80 -feet, constructed a flume section to by-pass the conduit section, and replaced the original three gate control structure with a larger, five gate structure. The modifications reduced the wave action created during generator shut-down while increasing the flow available for power production. The work was carried out under contract by the Martin K. Eby Construction Company between December 1977 and October 1981.[60]

With completion of the pumping plant, the next step toward expanding the project was construction of the second Bacon Siphon and Tunnel. Construction of the siphon and tunnel was wrought with controversy over the costs, benefits and repayment. The need for the expansion was clarified by increased groundwater pumping which significantly lowered the water table. Underscoring this problem in late 1968, the governor of Washington ordered a halt to well drilling. Congress appropriated funds for construction of the siphon and tunnel, but the Bureau of the Budget cut them. The funds were restored in 1969, and Reclamation called for bids for construction in March 1969, but canceled the call in April when the funds were once again cut. This process continued for several years as costs rose and questions of feasibility threatened the entire project. In 1975, the Washington State legislature allocated $15 million for construction of the siphon and tunnel, citing the benefits of increased employment and agricultural production as justification. Reclamation announced that a contract for construction would be issued immediately and Congress allocated $3.5 million for the project in 1976. But construction was still contingent on negotiating an acceptable repayment contract between the three irrigation districts and Reclamation. In August 1976, farmers from the Quincy and East Districts signed a new master agreement with Reclamation, clearing the way for construction, but requiring further negotiations in the future.

The contract for construction of the siphon and tunnel was let to the Guy F. Atkinson

60. United States Department of the Interior, Bureau of Reclamation, *Technical Report of Construction on Modification of Grand Coulee Feeder Canal*, (October 1989), 1-3, 5, 8.

Company in June 1976, and ground breaking took place in October. But in March 1977, President Jimmy Carter released his "hit list" of water projects, including the Bacon Siphon and Tunnel, and the project was once again threatened. Washington States Senators "Scoop" Jackson and Warren Magnuson jumped to save the project and maintain the funding for construction. Because of the influence of Magnuson and Jackson, Congress, with the support of the President, voted to continue funding of the project. In late 1977, crews had holed through the tunnel, and by early 1978, the project was a year ahead of schedule. But negotiations between Reclamation and the water users was falling behind schedule. On March 22, 1980, water flowed through the newly completed siphon and tunnel for the first time, but continued repayment negotiations prevented full use of the facilities for several years.[61]

In the late 1970s, the three Columbia Basin irrigation districts, the Quincy, East, and South Districts, entered into an agreement with the government whereby the districts would construct and operate powerplants at several locations. The plants would use the water from the project main canals, which drop over 1,000 feet over the length of the project. The first of these powerplants entered service in 1982, and the last in 1990. In all, there are seven powerplants which are owned and operated by the districts. Power generated at the plants is used to power pumps on the project, and surplus power is sold to area utilities. Power operations for the districts are administered by the Grand Coulee Project Hydro-Electric Authority.[62]

## Settlement of Project Lands

On May 1, 1948, three years before water began flowing through the project's main

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61. Pitzer, 318-23.
62. United States Department of the Interior, Bureau of Reclamation, *Hydropower 2002: Reclamation's Energy Initiative*, (November 1991), 75-76; Merle Gibbons, Grand Coulee Project Hydro-Electric Authority. Telephone interview by author, May 1998.

canal, the first water for irrigation reached project lands. That land was in the southern portion of the project near Pasco, and the water was pumped directly from the Columbia River into a canal. With water now available for irrigation, Reclamation moved forward with settlement of the project.[63]

The irrigated lands of the project were originally estimated to be a total of 1,029,000 acres. Refined survey techniques increased that figure to 1,095,000 acres. Within the project boundaries, the lands in the east received a greater amount of rain each year than those in the west. Much of the project area had been settled around the turn of the century, but settlements in the western part of the project area failed due to drought. Farmers in the eastern part of the basin, where rainfall was somewhat greater, consolidated their holdings and managed to survive as dryland wheat farmers. When the project was laid out, farmers in all parts of the project were anxious to see development of the irrigation system. But higher prices during and after World War II, and increased yields brought about by a wet cycle that began in 1940, caused may wheat farmers to lose interest in irrigation. Many of the farmers objected to the small size of the farm units that they would be allowed to retain if their lands were developed under the project. About three-quarters of the lands in the eastern part of the project were petitioned out of the project. So many landowners withdrew their lands from the project that construction of the East High Canal was determined impractical before it was even designed.[64]

On July 20, 1948, Public Announcement No. 11 was issued, stating the government-owned farm units on the Columbia Basin Project would be offered for sale to qualified

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63. *The Story of the Columbia Basin Project*, 1978, 30.
64. William E. Warne, *The Bureau of Reclamation*, (Boulder: Praeger Publishers, Inc., 1973; reprint, Boulder: Westview Press, 1985), 127.

applicants.  As most of the land within the project was privately owned, only federally owned lands would be sold in this manner.  To be eligible, applicants had to have farming experience, be physically and mentally fit, have good character references, and a net worth of at least $3,700. Veterans received preference over non-veterans.  Several hundred inquires were received for the 15 units that would be available in Irrigation Block 1, in the southern tip of the project.  In addition, 160 formal applications were filed by World War II veterans.  All applications were screened by an examining board which included a representative of the South Columbia Basin Irrigation District where the farms units were located, a veteran familiar with veterans affairs, and a representative of the Bureau of Reclamation.  On November 15, 1948, a drawing was held in Pasco where applicants received priority numbers.  After an interview with Reclamation officials, the applicants selected their farm units and signed a sales contract after which the land was theirs to develop.

In the years that followed, 35 such sales took place.  While the requirements changed over time, the basic procedure remained the same until most of the federally owned lands not needed for construction or operation of the project were sold.  The last sale was in 1967.  Other farm units were made available through sale from private owners.  Under stipulations of the contracts between the irrigation districts and Reclamation, no farm units larger than a specified size were allowed to receive project water.  Owners of large tracts were required to divide their holdings and sell the excess land.[65]

Under the original plan of development, the allowable size of a farm unit was based on the quality of the soil, the topography of the lands, and the tract's relationship to the irrigation

65. *Ibid*., 129-131; *The Story of the Columbia Basin Project*, (1964), 17; (1978), 30.

system. Using this formula, the tracts were plotted in sizes thought to be large enough to provide a comfortable living for the farmers. Considered revolutionary in the late 1930s when it was developed, the plan proved inadequate in the post war era when it was put into action. Soon settlers called for enlargement of the farm units, complaining that 60- to 120-acre farm units were too small to provide the incomes they desired. In addition, land development funds that were to aid settlers in development of their farms never materialized because the demand for farm units, although great, never reached the levels anticipated. It was eventually determined that the plan of development which had been drawn up prior to World War II did not provide sufficient opportunities for settlers in the post war era. In 1962, provisions of the 1943 Columbia Basin Project Act relating to the size of farms were abandoned in favor of the Reclamation standard of 160 acres for a single farmer and 320 acres for a husband and wife.[66]

In 1950, two years after the first farms units were opened for settlement, there were over than 7,000 acres of land available for irrigation on 68 farms. Of that total, 4,350 acres were under cultivation. By 1955, the acreage available for irrigation had risen to slightly more than 246,800 on 2,480 farm units. In 1955, almost 10,000 people lived on farms within the project with another 48,000 living in nearby towns and cities. In 1960, the number of farm units had dropped to 2,376, while the area available for irrigation had risen to almost 425,000 acres. The average size of each farm unit was just under 178 acres. Eight-thousand, four-hundred and fourteen people lived on project farms in 1960.[67]

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66. Warne, 124-5, 130-2.

67. United States Department of the Interior, Bureau of Reclamation, *1950 Crop Summary and Related Data, Federal Reclamation Projects*, (U.S. Government Printing Office: 1951), 1a, 37a; United States Department of the Interior, Bureau of Reclamation, *1955 Crop Report and Related Data, Federal Reclamation Projects*, (U.S. Government Printing Office: 1956), 30, 152; United States Department of the Interior, Bureau of Reclamation, *Statistical Appendix to 1960 Crop Report and Related Data, Federal Reclamation Projects*, (U.S. Government
(continued...)

In 1965, three years after the regulations determining the size of farm units had been modified, the average size of the farm units on the project had risen to just over 203 acres. In 1965, 482,181 acres on 2,369 farms were available for irrigation. Of that total, 410,281 acres received project water. The farm population in 1965 was 10,330 people. In 1975, 493,810 acres out of an available total of 527,769 acres received project water. The number of irrigated farms had dropped to 2,212 while the average size of each unit rose to over 236 acres. Just over 10,000 people were living on project farms in 1975. By 1985, facilities had been constructed to serve over 557,000 acres. In 1985, the number of farm units had dropped slightly, to 2,142, while the average size of each unit had climbed to 257 acres. In addition, the number of people living on project farms also rose, to 10,835.[68]

In 1992, 557,530 acres were available for irrigation, while just over 530,000 acres received water. The number of farm units had dropped further, to 2,050, while the average size of each unit had continued to climb, reaching to just over 268 acres. The number of people living on farms in the project also rose, reaching 12,577.[69]

### Project Benefits and Uses of Project Water

The Columbia Basin Project is a true multipurpose project, providing a wide range of benefits to the people of the Columbia Plateau and the Pacific Northwest. One of the main

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67. (...continued)
Printing Office, [1961], 14, 184, 186.

68. United States Department of the Interior, Bureau of Reclamation, *Federal Reclamation Projects, Statistical Appendix to 1965 Crop Report and related data*, (U.S. Government Printing Office, 1966), 15, 196, 198; United States Department of the Interior, Bureau of Reclamation, *Federal Reclamation Projects, Water & Lands Resource Accomplishments, 1975, Statistical Appendix I*, (U.S. Government Printing Office, [1976]), 16, 249, 251; United States Department of the Interior, Bureau of Reclamation, *1985 Summary Statistics, Vol. I Water, Land, and Related Data*, (U.S. Government Printing Office, [1986]), 62, 65, 118.

69. United States Department of the Interior, Bureau of Reclamation, *1992 Summary Statistics, Water, Land, and Related Data*, (Denver: U.S. Government Printing Office, 1995), 60, 63, 152.

benefits derived from the project is irrigation. Although designed to supply water to more than 1,000,000 acres, the current development is limited to just over 500,000 acres. In 1992, more than 530,000 acres on more than 2,000 farm units received project water with a total crop value of over $552,300,000. Crops grown on project lands range from forage and cereal crops to fruit, vegetable, and seed crops.[70]

Another primary benefit of the Columbia Basin Project is power. Grand Coulee's 27 generators and 6 pump/generating units produce between 19 and 20 billion kilowatt hours (kWh) each year, making the Grand Coulee Power Complex the largest in North America. Power generated at Grand Coulee is marketed by the Bonneville Power Administration. Revenues from the sale of power generated at Grand Coulee not only help to repay the cost of the power development, but also a portion of the cost of the irrigation development on Columbia Basin Project as well as other Reclamation projects in the Northwest.[71]

The recreational benefits provided by the Columbia Basin Project are enormous. More than 300,000 acres of land and water are open for recreational activities within the project area. The project also supports numerous wetlands areas within the project boundaries. These wetlands areas provide havens for numerous species of waterfowl as they move along the Pacific Flyway, a major waterfowl migration route. A portion of the project near Potholes Reservoir is included in the Columbia National Wildlife Refuge. Recreational activities and fish and wildlife management activities in the project area are administered by the Bureau of Reclamation, the U.S. Fish and Wildlife Service, National Park Service, the Washington State Department of Fish

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70. *Ibid*., 152.
71. United States Department of the Interior, Bureau of Reclamation, *New Generations: A New Era of Power, Performance, and Progress*, (National Performance Review Power Management Laboratory, 1997), PN-E1 - PN-E5; *Project Data*, 384.

and Wildlife, the Washington State Parks and Recreation Commission, the Colville Confederated Tribes, and the Spokane Tribe.[72]

Grand Coulee Dam and Franklin D. Roosevelt Lake provide significant flood control benefits by regulating the flows of the Columbia River. The dam is operated to keep flows of the river to less than 450,000 cfs at The Dalles, several hundred miles downstream from Grand Coulee. Flood control operations are based upon river flow forecasts that are adjusted for available storage capacity in other reservoirs along the river. Flood control operations are conducted under a formal agreement between the Bureau of Reclamation and the U.S. Army Corps of Engineers. Since 1950, Grand Coulee Dam and Franklin D. Roosevelt Lake have prevented more than $206,000,000 in damage along the Columbia River. Major cities downstream from the dam that benefit from this protection include the cities of Richland, Pasco, and Kennewick.[73]

## Conclusion

Grand Coulee Dam and the Columbia Basin Project have secured an important place in the history of the United States. No other reclamation project in the United States and few in the world have endeavored to do so much. It is a project that more than any other shaped the development of the Pacific Northwest. And it's influence and benefits spread outward to touch almost all parts of the United States and, indirectly, the World. Few could argue the importance that Grand Coulee's generators played in defeating the Axis powers in World War II. Even

72. *1992 Summary Statistics*, 111, 116; *Project Data*, 384.
73. *Project Data*, 384; Memorandum: Van Den Berg, Max, Regional Manager of Resources and Technical Service [Pacific Northwest Region], To Manager, Water, Land, and Cultural Resources, 1995 Flood Control Benefits Report, (21 June 1996); Rand McNally & Company, *The New Rand McNally College World Atlas*, (Chicago: Rand McNally & Company, 1985), 184.

today, following the construction of the Third Powerhouse, Grand Coulee's hydropower benefits continue. The largest power generating facility in the United States and among the largest in the World, Grand Coulee's generators each year return revenues to the U.S. Treasury nearly equal to the entire budget of the Bureau of Reclamation. And the benefits extend beyond those of hydropower. Each year, the crops grown on the more than 500,000 acres of land currently under irrigation, total in value more than half a billion dollars. In size, benefits, and historical importance, there can be little doubt that Grand Coulee Dam and the Columbia Basin Project are, in the words of American folk singer Woody Guthrie, ". . . the biggest thing that man has ever done."

**About the Authors**

William Joe Simonds was born and raised in Colorado and has a clear understanding of the importance of water in the American West and its influence on the development of that region. He attended Colorado State University where he received a BA in History in 1992 and a Masters Degree in Public History in 1995. He lives with his wife and two children in Fort Collins, Colorado.

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