

# RECLAMATION

*Managing Water in the West*

U.S. Department of the Interior  
Bureau of Reclamation

## Grand Coulee Dam: *A Man Made Marvel*

[ wind ]

A century ago, many looked at the Columbia Basin as a vast wasteland. But a few dreamers saw something more, an idea to turn that harsh landscape into acres of farmland.

[ Music ]

These visionaries understood the potential of the Columbia River. The power to irrigate, create energy, and control flows would become a reality. But it would take decades of tenacity, manpower, and focus.

[ Music ]

The first really active person was an attorney named Billy Clapp, who was promoting the area. You know this is a long Western tradition to promote your area and try to get a settlement and try and get towns and try and get agriculture.

An attorney from Ephrata, Washington, Clapp saw an untapped potential in the Columbia Basin. In 1917, he proposed damming the Columbia just below the Grand Coulee. He befriended Rufus Woods, publisher of the Wenatchee Daily World, and Western attorney James O'Sullivan. The threesome became known as the Dam College and supported the idea of a high dam that would pump irrigation water into the Columbia Basin.

People don't realize, but by 1900 virtually every major dam site in the American West was already identified by the engineering community. They knew where the good dam sites were. Grand Coulee, of course, was a really good dam site in terms of reservoir size and also in terms of location.

Opponents felt the cost of providing power and irrigation into the unpopulated high desert of the West was too high.

So there were a lot of people saying, "Oh, we'll never be able to use this power. We'll never be able to use it." Well, of course, they were proven wrong.

The private power industry of course didn't want public power in competition with them, and naturally they were going to fight it. But there were many, many newspapers all over the world, especially in the state of Washington, who thought the whole project was a mistake. They thought that it was never going to pay for itself. Who is going to use all this power? There is no market for power from Grand Coulee Dam.

Despite opposition, Bureau of Reclamation engineers were directed to build a low dam in early 1933. This design, at 290 feet tall, would only generate electricity. Congress approved the \$63 million to excavate the riverbed and build the dam's foundation. Now work lay ahead for Reclamation to begin transforming the unused potential of the mighty Columbia River.

[ water flows ]

[ hammering ]

On a hot summer's day in 1933, Sanpoil tribal chief Jim James held a stake, while Washington governor Clarence Martin hammered it in. This signaled the start of construction and the beginning of the largest water project of the era. It also marked the center axis of a new dam that would straddle the Columbia River and bridge the boundary line between tribal and federal lands.

[ gravel drops ]

Six months later, the David H. Ryan Company and his subcontractors started excavation. Teams of men and heavy equipment worked round the clock to scrape the area down to the ancient river bed and haul it away.

Everything that's there on top of the bedrock has to be removed, and there's a general name given to all of this stuff, and it's called overburden. The overburden has to be carted away somewhere so that you get down to the solid rock. At the Grand Coulee, there was a lot of it.

Over 22 million cubic yards of earth and stone needed to be excavated before the dam's foundation could be built. The sheer size and scale of the project was unprecedented.

It wasn't an ordinary construction job.

It was a monumental project to contend with.

[ machinery ]

Soon after work began, Mason, Walsh, Atkinson, and Kier, a consortium of companies known as MWAK, won the construction bid for the dam and power plant. The next several months brought electricity to the dam site, supplied by the Washington Power Company, which ironically was an early opponent of the dam. Reclamation Chief Construction Engineer Frank Banks oversaw the construction of Grand Coulee Dam. One of the first tasks at hand was to provide the workforce with living quarters. Reclamation built Engineer's Town to accommodate government employees, while the construction laborers were housed in Mason City, which was built by MWAK.

When MWAK set up Mason City, well, of course it was an interesting time. They had barracks for the single man and housing for families as well. Across the river of course was the fancy quarters for the engineers. They built permanent houses there that are still being used. They had nice streets and beautiful headquarters for the engineers that worked on the dam. The early construction times were making headlines all over the country.

[ Music ]

As the need for workers increased, so did the need for housing.

Something like 14 towns were scattered around the Grand Coulee Dam area.

The scope of the project continued to expand with the addition of a government-run railroad line, a bridge over the Columbia River, and the entire supporting infrastructure.

[ Music ]

Right after New Year's Day in 1935, the first steel pilings were driven into the riverbed, forming a temporary dam called the West Cofferdam. The plan was to reroute the mighty Columbia River around the construction site, using the Cofferdam's steel walls to keep the water at bay so work could begin.

There were a number of engineers who said, no, you'll never tame that river. You won't be able to do it.

The Columbia River is a huge river. Nobody stops the Columbia River. The best you can do is on a low flow day you can push it to one side. That's the best you can do. And that's what they did.

They did through an ingenious plan of Cofferdams where they built this elongated, horseshoe-shaped structure that blocked part of the flow of the river. And then they began building the foundation in that area once it was drained of water. Very clever technology to do that.

It was winter, and the river was flowing at its lowest, making a Cofferdam easier to build. Laborers called pile bucks guided each metal sheet of the Cofferdam into place, while steam-powered sledgehammers drove them deep into the ground.

They would drive these into the underlying soil. They would take steel sheets and put them in between two of the beams and let the sheets go down and drive them into the soil. And they'd stack the sheets on top of each other, forming like a continuous steel wall.

The Cofferdams were the key to building the dam.

By late September, work began on the opposite shore. But a new challenge threatened to slow construction.

[ earth crumbles ]

Collapsing hillsides or abutments. These abutments anchored the dam and upheld its structural integrity. Continuous hillside sloughing had set back progress and hampered the removal efforts.

They'd take out a cubic yard here, and a cubic yard would come down and fill it back in. And they couldn't deal with that appropriately.

In ancient times, the winds in the east side of Washington State blew a fine dust into the area, which accumulated over the centuries and formed very good soil for growing. This is called loess. It's a German word. The problem with Grand Coulee is this substance, if you start digging in it, it tends to collapse in on itself. It is very hard to dig out. It can get to be a very tedious and sometimes disheartening job. The engineers came up with a unique solution to their problem of the hillside collapsing. They borrowed an old miner's trick of freezing the land.

The result was an ice-filled arch dam that froze the east abutment in place. Standing 40 feet high, the dam measured 15 feet thick and over 120 feet long. An ammonia solution kept the temperature between zero and 10 degrees Fahrenheit at all times. It held the hillside together while excavation

continued and the abutments were strengthened. Engineers estimated the frozen dam saved almost a million dollars in construct time alone. Grand Coulee was riding on the cutting edge of construction technology.

[ Music ]

During that period of course, there were innovations in the construction machinery. They got bigger and bigger steam shovels, bigger and bigger trucks. There were all kinds of new innovations that came along to make it more efficient. Nobody else had hauled that much dirt out of a dam site, and it was a great dam site.

It was no surprise then that contractors hired at Grand Coulee became ever more creative, this time using giant conveyer belts to get the job done. Dirt, rock, and loose gravel were carried two miles away to Rattlesnake Canyon on the west side of the river.

One of the solutions that the contractor found for dealing with the overburden was to haul it away on conveyer belts, and they developed a rather unique series of conveyer belts onto which they could load the overburden and have it shipped off to piles somewhere where it was out of the way. It was one of the innovations, and surprisingly enough conveyer belts turned to be an innovation throughout the construction of Grand Coulee Dam, moving rock and sand, concrete into the construction area. They became very good at using these large, extensive conveyor belts.

[ Music ]

[ water jet ]

With excavation underway, the bedrock was prepared and cleaned so concrete would adhere to it and secure the dam's foundation. As crews worked into the fall of 1935, the next construction phase would begin, placing concrete and lots of it.

[ concrete ]

Plans to build the almost mile-wide Grand Coulee Dam would use more concrete than any other construction project in the world at that time.

The most unique thing about Grand Coulee Dam was its size. It's big.

[ crowd cheers ]  
[ camera shutters ]

On a cold day in December, Washington governor Clarence Martin, dressed in overalls and a miner's cap, ceremoniously performed the new dam's first concrete placement. Then, working the fresh concrete into place, he made a show for the press and the assembled public. The slurry was a precise mixture of cement and aggregate taken from the nearby Brett Pit.

They got the aggregate locally right at the dam site. They got the sand locally. In fact, they had a problem with the sand and the aggregate, and they had to shake that where they separated these elements in order to get enough aggregate. And that pile is still there. It's like a geographic feature. There is a comical pile of sand that is almost as tall as the dam downstream of Grand Coulee Dam on river right.

To get good concrete, you need good aggregate. The glaciated deposits here were excellent for aggregate. And of course they would screen it for size, wash it, and then with those different aggregates, then they would make test mixes to come up with you know how much larger, medium, and smaller aggregates and sand. So you knew the concrete was going to be good if the batching was right.

The concrete was then mixed and placed into individual blocks that varied in size. To prevent the cement from overheating, each block contained cooling pipes.

Concrete generates heat as it cooled, and they had to use another trick to see that it cooled evenly and completely. Again, they ran pipes in each pour of concrete, and they ran a saline solution through those pipes so that it would cool evenly and not crack or break up as it generated heat.

After each bucket was poured, the concrete was vibrated to consolidate and eliminate rock pockets and trapped air bubbles. Once complete, the next block was prepared in succession.

It was just a whole series of individual block placement. But before that could be done, the previous block had to be sandblasted and cleaned with water jets and air jets and no dirt, no grease, no nothing on it. It had to be fresh blasted concrete for that next one to start off on so -- you know so water couldn't work its way through between the blocks. It had to be one mass when you were done.

>> You could take your breakfast and set it on that eat it off the foundation where they had cleaned it. They'd blow it. They'd dry it. They washed it would water. They'd scrub it if necessary. You could eat off it, and you wouldn't have grit in your food. That's how clean this would be, honestly.

While concrete crews were setting records building the dam, a dramatic change occurred in the plans for the dam's construction. After two years of political wrangling, Congress approved funds to build a high dam. The additional height would generate more hydropower revenues and help pay for the cost of the dam. Now contractors were faced with a new challenge to build a dam 550 tall with a foundation almost as wide. The higher dam would not only generate more hydropower, but would also deliver irrigation water and control springtime floods, protecting communities downstream.

[ Music ]

When complete, the larger dam would back up water almost 150 miles to the Canadian border.

But when you look at Grand Coulee Dam, you're actually looking at two dams, the low dam foundation and the high dam imposed on top of it.

[ machinery ]

[ Music ]

Sometimes in building, thousands of workers working together 6, 7, 8,000 people trying to stay out of each other's way, doing a job. I suppose from a distance it looked not so much like an anthill with people running around on scaffoldings, with tram cars riding across the temporary bridges that were built, booms carrying containers of concrete rising up and down, conveyor belts moving large amounts of concrete, moving sand, moving the raw cement.

If you're a worker in this process, there are a lot of problems. There are people moving heavy steel parts around you and moving the cranes. The communication with the cranes with all the noise was difficult. The people directing the work and the crane operators can't see each other. So they will typically have the person directing the work standing off to the side.

[ Music ]

A crane operator frequently more than half the time can't see the place where the hook on the crane is going, where the work is happening.

It would be difficult, hot work. You would be fatigued because they'd work full shifts with nothing but a half hour break to each lunch. And basically you couldn't go away, and if you decided that you needed to stop because you were too fatigued, they would replace you. There was no problem of that. This was the Depression, and there was no lack of people that they could replace you with, and they did.

Thousands of Depression Era workers were not alone in their interest in Grand Coulee Dam. A steady stream of curious residents and travelers from across the country watched the dam take shape. Grand Coulee was transforming the area, and its success was constantly in the news.

[ film projector ]

[ Music ]

Never in all history has any people built on a scale so colossal. The Public Works Program of dam construction, typified by the mighty Grand Coulee on the Upper Columbia River, is a program of such immensity as to be almost inconceivable.

>> They sold it as building the biggest thing on earth. This huge structure that was putting thousands of people to work at a time of great economic depression. They talked about how material and various parts from all 48 states came to Grand Coulee Dam to help in the construction, how workers came from all over the country to build this great dam. And there was pride in the United States building the most monumental thing on the planet at a time of Great Depression in the United States.

The program is sharing a fertile promised land, where only iron stretches now exist. The program is sharing limitless power, from which may rise a new and faster industrial empire, bringing prosperity equally to all the people of the 48 states. Grand Coulee alone will provide irrigation for more than a million acres of barren land. It will be the largest hydroelectric power development concentrated on the continent of North America.

[ Music ]

Movie news reels touted that the dream of unlocking the power and potential of the Columbia River was now becoming a reality, and America couldn't get enough.

It was a hot topic because it was so big, and there was nothing like it. It was just made to order for publicity.

Grand Coulee was really important to the Roosevelt Administration because it was a big public works project, and in those days you got your news from news reels and from the radio. They loved to feature Hoover and Coulee.

[ Music ]

It was a huge morale booster for the American people. This was sort of the height of Reclamation popularity because we were seen as putting people to work in an era when a lot of people were out of work.

[ Music ]

The \$130 million Grand Coulee Dam, largest in the world, is about to produce electricity 2 years ahead of schedule.

With the blueprints turned into concrete after 8 years' work, Governor Langley of Washington prepares to make dreams come true.

The big moment arrives. The governor throws the switch, and the first of 18 giant generators begins to make history and electricity.

The ultimate capacity of the dam is 2 and a half million horsepower, with lines of distribution far and wide.

[ Music ]

[ water roaring ]

On June 1st, 1942, water finally flowed over the completed spillway. Just 7 months earlier, Pearl Harbor was attacked.

[ gunfire ]

[ explosions ]

With America entering World War II, Grand Coulee's focus shifted from developing irrigation for agricultural needs to supplying power for the war effort.

[ canon fire ]

When December 7th came along, there was no question about what the country had to do. They postponed every kind of civilian activity to put people to work on the war.

For this was total war, and we realized victories were borne in the production line. We needed more ships, more planes, more tanks, more guns, more shells.

With the power plant works only half complete and energy demand for war production expected to soar, construction on the right powerhouse was suspended so that the left powerhouse and generators could be put online more rapidly. Plans for irrigating the Columbia Basin were put on hold as energy production took top priority. To that end, two generators were transferred from Shasta Dam, which was under construction, to accommodate the increased power demands at Grand Coulee.

[ Music ]

It was funneled into shipbuilding on the coast. It was funneled into aircraft building up in the Seattle area. And it was also funneled into the desert, where it just sort of disappeared into the Hanford Reservation, where they were manufacturing fissionable materials for the atomic bombs.

And that demand for power continue to increase after the war.

Subsequently, the huge amount of power in the Pacific Northwest altered the entire way the Northwest culture developed because they used electricity for home keeping and lots of things that other areas of the country didn't use it for. Now by the end of the war, Grand Coulee was only producing power. It wasn't producing irrigation water at that time.

[ Music ]

President Truman drives to the Grand Coulee Dam for the dedication ceremonies, which were the official reason for his cross-country whistle-stop tour. Dedicating the dam's lake, named for President Roosevelt, Mr. Truman says the Grand Coulee project is the reason the Northwest is America's fastest growing section.

[ Music ]

With the war over, irrigation was again a hot topic for the West. Proponents of the Columbia Basin once more focused their efforts on expanding the potential use of the mighty Columbia.

The goal of irrigating the Columbia Basin project was always there, just sidetracked for a few years during the war. The government then began working on building the pump station, putting in a number of rather unique generators, which can be used to pump water up the hill and from the reservoir it creates up the hill in Banks Lake. The water can during peak power periods be channeled down through these units to generate power. It's a very clever concept, and it gets water up the hill into the lake to then be channeled on down into the irrigation project.

Irrigation became a priority in the continual transformation of Grand Coulee Dam. It was an optimistic, hopeful time. And on May 7th, 1951, the first pump was started during a nation-wide radio broadcast.

Here comes the water from the Grand Coulee, rushing towards the dusty acres, under control.

[ water roaring ]

Thirty-four years after Billy Clapp proposed the taming of the Great Columbia River, the Columbia Basin irrigation project finally became a reality. Now water flowed south to create fertile farmlands in central Washington, while hydroelectricity lit homes and powered industries throughout the Northwest.

The Grand Coulee Dam is the key to the control of water on Donald Dunn's farm and on thousands of farms like it, covering an area larger than the state of Delaware. The dam was started 19 years ago to reclaim this wasteland. But its land-saving duty had to wait for the end of the war, while all Grand Coulee power flowed into the factories. Now there is power available for the great pumps, and soon water will flow along the pipes into the waiting conduits, bringing life to a million dead acres.

With irrigation development in full swing, Grand Coulee entered yet another phase. Engineers believed an additional power plant and greater coordination with new Canadian dams upstream could further expand the Columbia's potential. A third power plant would enhance flood control measures and significantly enlarge Grand Coulee's power generating capacity.

They started working with Canada, and they began working on a treaty. And the idea there was that dams would be built upstream in Canada. Those dams themselves could generate power, and they could provide water supply to Lake Roosevelt and Grand Coulee. And so they could increase the water supply by storing it.

The United States signed the Columbia River Treaty with Canada in 1964, and President Lyndon Johnson approved the construction of the third power plant in June of 1966. To make room for the new powerhouse, homes in Mason City built below the dam were dismantled or moved. Then demolition teams blasted off the right abutment and part of the dam itself.

[ explosion ]

But it was huge. I mean they blew the end off of Grand Coulee Dam to attach that thing. We were impressed that they had actually dynamited off. They'd used explosives to remove the end of Grand Coulee Dam in order to make that channel. Now you know that's not the kind of thing that people do lightly. That's like performing surgery with a chainsaw. That's -- that was really impressive that they were able to do that economically. And well, you know clearly it worked. It worked very well.

Reclamation structural designers made sure everything in the third power plant was oversized and designed for large capacity. After extending the dam by 1100 feet, crews set to work building a 20-story power plant that held six 40-foot diameter penstocks to direct water into stainless steel turbines four stories underground. The oversized turbine blades rotated inside 70-foot diameter generators, weighing over 120 tons apiece. The new power plant hardware was truly larger than life.

Don't forget. No one had built anything remotely as big as Grand Coulee Dam. The shaft bolts on the third power plant units are 5 or 6 inches in diameter. The nuts, to move a nut for a bolt that holds the couplings on the shaft on the third power plant units, they drilled and tapped the nut, and they put an eye hook in it so they could lift it with a crane. They weigh hundreds of pounds. They are huge.

Reclamation put to work the country's best hydropower engineers to expand the dam's ever larger generating capacity. Adding to the power plant's stature, world-famous architect Marcel Breuer lent his creative energy to the power plant inside and out.

[ Music ]

Columbia, Columbia, this is Houston AOS, over.

The race to put a man on the moon was no doubt the most visible facet of our increasingly heated competition with the Soviet Union. But while the world's attention was focused on space exploration, the U.S. battled for supremacy in another area, hydropower generation.

The third powerhouse was politically very important for Reclamation and the United States because Russia had just put a huge power plant online. This sort of challenged Reclamation's Washington office to come up with a way of one-upping Russia.

They decided, well, can you make one that's 400? Can you make one that's -- can you make one that's 600? Well, let's do 700. I mean it -- since they had the volume of water, just make some big ones.

And big they were, three 600 and three 700 megawatt generators were installed in the third power plant between 1975 and 1980. Upgrades in the 1990s expanded its power capacity to an impressive 805 megawatts on three generators. Today the third power plant generates 2/3 of the energy produced at Grand Coulee.

The third powerhouse for a time was the largest power plant in the world. And if you combined it with the left and right powerhouses already at Coulee, it was a big power plant.

It made you proud of what you were doing because it was a project that wasn't being done in every state. It was one of a kind.

Installation of the last giant generator marked the completion of the third power plant, and over five decades of continuous construction, growth, and activity at Grand Coulee. For over 20 years following, the completed dam was known as the largest power plant in the world. Today it continues to be the largest hydropower plant in the United States, promising to exceed its generating capacity in the years to come.

[ Music ]

Even Grand Coulee Dam's success as a hydropower giant and agricultural dynamo could not eclipse the loss of Native fish runs that had once traveled freely up the Columbia River and its tributaries. This had a devastating impact on the Colville and Spokane tribes, whose traditions and cultural ties to the land, water, and wildlife were disrupted. By 1937, the dam's slow rise from the riverbed had completely halted salmon, steelhead, and other species from reaching important tribal fishing sites like Kettle Falls on the Columbia River and Little Falls on the Spokane River. Tribal members could no longer fish for this most valued commodity on which they depended. The annual salmon runs that anchored the tribe's yearly schedules, including the timing of their most important ceremonies, were gone.

[ Music ]

In addition, land was cleared for the dam site and reservoir. This impacted more than 3,000 homesteaders and Native Americans who were displaced during the early design and construction phase. Tens of thousands of acres were cleared, at a cost of over \$10 million. Prime bottom land, where Native Americans and pioneers had been living, hunting, and fishing for generations. Both the Colville and Spokane tribes were asked to relocate the remains of their ancestors by moving them to new cemeteries on higher ground. To compensate for this loss, Colville Confederated tribal members receive a portion of Grand Coulee's hydropower revenues each year. The Spokane tribe is also actively seeking similar funds through the Equitable Compensations Settlement Act, currently under consideration by Congress.

[ machinery ]

In the 50-year span of construction work at Grand Coulee Dam and the third power plant, 81 men lost their lives.

You know we had some tragedies. We had a form on the main dam break and go down, take some people with it.

[ Music ]

You know a lot of people were killed, mainly by falls during the construction days. They were real tragedies. The father who dropped something, and his son was killed down below. Some men fell in the river and were drowned. But the majority of it came from falls. There weren't anybody buried in the concrete. You always get asked that question.

[Singing] I clumb the Rocky Canyon where the Columbia River rolls, seen the salmon leaping, the rapids, and the falls. The big Grand Coulee Dam in the state of Washington is just about the biggest thing that man has ever done.

[ Music ]

A challenge to Reclamation engineers to match the wonders of the Ice Age, to duplicate the glacial dam which centuries before had blocked the Columbia, to make a million acres bloom anew, to build an industrial empire from the wasted power of the Columbia. Not useless leaf raking, but productive public works. They moved mountains and froze the landslide, laid down 10 million yards of concrete.

[ Music ]

The most amazing thing about Grand Coulee Dam, the contractors of this huge project finished on time and under budget, and that's an amazing fact about Grand Coulee Dam. Think about that in comparison with contemporary large projects.

[ Music ]

Today as we marvel at the accomplishments of America's engineering pioneers, we look to the future and wonder how modern engineers might continue to unlock the Columbia River's potential. Grand Coulee, providing America with renewable, sustainable energy for decades to come.

[ Music ]