orange peel bucket. Master Mechanic N.E. Fordham was assigned to this work by the Denver office. To make certain that no stream flow would pass over the spillway while the job was in progress and thus drown out work at the base of the dam; it was decided also to lower the reservoir to elevation 5,330 as soon as it could be done. This could be accomplished by October 1st the close of the irrigation season, when discharge through the power plant was ample for stream flow requirements below the reservoir.

EXCAVATION: The excavation at the inlet of the pipes was a tedious job. The 1 1/2-inch cableway that had been used for the installation of the 58-inch valves in 1914 was moved above the dam on a line at right angles to the radius bisecting the two 42-inch pipes and 10 feet above the inlets to the pipes. A 3/4 cubic yard orange peel bucket was purchased in Denver and the three drum electric hoist rented from General Machinery and Supply Company of Denver, Colorado. The excavated material was dumped on a 12 foot x 16 foot homemade barge which was hauled about 1,000 feet upstream by a gas launch made by the power plant crew. The photograph on page 61 gives an idea of the layout. Excavation was slow as the hoist speed was slow, towing the barge was slow, and windy weather stopped the work because of waves. Excavation started October 12th and was completed November 21st. Mr. Fordham estimated that 800 to 1,000 cubic yards were excavated.

THE BALL: While work on excavation was in progress a new wooden ball was made in the Powell shop. Drawing 13-Y-3277.04 shows the details. The material was native cottonwood except the end segments which were oak. The layers were mostly 3-inches thick, six segments to a layer. After the rough ball was bolted together it was mounted on a shaft and turned true to shape on an extension to the iron cutting lathe in the rigging of which Master Mechanic L.L. Ruhlen showed much ability. After being turned true the center was filed with a 1:3 Portland cement grout and the outside covered first with a 1/2-inch thick felt layer and then a canvas cover.

THE BULKHEAD: Drawing No. 26-D-354 shows the details of the structural steel bulkhead. Pressure of the water on the bulkhead is relied on to seat the lead gasket around the periphery tightly against the end of the cast steel liner. The same pressure was relied upon the seat the lead gasket over the crack between the successive beams. The principal chances taken in the design were that the liner might not be truly round or that the end might not be a plane. Thanks to careful manufacture or inspection when these were made they were found to be true.

SEATING THE BALL: Excavation was completed the 21st of November. The cableway lines were rerigged, and on November 25th an attempt was made to seat one of the old balls used when building the power plant. The attempt was unsuccessful probably because the ball was not quite close enough to the opening. With the south pipe shut off and the penstock open only about 50 second feet passed through the north pipe which quantity of water could cause but little entrance velocity at the head of the pipe and would require the ball to be exactly in position to be sucked into place. On November 27th a second attempt was made to seat the old ball. This time more accurate measurements of position were taken and provision was made to have a variable luff to the cableway so that the ball could be spotted to a nicety. This attempt was successful, as was a second attempt the same day, although on the second attempt the closure was not complete as a hole was torn out of the ball. With the knowledge that the modus operandi was well in hand, the new ball was lowered into position and successfully seated November 28th. Leakage past it at that time was estimated to be 2 ½ second feet.

PLACING THE BULKHEAD: With the ball at the inlet to the north pipe, advantage was taken of the first lull in power plant load to shut the plant down and install the bulkhead at the end of the 60-inch pipe. Such a lull is from Saturday midnight to Monday morning. During this interval the Gebo Steam Plant is able to handle the load. Accordingly at 11:00 p.m. on December 3rd the plant was shut down and the penstock opened for the purpose of installing the bulkhead. Very little deviation from the planned schedule occurred, and the job was completed and the plant back on line in thirty-five hours. The manhole on the 60-inch pipe was left open to discharge leakage past the ball and bulkhead. It was found to be discharging about 2 second feet the day after the closure job was completed.

TIGHTENING BALL: The above discharge was too much to handle easily in pipes, so shale was dumped around the ball. This reduced the leakage so that it could all be discharged through the 4-inch drain pipe at the bottom of the 60-inch pipe with little head. Time has tightened the bulkhead and also the leaks about the ball so at the present time the leakage past the bulkhead is 3 gallons per minute and that past the ball 10 gallons per minute. The one is easily handled by a 1 ½ -inch pipe line and the other by a 2-inch pipe line so that practically the entire length of pipe from ball to bulkhead can be dried up for painting and cleaning.

REMOVAL OF OBSTRUCTION: Upon examination of the penstock conditions were found to be about as follows:

From the ball to near the valve about a cubic yard of rock was strewn in small patches. The 48-inch valve passage way was choked practically tight with rocks and other debris and there was about one cubic yard above the valve. Among the debris was an iron oil barrel which was compressed so flat that it could be recognized only by the bung holes. Below the valve and up the slope of the taper bend there was about two cubic yards of rock. Between the bend and the end of the 60-inch pipe three was another cubic yard of rock in scattered patches. At the end of the 60-inch pipes there was a five cubic yard pipe of rocks, sand and gravel. The biggest rock above the valve was 14 inchesx18 inchesx20 inches. The removal of this debris took about a week. At the same time an examination was made of the internal operating mechanism of the 48- inch valve, and it was found to be badly broken. The break is supposed to have occurred on November 25th when the first attempt to seat the ball was made in consequence of attempting to open the valve from the power plant with the 4-inch bypass closed.

CONDITION OF PIPES: The 96-inch penstock section was found to be in tolerably good condition. Much of the original coal gas tar paint was s!J.ll in place although very brittle. Barnacles and rust showed principally on rivet heads and edges of steel plates. The 60-inch pipes were in much worse shape, being probably 25 or 30% barnacle covered. The inclined sections were nearly solidly pitted. The 42-inch pipe was very badly tuberculated. Some of the tubercular spots represented pits as large as a quarter and 3/16-inch deep, but most of them did not represent a very great amount of oxidation. The transition from 42-inch to 48-inch sections installed when the power plant was built was found to be in much worse condition with respect to pitting than the remainder of the pipe. The presumption is that the difference is due to a difference in quality of iron.

PAINTING THE PIPE: Bids for cleaning and painting the pipe were opened December 10th but they were rejected because of the high price and the inter-mixture of responsibilities between the government and the contractor that conditions made necessary. At the close of the year equipment is being assembled for doing the cleaning and painting by government forces.

VALVE REPAIRS: As soon as the valve damage became apparent its repair was made the main order of business. The cableway is being reconditioned, a new carriage for it is being made, and work on chipping out concrete around the old valve was in progress at the close of the year. To remove the valve it is necessary to remove the valve piston, and to remove the valve piston it is necessary to uncouple the steel pipe at the beginning of the taper bend below the valve house. Through all the work the concrete cofferdam built in 1931 has been of great value as a water ejector. It keeps it dry and work all around the lower end of the penstock pipes in the dry is possible.

Reclamation Act / Newlands Act of 1902

Reclamation Act/Newlands Act of 1902

The Reclamation Act (also known as the Lowlands Reclamation Act or National Reclamation Act) of 1902 (Pub.L. 57-161) is a United States federal law that funded irrigation projects for the arid lands of 20 states in the American West.

The act at.first covered only 13 of the western states as Texas had no federal lands. Texas was added later by a special act passed in 1906. The act set aside money from sales of semi-arid public lands for the construction and maintenance of irrigation projects. The newly irrigated land would be sold and money would be put into a revolving fund that supported more such projects. This led to the eventual damming of nearly every major western river. Under the act, the Secretary of the Interior created the *United States Reclamation Service* within the United States Geological Survey to administer the program. In 1907 the Service became a separate organization within the Department of the Interior and was renamed the United States Bureau of Reclamation.

The Act was authored by Representative Francis G. Newlands of Nevada. Amendments made by the Reclamation Project Act of 1939 gave the Department of the Interior, among other things, the authority to amend repayment contracts and to extend repayment for not more than 40 years. Amendments made by the Reclamation Reform Act of 1982 (P.L. 97-293) eliminated the residency requirement provisions of reclamation law, raised the acreage limitation on lands irrigated with water supplied by the Bureau of Reclamation, and established and required full-cost rates for land receiving water above the acreage limit.

Background

John Wesley Powell often considered the father of reclamation began, in 1867, a series of expeditions to explore the West. He saw that after snow-melt and spring rains, the rivers of the West flooded, releasing huge amounts of water and that for the rest of the year not enough rain fell to support any kind of real agriculture. He became convinced that irrigation was the only means by which much of the West could sustain population. He mapped locations for dams and irrigation projects. He found widespread support throughout the West, especially through the droughts of the 1890s.

Several private and local farming organizations proved the benefits of irrigation projects. However, when it became apparent that a greater effort would be required, Representative Francis G. Newlands of Nevada introduced legislation into the United States Congress to provide federal help for irrigation projects. The resulting act passed on June 17, 1902.

Newlands carried the bulk of the legislative burden and had strong technical backup from Frederick Haynes Newell of the Department of the Interior. President Theodore Roosevelt cobbled together the legislative alliances that made passage of the act possible.

It was later amended by the Reclamation Reform Act of 1982 (Pub.L. 97-293, Title II) to limit corporate use of water and speculation on land that would benefit from irrigation. Reclamation includes draining, too.

Summary of the Act

The full name of the act is *"An Act appropriating the receipts from the sale and disposal of public Lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands".*

Section One - This section identifies the 16 states and territories to be included in the project; Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming. It requires surplus fees from sales of land be set aside for a *"reclamation fund"* for the development of water resources. Also requires the Treasury Department to fund education from unappropriated monies under certain conditions.

Section Two - Authorizes the Secretary of the Interior to determine the reclamation projects.

Section Three - Requires the Secretary of the Interior to withdraw all such land from public entry.

Section Four - Authorizes the Secretary of the Interior to contract for the project with certain conditions. Also requires that the work day will be 8 hours and that no so-called *Mongolian* labor (unskilled laborers from Asia) will be used.

Section Five - Sets certain requirements for those using the water, including; half of the land must be for agriculture, user must pay apportioned charges, user cannot use more than the apportioned water, user cannot sell entire water to one neighbor or any water to a non-resident, and user must pay apportioned charges annually.

Section Six - Authorizes to Secretary of the Interior to use the reclamation fund for all works constructed under the act and to pass management of projects over to the users once they have paid.

Section Seven - Gives the Secretary of the Interior the power of Eminent Domain for construction projects.

Section Eight - Requires the Secretary of the Interior to conform to state laws with certain exceptions.

Section Nine - Requires the Secretary of the Interior to expend monies generated by each state within that state as much as is practicable.

Section Ten – Authorizes the Secretary of the Interior to make such rules and regulation as is necessary to carry out the provisions of the act.

Results of the Act

Below are listed the larger of the irrigation projects of the United States, with the area reclaimed or to be reclaimed as of 1925.

- *Arizona:* Salt River, 182,000 acres reclaimed
- *Arizona-California:* Yuma, 158,000 acres reclaimed
- *California:* Orland, 20,000 acres reclaimed
- *Colorado:* Grand Valley, 53,000 acres reclaimed; Uncompahgre Valley, 140,000 acres reclaimed

- *Idaho:* Boise, 207,000; Minidoka, 120,500 acres reclaimed
- *Kansas:* Garden City, 10,677 acres reclaimed
- *Montana:* Blackfeet, 122,500 acres reclaimed; Flathead, 152,000 acres reclaimed; Fort Peck, 152,000 acres reclaimed; Huntley, 32,405 acres reclaimed; Milk River, 219,557 acres reclaimed; Sun River, 174,046 acres reclaimed
- *Montana-North Dakota:* Lower Yellowstone, 60,116 acres reclaimed
- *Nebraska-Wyoming:* North Platte, 129,270 acres reclaimed
- *Nevada:* Truckee-Carson, 206,000 acres reclaimed
- *New Mexico:* Carlsbad, 20,261 acres reclaimed; Hondo, 10,000 acres reclaimed; Rio Grande, 155,000 acres reclaimed
- *North Dakota:* North Dakota Pumping, 26, 314 acres reclaimed
- *Oregon:* Umatilla, 36,300 acres reclaimed
- *Oregon-CaLifornia:* Klamath, 70,000 acres reclaimed
- *South Dakota:* Belle Fourche, 100,000 acres reclaimed
- *Utah:* Strawberry Valley, 50,000 acres reclaimed
- *Washington:* Okanogan, 10,999 acres reclaimed; Sunnyside, 102,824 acres reclaimed; Tieton (Teton), 34,071 acres reclaimed
- *Wyoming:* Shoshone, 164,122 acres reclaimed

Much of the West could not have been settled without the water provided by the Act. The West became one of the premier agricultural areas in the world. Bureau of Reclamation statistics show that the more than 600 of their dams on waterways throughout the West provide irrigation for 10 million acres (40,000 km^2) of farmland, providing 60% of the nation's vegetables and 25% of its fruits and nuts. Currently, the Bureau operates about 180 projects in the West.

Not envisioned by the act, Bureau of Reclamation dams support 58 power plants producing 40 billion kilowatt hours of electricity annually. Most of the large population centers in the Far West owe their growth to these power sources.

Reclamation Act/Newlands Act of 1902

The Newlands Act of 1902, named for its author Francis Griffith Newlands, Democratic Representative from Nevada, preceded the Reclamation Service, created in July 1902, which later became the Bureau of Reclamation. The bill allowed the government to undertake irrigation projects to establish farms for relief of urban congestion.

FIFTY-SEVENTH CONGRESS. Sess. I. CH. 1093-- June 17, 1902 [Public, No. 161]

CHAPTER 1093. -- An Act Appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands.

Be it enacted by the Senate and House of Representatives of the United States of

America in Congress assembled, That all moneys received from the sale and disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and ***Wyoming,*** beginning with the fiscal year ending June thirtieth, nineteen hundred and one, including the surplus of fees and commissions in excess of allowances to registers and receivers, and excepting the five per centum of the proceeds of the sales of public lands in the above States set aside by law for educational and other purposes, shall be, and the same are hereby, reserved set aside, and appropriated as a special fund in the Treasury to be known as the "reclamation fund," to be used in the examination and survey for and the construction and maintenance of irrigation works for the storage, diversion, and development of waters for the reclamation or arid and semiarid lands in the said States and Territories, and for the payment of all other expenditures provided for in this Act: Provided, That in case the receipts from the sale and disposal of public lands other than those realized from the sale and disposal of lands referred to in this section are insufficient to meet the requirements for the support of agricultural colleges in the several States and Territories, under the Act of August thirtieth, eighteen hundred and ninety, entitled "An Act to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts, established under the provisions of an Act of Congress approved July second, eighteen hundred and sixty-two," the deficiency, if any, in the sum necessary for the support of the said colleges shall be provided for from any moneys in the Treasury not otherwise appropriated.

***Section** 2.* That the Secretary of the Interior is hereby authorized and directed to make examinations and surveys for, and to locate and construct, as herein provided, irrigation works for the storage, diversion, and development of waters, including artesian wells, and to report to Congress at the beginning of each regular session as to the results of such examinations and surveys, giving estimates of cost of all contemplated works, the quantity and location of the lands which can be irrigated therefrom, and all facts relative to the practicability of each irrigation project; also the cost of works in process of construction as well as of those which have been completed.

***Section** 3.* That the Secretary of the Interior shall, before giving the public notice provided for in section four of this Act, withdraw from public entry the lands required for any irrigation works contemplated under the provisions of this Act, and shall restore to public entry any of the lands so withdrawn when, in his judgment, such lands are not required for the purposes of this Act; and the Secretary of the Interior is hereby authorized, at or immediately prior to the time of beginning the surveys for any contemplated irrigation works, to withdraw from entry, except under the homestead laws, any public lands believed to be susceptible of irrigation from said works: Provided, That all lands entered and entries made under the homestead laws within areas so withdrawn during such withdrawal shall be subject to all the provisions, limitations, charges, terms, and conditions of this Act; that said surveys shall be prosecuted diligently to completion, and upon the completion thereof, and of the necessary maps, plans, and estimates of cost, the Secretary of interior shall determine whether or not said project is practicable and advisable, and if determined to be impracticable or unadvisable he shall thereupon restore said lands to entry; that public lands which it is proposed to irrigate by means of any contemplated works shall be subject to entry only under the provisions of the homestead laws in tracts of not less than forty nor more than one hundred and sixty acres, and shall be subject to the limitations, charges, terms, and conditions herein provided: Provided, That the commutation provisions of the homestead laws shall not apply to entries made under this Act.

Section 4. That upon the determination by the Secretary of the Interior that any irrigation project is practicable, he may cause to be let contracts for the construction of the same, in such portions or sections are available in the reclamation fund, and irrigable under such project, and limit of area per entry which limit shall represent the acreage which, in the opinion of the Secretary, may be reasonably required for the support of a family upon the lands in question; also of the charges which shall be made per acre upon the said entries, and upon lands in private ownership which may be irrigated by the waters of the said irrigation project, and the number of annual installments, not exceeding ten, in which such charges shall be paid and the time when such payments shall commence. The said charges shall be determined with a view of returning to the reclamation fund the estimated cost of construction of the project, and shall be apportioned equitably: Provided, That in all construction work eight hours shall constitute a day's work, and no Mongolian labor shall be employed thereon.

***Section* 5.** That the entryman upon lands to be irrigated by such works shall, in addition to compliance with the homestead laws, reclaim at least one-half of the total irrigable area of his entry for agricultural purposes, and before receiving patent for the lands covered by his entry shall pay to the Government the charges apportioned against such tract, as provided in section four. No right to the use of water for land in private ownership shall be sold for a tract exceeding one hundred and sixty acres to any one landowner, and no such sale shall be made to any landowner unless he be an actual bona fide resident on such land, or occupant thereof residing in the neighborhood of said land, and no such right shall permanently attach until all payments therefor are made. The annual installments shall be paid to the receiver of the local land office of the district in which the land is situated, and a failure to make any two payments when due shall render the entry subject to cancellation, with the forfeiture of all rights under this Act, as well as of any moneys already paid thereon. All moneys received from the above sources shall be paid into the reclamation fund. Registers and receivers shall be allowed the usual commissions on all moneys paid for lands entered under this Act.

Section 6. That the Secretary of the Interior is hereby authorized and directed to use the reclamation fund for the operation and maintenance of all reservoirs and irrigation works constructed under the provisions of this Act: Provided, That when the payments required by this Act are made for the major portion of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby, to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior: Provided, That the title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided by Congress.

Section 7. That where in carrying out the provisions of this Act it becomes necessary to acquire any rights or property, the Secretary of the Interior is hereby authorized to acquire the same for the United States by Purchase or by condemnation under judicial process, and to pay from the reclamation fund the sums which may be needed for that purpose, and it shall be the duty of the Attorney-General of the United States upon every application of the Secretary of the Interior, under this Act, to cause proceedings to be commenced for condemnation within thirty days from the receipt of the application at the Department of Justice.

Section 8. That nothing in this Act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use, or distribution of water used in irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this Act, shall proceed in conformity with such laws, and nothing herein shall in any way affect any right of any State or of the Federal Government or of any landowner, appropriator, or user of water in, to, or from any interstate stream or the waters thereof: Provided, That the right of the use of water acquired under the provisions of this Act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right.

Section 9. That it is hereby declared to be the duty of the Secretary of the Interior in carrying out the provisions of this Act, so far as the same may be practicable and subject to the existence of feasible irrigation projects, to expend the major portion of the funds arising from the sale of public lands within each State and Territory hereinbefore named for the benefit of arid and semiarid lands within the limits of such State or Territory: Provided, That the Secretary may temporarily use such portion of said funds for the benefit of arid or semiarid lands in any particular State or Territory herein before named as he may deem advisable, but when so used the excess shall be restored to the fund as soon as practicable, to the end that ultimately, and in any event, within each ten-year period after the passage of this Act, the expenditures for The benefit of the said States and Territories shall be equalized according to the proportions and subject to the conditions as to practicability and feasibility aforesaid.

Section 10. That the Secretary of the Interior is hereby authorized to perform any and all acts and to make such rules and regulations as may be necessary and proper for the purpose of carrying the provisions of this Act into full force and effect. Approved, June 17, 1902.

Shoshone Project

The ***Shoshone Project*** is an irrigation project in the U.S. state of Wyoming. The project provides irrigation for approximately 107,000 acres (430 km^2) of crops in the Big Horn Basin, fulfilling the vision of local resident and developer Buffalo Bill Cody, who hoped to make the semi-arid basin into agricultural land. Buffalo Bill Dam on the Shoshone River impounds water for the project in Buffalo Bill Reservoir. In addition to its role in irrigation, the project provides flood control on the Shoshone and generates power, using the 350-foot (110m) height of Buffalo Bill Dam, once a world record, and the considerable fall of the river through Shoshone Canyon to generate hydroelectric power. Chief crops in the Big Horn Basin are sugar beets, alfalfa, barley, oats, corn and beans.

Establishment

At the end of the 19th century Buffalo Bill Cody settled in his namesake town of Cody, Wyoming, buying much of the surrounding lands. Cody promoted a plan to use the waters of the Shoshone to irrigate the plains of the Bighorn Basin extending eastward from Cody. Franklin Wheeler Mandell, later U.S. Senator from Wyoming, filed for the first water rights in 1893 but was unable to follow up on his project. Cody and his partner Nate Salisbury obtained a permit to irrigate 120,000 acres (49,000 ha) using three canals, but were in turn unable to construct the necessary infrastructure. Cody and local promoters again obtained water rights to irrigate 60,000 acres (24,000 ha) from the state of Wyoming in 1899 and attempted to build a private canal, but lacked sufficient resources. Following the passage of the Reclamation Act in 1902 the state urged the Department of Interior to take over the project. The federal government- backed Shoshone Project was authorized in 1904 by Secretary of the Interior Ethan Allen Hitchcock, based on the 1899 Cody-Salisbury permit. The project started the same year, administered by the Bureau of Reclamation. Work on Buffalo Bill Dam started in 1905. The small Ralston and Corbett dams were completed in 1908. Buffalo Bill Dam (known as Shoshone Dam until 1946) was completed in 1910 at a cost of $1.4 million, at a height of 325 feet (99 m), then the tallest dam in the world. The dam's height was extended by another 25 feet (7.6 m) to 350 feet (110m) in the 1990s, significantly expanding reservoir capacity.

Land was opened for settlement near Powell in the Garland Division, with extensive agricultural development by 1918. The Frannie Division was opened at about this time. The Willwood Division was opened to development between 1927 and 1938, while the Heart Mountain Division was not opened until 1947.

Administration

The project is administered in four divisions:

The ***Garland Division,*** with 35,863 acres (14,513 ha) of irrigated land, receives water diverted into the Garland Canal by the Corbett Diversion Dam on the Shoshone, 16 miles (26 km) downstream from Buffalo Bill Dam. The 18 miles (29 km) canal has a capacity of 1,000 cubic feet per second. The Garland Division is administered by the Shoshone Irrigation District, directed by local water users.

The ***Heart Mountain Division***, with 31,120 acres (12,590 ha) receives seasonal output from the Heart Mountain Powerplant, which discharges into an inverted siphon crossing the Shoshone River. The 26 miles (42 km) Heart Mountain Canal transports the water to users at a rate of 915 cubic feet per second. Portions of the Heart Mountain Canal were built with labor provided by the Civilian Conservation Corps from camp BR-72. Japanese American internees from the Heart Mountain Relocation Center worked on the canal in from 1942 until May 1944. Work was finally completed in 1947.

The ***Frannie Division,*** with 14,600 acres (5,900 ha) receives water from the Garland Canal through a branch canal, the Frannie Canal, which is 44 miles (71 km) long and carries 550 cubic feet per second.

The ***Willwood Division***, with 11,530 acres (4,670 ha) receives water from the Willwood Diversion dam on the Shoshone, 8 miles (13 km) downstream from the Corbett Diversion Dam. The Willwood Canal extends for 28 miles (45 km) and can deliver water at 320 cubic feet per second.

Power Generation

Waters impounded by Buffalo Bill Dam operate four power plants, two close to the dam's base and two others operated by water piped from the dam, taking advantage of the height change through Shoshone Canyon to place the power stations in the flats beyond the mountain canyon. The original powerplant, the Shoshone Powerplant, and what was initially intended to be a temporary Heart Mountain Powerplant, were supplemented and upgraded with the dam's increase in height from 1992-1994.

Shoshone Powerplant: Originally built in 1922, the Shoshone Powerplant is located in Shoshone Canyon 600 feet (180m) from the base of the dam, and operated until 1980. Units 1 and 2 came on line in 1922, Unit 3 in 1931. Installed capacity was 6.012 MW. All three units were shut down in 1980, worn out from fifty years of service. 1 and 2 were decommissioned and left in place, while 3 was replaced with a new 3 MW Francis turbine unit that started operation in 1992. The plant operates with a head of 220 feet (67 m).

Buffalo Bill Powerplant: The Buffalo Bill Powerplant was built concurrently with work to increase the dam's height by 25 feet (7.6 m) in 1992. The plant, located in Shoshone Canyon downstream from the original Shoshone Powerplant, operates a Francis turbine rated at 18 MW on a head of 266 feet (81 m).

Heart Mountain Powerplant: Located at the outlet of the Shoshone Canyon Conduit, the Heart Mountain Powerplant was built in 1947 as a temporary facility. It was rebuilt concurrently with the dam heightening project and is operated on a seasonal basis. It operates a 5 MW Francis turbine on a 265-foot (81 m) head. Located near a geothermally active area, construction of the tunnel proved difficult, with fumes contributing to the deaths of two construction workers in 1937.

Spirit Mountain Powerplant: The Spirit Mountain Powerplant receives pressurized water through a conduit. It primarily functions to dissipate the pressure in the conduit before it enters an open canal, generating power as a byproduct. The unit operates a Francis turbine generating 4.5 MW on a seasonal base load basis, with a 110-foot (34m) head. It was built in 1994.

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Glossary of Dam Building Terms

Glossary of Dam Building Terms

Abutment - That part of the valley side against which the dam is constructed. The left and right abutments of dams are defined with the observer viewing the dam looking in the downstream direction, unless otherwise indicated.

Acre-Foot - A unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet.

Adit - Man and equipment access shaft, coming from the side into a tunnel.

Appurtenant Structure - Ancillary features of a dam such as outlets, spillways, power plants, tunnels, etc.

Apron - Protective pad, usually concrete, below a dam.

Axis of Dam - The vertical plane or curved surface, chosen by a designer, appearing as a line, in plan or in cross-section, to which the horizontal dimensions of the dam are referenced. Horizontal center of a dam.

Barrel of Cement - Equal to four cubic feet or four sacks. Each sack is one cubic foot and weighs 94 pounds.

Base Thickness - Also referred to as base width. The maximum thickness or width of the dam measured horizontally between upstream and downstream faces and normal to the axis of the dam, but excluding projections for outlets, or other appurtenant structures.

Bedrock - The consolidated body of natural solid mineral matter which underlies the overburden soils.

Breach – An opening through a dam which drains the reservoir. A controlled breach is a constructed opening. An uncontrolled breach is an unintentional discharge from the reservoir.

Cavitation - The formation of a partial vacuum at the interface of fast-flowing water with a surface, typically at a point of turbulence such as a valve or impeller or immediately downstream from an obstruction or offset. Usually accompanied by noise and vibration, and is potentially destructive.

Channel - A general term for any natural or artificial facility for conveying water.

Cofferdam - A temporary structure to facilitate construction dewatering or to divert water away from construction, which is removed prior to completion of construction as part of construction phasing. Common types include steel sheet piles, earthen dikes, and water-filled bladders.

Concrete Arch Dam - A thin concrete arch which transmits the pressure to the sides (abutments).

Concrete Gravity Dam - Proportioned so its own weight provides the major resistance to the forces exerted upon it. Willwood and Corbett Dams are concrete gravity dams.

Conduit - A closed channel to convey water through, around, or under a dam.

Consequences of Failure - Potential loss of life or property damage downstream of a dam caused by floodwaters released at the dam or by waters released by partial or complete failure of dam; includes effects of landslides upstream of the dam on property located around the reservoir.

Contact Grouting - Filling, with cement grout, any voids existing at the contact of two zones of different materials, e.g. between a concrete tunnel lining and the surrounding rock.

Core - A zone of low permeability material in an embankment dam. The core is sometimes referred to as central core, inclined core, puddle clay core, rolled clay core, or impervious zone.

Core Wall – A wall built of relatively impervious material, usually of concrete or asphaltic concrete, in the body of an embankment dam to prevent seepage.

Crest of Dam - The lowest elevation of the uppermost surface of a dam, usually a road or walkway excluding any parapet wall, railing, etc.

Crest Width - The thickness or width of a dam at the crest level (excluding corbels or parapets). In general, the term thickness is used for gravity and arch dams, and width is used for other dams.

Cross Section - An elevation view of a dam formed by passing a plane through the dam perpendicular to the axis.

Cubit-Foot-Per-Second (cfs) - Often called a "second-foot," 450 gallons of water per minute.

Curtain Wall - In most cases, is a series of grout holes, a grout barrier in the foundation below a dam which increases the length of the percolation path. At Buffalo Bill Dam the curtain wall was similar to a retaining wall.

Dam - A Barrier constructed across a watercourse or off channel for the purpose of storage, control, or diversion of water. Types of dams are listed below.

a. Arch Dam: A concrete or masonry dam, which is curved upstream so as to transmit the major part of the water load to the abutments.

b. Buttress Dam: A dam consisting of a watertight part supported at intervals on the downstream side by a series of buttresses. Buttress dam can take many forms, such as flat slab or massive head buttress.

c. Concrete Dam: A dam constructed primarily of concrete, usually cast-in place but possibly including precast or roller-compacted elements. Types of concrete dams include arch, buttress, and gravity, among others.

d Live Storage: The storage volume of a reservoir that is available for use and lies above the invert of the lowest outlet.

e. Reservoir Storage Capacity: The sum of the dead and live storage of the reservoir.

f. Earth Dam: An embankment dam in which more than 50% of the total volume is formed of compacted earth material generally smaller than 3-inch size.

g. Gravity Dam: A dam constructed of concrete and/or masonry which relies on its weight and internal strength for stability.

h. Masonry Dam: Any dam constructed mainly of stone, brick or concrete blocks jointed with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.

i. Multiple Arch Dam: A buttress dam comprised of a series of arches for the upstream face.

j. Rockfill Dam: An embankment dam in which more than 50% of the total volume is comprised of compacted or dumped cobbles, boulders, rock fragments, or quarried rock generally larger than 3-inch size.

k. Roller Compacted Concrete Dam: A concrete gravity dam constructed by the use of a dry mix concrete transported by conventional construction equipment and compacted by rolling, usually with vibratory rollers.

L Saddle Dam (or Dike): A subsidiary dam of any type of constructed across a saddle or low point on the perimeter of a reservoir. When a saddle dam is above the water surface for the permanent storage pool, it may be referred to as a saddle dike.

m. Tailings Dam: An industrial waste dam in which the waste materials come from mining operations or mineral processing. The waste products are conveyed as fine material suspended in water to the reservoir impounded by the embankment. The embankment may be built of conventional materials but sometimes incorporates suitable waste products.

Dam Failure – The catastrophic breakdown of a dam, characterized by the uncontrolled release of impounded water. There are varying degrees of failure.

Design Water Level – The maximum water elevation including the flood surcharge, that a dam is designed to withstand.

Diversion Channel, Canal, or Tunnel - A waterway used to divert water from its natural course. The term is generally applied to a temporary arrangement, e.g. to by- pass water around a dam site during construction. "Channel" is normally used instead of "canal" when the waterway is short.

Drain, Blanket – A horizontal or gently sloping layer of pervious material placed to facilitate drainage of the foundation and/or embankment.

Drain Chimney – A vertical or inclined layer of pervious material in an embankment to facilitate and control drainage of the embankment fill.

Drain Toe – A system of pipe and/or pervious material along the downstream toe of a dam used to collect seepage from the foundation and embankment and convey it to a free outlet.

Drainage Area - The area draining to a particular point of study on a river or stream.

Drainage Curtain (also called Drainage Wells or Relief Wells) - A Line of vertical wells or boreholes to facilitate drainage of the foundation and abutments and to reduce water pressure.

Drawdown – The difference between a water level and a lower water level in a reservoir within a particular time. Used as a verb, it is the lowering of the water surface.

Erosion - The wearing away of a surface (bank, streambed, embankment) by floods, waves, wind, or any other natural process.

Face - Downstream side of a dam.

Fault - A fracture or fracture zone in the earth crust along which there has been displacement of the two sides relative to one another.

Fetch - The straight line distance across a body of water subject to wind forces. The fetch is one of the factors used in calculating wave heights in a reservoir.

Filter (Filter Zone) – One or more layers of granular material graded (either naturally or by selection) so as to allow seepage through or within the layers while preventing the migration of material from adjacent zones.

Flood - A temporary rise in water surface elevation resulting in inundation of areas not normally covered by water. Hypothetical floods may be expressed in terms of average probability of exceedance per year such as one-percent-chance flood, or expressed as a fraction of the probable maximum flood or other reference flood.

Flood Inundation Zone - The downstream area that would be inundated or otherwise affected by the failure of a dam or by large flood flows.

Flood Routing - A process of determining progressively over time the amplitude of a flood wave as it moves past a dam and continues downstream.

Flood Storage – The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel.

Freeboard - Vertical distance between the spillway crest and the lowest point of the top of dam, without chamber.

Gallery - A passageway in the body of a dam used for inspection, foundation grouting, and/or drainage.

Gate – A movable water barrier for the control of water.

a. Bulkhead Gate: A gate used either for temporary closure of a channel or conduit before dewatering it for inspection or maintenance or for closure against flowing water when the head difference is small, e.g., for diversion tunnel closure.

b. Emergency Gate (Guard Gate): A standby or auxiliary gate used when the normal means of water control is not available.

c. Outlet Gate: A gate controlling the flow of water through a reservoir outlet.

d Regulating Gate (Regulating Valve): A gate or valve that operates under full pressure flow conditions to regulate the rate of discharge.

e. Slide Gate (Sluice Gate): A gate that can be opened or closed by sliding in supporting guides.

Gate Chamber (Valve Chamber) - A room from which a gate or valve can be operated, or sometimes in which the gate is located.

Groin - The area along the contact (or intersection) of the face of a dam with the abutments.

Grout - A fluidized material that is injected into soil, rock, concrete or other construction material to seal openings and to lower the permeability and/or provide additional structural strength. There are four major types of grouting materials: chemical; cement; clay; and bitumen.

Grout Curtain - One or more zones, usually thin, in the foundation into which grout is injected to reduce seepage under or around a dam.

Head, Static - The vertical distance between two points in a fluid.

Headworks - Controlling gates and valves of a dam.

Heel - The junction of the upstream face of a gravity or arch dam with the ground surface. For an embankment dam the junction is referred to as the upstream toe of the dam. Upstream base of a dam.

Height - The maximum height from the lowest natural ground surface, which is typically on the downstream side, to the top of the dam.

Height, Structural - The vertical distance between the lowest point of the excavated foundation to the top of the dam.

Hydrograph, Breach or Dam Failure - A flood hydrograph resulting from a dam breach.

Hydrograph, Flood - A graphical representation of the flood discharge with respect to time for a particular point on a stream or river.

Hydrology – One of the earth sciences that encompasses the natural occurrence, distribution, movement, and properties of the waters of the earth and their environmental relationships.

Intake - Any upstream structure in a reservoir, dam or river through which water can be discharged.

Inundation Map - A map delineating the area that would be flooded by a particular flood event.

Left, Right Abutment - Left and right abutments are determined by looking downstream. Abutments are the point of contact between a cliff and dam.

Length of Dam - The length measured along the dam axis at the top of dam. This also includes the spillway, powerplant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam these structures should not be included.

Liquefaction - A condition whereby soil undergoes continued deformation at a constant low residual stress or with low residual resistance, due to the buildup and maintenance of high pore water pressures, which reduces the effective confining pressure to a very low value. Pore pressure buildup leading to liquefaction may be due either to static or cyclic stress applications and the possibility of its occurrence will depend on the void ratio or relative density of a cohesionless soil and the confining pressure.

Minimum Operating Level – The lowest level to which the reservoir is drawn down under normal operating conditions.

Notification – To inform appropriate individuals about a condition so they can take appropriate action.

Observation Well – A hole used to observe the groundwater surface at atmospheric pressure within soil or rock.

One-Hundred Year Flood – A flood that has 1 chance in 100 of being equaled or exceeded during any year.

Outlet – An opening through which water can be discharged.

Outlet Works – A dam appurtenance that provides release of water (generally controlled) from a reservoir.

Parapet Wall – A solid wall built along the top of a dam (upstream or downstream edge) used for ornamentation, for safety of vehicles and pedestrians, or to prevent overtopping caused by wave runup.

Phreatic Surface – The free surface of water seeping at atmospheric pressure through soil and rock.

Piping – The progressive development of internal erosion by seepage.

Probability – The likelihood of an event occurring.

Reservoir – A body of water impounded by a dam and in which water can be stored.

Reservoir Rim – The boundary of the reservoir including all areas along the valley sides above and below the water surface elevation associated with the routing of the IDF.

Reservoir Surface Area – The area covered by a reservoir when filled to a specified elevation.

Riprap — A layer of large uncoursed stone, precast blocks, bags of cement or other suitable material, generally placed on the upstream slopes of an embankment or along a watercourse as protection against wave action, erosion or scour. Riprap is usually placed by dumping or other mechanical methods and in some cases is hand placed. It consists of pieces of relatively large size as distinguished from a gravel blanket.

Risk – The relationship between the consequences resulting from an adverse event and its probability of occurrence.

Slope – Inclination from the horizontal. Sometimes referred to as ***Batter*** when measured from vertical.

Sluice – An opening for releasing water from below the static head elevation.

Spillway – A Structure over or through which flow is discharged from a reservoir. If the rate of flow is controlled by mechanical means such as gates, it is considered a controlled spillway. If the geometry of the spillway is the only control, it is considered an uncontrolled spillway.

a. Auxiliary: Any secondary spillway which is designed to be operated very infrequently and possibly in anticipation of some degree of structural damage or erosion to the spillway during operation.

b. Principal (or Service): A spillway designed to provide continuous or frequent releases from a reservoir, without significant damage to either the dam or its appurtenant structures.

c. Emergency: A spillway that is designed to provide additional protection against overtopping of dams, and is intended for use under extreme flood conditions or misoperation or malfunction of the service spillway and/or the auxiliary spillway.

Spillway Channel – An open channel or closed conduit conveying water from the spillway inlet downstream.

Spillway Crest - The lowest level at which water can flow over or through the spillway.

Stilling Basin – A basin constructed to dissipate the energy of rapidly flowing water, e.g., from a spillway or outlet, and to protect the riverbed from erosion.

Storage- The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel. Definitions of specific types of storage in reservoirs are:

a. Dead Storage: The storage volume of a reservoir that lies below the invert of the lowest outlet and that, therefore, cannot readily be withdrawn from the reservoir.

b. Flood Surcharge Storage: The storage volume between the maximum operating level and the design water level.

c. Maximum Storage: The sum of the reservoir storage capacity and flood surcharge storage.

Storm – The depth, area, and duration distribution of precipitation.

Sunny Day Failure - Failure from other than a large flood such as earthquake induced, structural weakness, piping, etc. The maximum operating water level is assumed.

Toe of Dam – The junction of the downstream slope of a dam with the ground surface; also referred to as the downstream toe. The junction of the upstream slope with the ground surface is called the heel or the upstream toe. Downstream base of a dam.

Trashrack – A device located at an intake to prevent floating or submerged debris from entering the intake.

Tunnel – A long underground excavation with two or more openings to the surface, usually having a uniform cross section used for access, conveying flows, etc.

Upstream Blanket - An impervious blanket placed on the reservoir flood and abutments upstream of a dam. For an embankment dam, the blanket may be connected to the core.

Valve - A device fitted to a pipeline or orifice in which the closure member is either rotated or moved transversely or longitudinally in the waterway so as to control or stop the flow.

Volume of Dam - The total space occupied by the materials forming the dam structure computed between abutments and from top to bottom of dam. No deduction is made for small openings such as galleries, adits, tunnels, and operating chambers within the dam structure. Portions of powerplants, locks, spillway, etc., should be included only if they are necessary for the structural stability of the dam.

Wave Runup - Vertical height above the stillwater level to which water from a specific wave will run up the face of a structure or embankment.

Watershed - The region draining into a river, river system or body or water.

Weir - An overflow structure built across an open channel to raise or control the upstream water level and/or to measure the flow of water.

a. Weir, Broad-Crested: An overflow structure on which the nappe is supported for an appreciable length in the direction of flow.

b. Weir, Measuring: A device for measuring the rate of flow of water. It generally consists of a rectangular, trapezoidal, triangular, or other shaped notch, located in a vertical, thin plate over which water flows. The height of water above the weir crest is used to determine the rate of flow.

c. Weir, Ogee: An overflow structure with its cross-section in the form of a reverse curve, shaped like an elongated letter "S". The downstream faces of overflow spillways are often made to this shape.