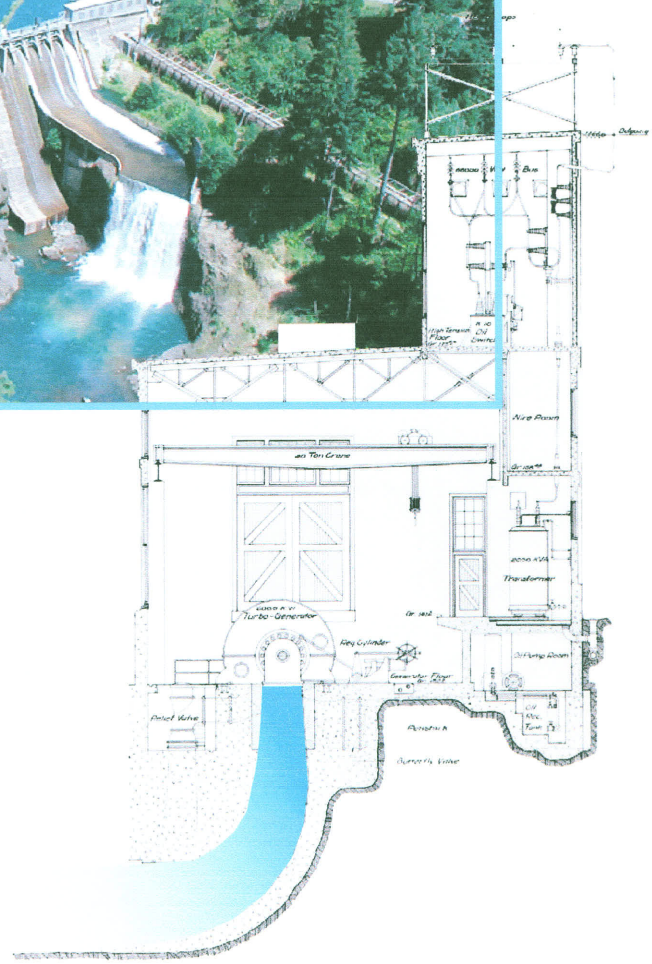


History

of the

Condit Hydroelectric Project

Prepared by
EDAW, Inc.

Prepared for
PacifiCorp

Prepared in Accordance with the
Historic American Engineering Record (HAER)

December 2002

CONTENTS

CONTENTS
(continued)

LIST OF TABLES

LIST OF GENERAL FIGURES

Note: Construction photographs are presented following Chapter 4.0, and Historical and Descriptive Figures are presented following Chapter 5.0. Separate photo/figure indices are included in Chapters 4.0 and 5.0.

1.0 HAER DATA SHEET

HISTORIC AMERICAN ENGINEERING RECORD

CONDIT HYDROELECTRIC PROJECT

1.1 DATA

Location: The Condit Hydroelectric Project is located on the White Salmon River in southern Washington State in Skamania and Klickitat counties. The project is located near the towns of White Salmon and Hood River, 3.3 miles from the confluence of the White Salmon and Columbia rivers, and about 65 miles from Vancouver, Washington, and Portland, Oregon (Figure 1-1). The project is situated at the lower end of a sparsely settled, narrow valley of the Cascade Range abutting the Gifford Pinchot National Forest (GPNF).

U.S.G.S. 7.5' Quadrangle Northwestern Lake, Washington

UTM References

	Zone	Easting	Northing
A	10	614550	5067400
B	10	613800	5069050
C	10	613700	50opp050

Date of Construction: 1912-1913

Engineer: B.C. Condit

Builder: Stone & Webster Engineering Corporation

Present Owner: PacifiCorp
825 NE Multnomah
Portland, Oregon 97232

Present Use: Hydroelectric Plant

Significance: The Condit Hydroelectric Project was among those listed on the "Hydroelectric Power Plants in Washington State, 1890-1938" multiple property listing filed in 1988 by the Washington State Office of Archeology and Historic Preservation (NPS, Undated). It is considered to be a significant example of an early 20th century, medium head hydroelectric facility in Washington State, designed primarily to provide power to a single industry. The Condit Hydroelectric Project provided electrical power over a long distance to the Crown Columbia Paper Mill in Camas, Washington, and to the City of Portland, Oregon. Several design features are noteworthy examples of design developments from the period. These include the unusually large penstocks, and especially the massive wood-stave flow line measuring 13.5’ in diameter for a distance of 5,100’ that, at the time of its construction, was reputed to be the largest pipe of its kind in the world. There have been a number of changes to the Condit Hydroelectric Project over the years; however, no element has been so altered that the integrity of the historic system has been compromised.

Historian: Mike Usen, September 2002

1.2 PROJECT INFORMATION SUMMARY

On September 22, 1999, PacifiCorp signed an agreement to remove Condit Dam. This agreement was the culmination of 2 years of negotiations with State and Federal agencies, American Whitewater, and 13 other environmental organizations. The agreement calls for removal of the 125’ tall concrete dam that since 1913 has diverted water from the natural channel, obstructing downstream navigation and blocking upstream fish passage. In 2002, PacifiCorp’s consultants prepared the Historic American Engineering Record (HAER) historical and architectural documentation of the Condit hydroelectric system as part of the overall documentation being undertaken in compliance with the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act (NHPA).

1.3 CHRONOLOGY

1910	Herbert and Mortimer Fleishhacher hire B.C. Condit to investigate possibilities of hydroelectric power supply for the Crown mills at Camas, Washington. Condit investigated the Lewis, Klickitat, and White Salmon rivers.
1911	Land and water rights for dam were acquired on White Salmon River in spring of 1911. Northwestern Electric Company incorporated July 14, by investors who owned Crown Columbia Paper Mill at Camas, Washington. First activity was to provide added power for the paper mill by building hydroelectric plant.
	Mortimer Fleishhacher negotiated agreement to acquire necessary land and water rights to White Salmon River for Northwestern Electric Company and acquired title to first 90-acre parcel on November 22 and 23.
1912	City of Portland granted franchise to Northwestern Electric Company to build Condit Hydroelectric Project and obtains franchises for distribution of light and power in the cities of Camas and Washougal. Mortimer Fleishhacher acquired remaining land and water rights for 2,250 acres on April 24. Northwestern Electric Company contracts with Stone & Webster Engineering Corporation for design and construction of Condit Project. Construction of Condit Dam initiated in early spring.
1913	Condit Dam and power generation facilities completed, with first generation on March 21. Electric substation in Portland also completed, allowing regional sales and distribution of surplus power from Crown Columbia Paper Mill
1914	Original wooden fish ladder washed out during a flood shortly after the project was completed; fish ladder was rebuilt.
1917	A new 66 kV transmission line was constructed to connect Pacific Power and Light's Powerdale plant at Hood River with the Condit plant.
1918	Second fish ladder washed out. This time, Northwestern Electric Company and Washington State Fish Commission agreed not to rebuild fish ladder.

1919	Northwestern Electric Company paid a sum of money as mitigation in 1919 to be used to construct a fish hatchery on the lower Columbia River.
1923	Replacement of the original wooden flow line support cradles with new wooden cradles of a different design was initiated. Transmission line to Camas extended to serve the industrial section of Vancouver, Washington. In addition, the apron at the tow of the dam was extended 8' to protect the dam's foundation.
1925	Experimental fish elevator (skip hoist) attempted.
1927	Modifications made to the dam to raise the maximum reservoir operating level from elevation 290' to elevation 295'. Two vertical lift gates were installed in place of the original bulkheads; original wooden flashboards on the spillway were removed and replaced with five steel radial gates and taller wooden flashboards. Other facility modifications included a new spillway apron below the tainter gates and a concrete overflow spillway that was constructed for the surge tank to replace the original wooden spillway structure. Also, a 73,000 volt, 600 amp oil switch was installed at the powerhouse.
1930	Pacific Power and Light built a 110 kV transmission line from Condit to connect with growing utility grid at Union Gap.
1933	Water overtops flashboards during December flood.
1947	Pacific Power and Light acquired Condit Project through merger with Northwestern Electric Company on May 31. The high voltage transformer was also re-located to an outdoor location north of the powerhouse from the original location on the top floor of the power station.
1962	Approximately 320' of original 13.5' diameter woodstave flow line ruptured on May 14. Approximately 4,000 linear feet of this flow line was replaced using in-kind materials. The work, which was completed on September 14, was covered by insurance. One of two original 9' diameter woodstave penstocks was also replaced with a welded steel penstock at the same time.
1963	Flashboards installed in 1927 were replaced in-kind with 10' high wooden flashboards having three trippable or removable sections and two fixed sections.

1968	Second 9’ diameter woodstave penstock was replaced in-kind. The Condit Project was issued its first operating license following enactment of the Federal Power Act.
1969	Independent consultant inspected dam.
1970	Geological reconnaissance of Condit Project was conducted.
1971	Dam drilling and testing program conducted.
1972	Dam was upgraded with various structural reinforcements; drainage improvements were made to diversion tunnel and into the two low-level sluiceways equipped with valves and pressure gauges to monitor seepage and uplift pressures, and flashboard tripping winch was relocated to ensure proper operation during flood conditions.
1974	January 16 flood of 143,000 cubic feet per second (cfs) overtopped the flashboards, spillway gates, and the floor of intake gate house. Flood water elevation reached 297.8’, exceeding reservoir forebay elevation of 295’.
1980	Generator unit 2 was rewound with no increase in generating capacity following localized flood event on April 1.
1983	Generator unit 1 was rewound with no increase in generating capacity.
1986	A 20 kW emergency power generator was installed to operate the spillway and intake gates should loss of station service occur, and a 45 kW emergency power generator was installed at the powerhouse to provide power for shutdown and restart of units should loss of station service occur; additional dam structural strengthening was carried out to address uplift, silt, and earthquake loads. The Condit Hydroelectric Project was also nominated for listing on the National Register of Historic Places.
1993	PacifiCorp's first federal license to operate Condit Project expired.
1995	A new Limitorque motor operator for radial gates 1 and 2 installed on spillway deck.
1996	FERC issued final Environment Impact Statement (EIS) requiring PacifiCorp to install $30 million worth of fish ladders and screens for fish passage.

1997	Flashboards replaced by a modern Obermeyer crest gate system after destruction by the February 1996 flood. The west vertical gate was removed and the log sluice plugged. PacifiCorp requested FERC to halt the relicensing proceedings to reach a settlement agreement regarding the conditions under which the dam could be decommissioned.
1998	PacifiCorp signed a Settlement Agreement with interveners to remove Condit Dam.
1999	New turbine runners installed in No. 2 generator. Steel support columns installed at flow line trestle.
2006	Power generation scheduled to cease followed by breach and removal of Condit Dam and support infrastructure.

Source: ESRI Data & Maps, 1999

Figure 1-1:

Location of Condit Hydroelectric Project and Northwestern Lake

Legend

- Roads
- County Lines
- Urbanized Areas
- Lakes and Rivers

N

10 0 10 Miles

EDAW

P:\1e002.01ConditHAER\gis\apr\region.apr

Back of Figure 1-1

2.0 INTRODUCTION

The Condit Dam and other components of the Condit Hydroelectric Project (initially named the White Salmon Project) were built in 1912-1913 on the White Salmon River. The project was designed to produce hydroelectricity to supply the Crown Columbia Paper Mill in Camas, Washington, and the growing municipal market from Washougal to Portland, Oregon. As a result of this development, paper production in Camas increased, electricity became available for the first time in the lower Columbia River valley, and the river level raised 98' in elevation to form what would later become a popular recreation lake. In addition, one unintended consequence of the project was the cessation of a run of salmon permanently blocked by the 125' tall wall of concrete forming the Condit Dam. Despite several novel but ultimately unsuccessful attempts to restore fish passage, the demise of this river's namesake fish run would ultimately result in the dam's removal just shy of a century after its installation in another historic undertaking.

2.1 PROPOSED ACTION

In 1999, 21 parties, including PacifiCorp, the National Marine Fisheries Service (NMFS), environmental groups, and the Washington State Department of Ecology, reached an agreement supporting removal of the Condit Dam as the most cost-effective way to restore fish passage. The agreement proposes to excavate a 12' high by 18' wide, low-level drain tunnel through the concrete base of the dam from the downstream side of the dam. When the final 15' is drilled and blasted in October 2006, the tunnel would discharge at a rate of 10,000 cfs, allowing the reservoir and impounded sediments to rapidly sluice downstream, lowering the reservoir to stream level in a 6-hour period (Espenson, 2002). Afterwards, the dam, flow line, surge tank, and penstocks would be demolished and removed from the site, restoring the river canyon to a more natural condition. Only the powerhouse structure, the operators quarters, and the pile of concrete debris formerly comprising the dam would remain when project removal is complete.

2.2 OVERVIEW OF PROJECT COMPONENTS

The Condit Project is located on the White Salmon River in the state of Washington, about 3 miles upstream of the confluence of the White Salmon and the Columbia rivers. The impoundment created by Condit Dam, known as Northwestern Lake, is approximately 2.3 miles long and has a surface area of 97 acres at a reservoir water surface at elevation 301.0' USGS datum or elevation 295.0' using PacifiCorp datum. The drainage area above Condit Dam is about 386 square miles. The gross storage capacity of Northwestern Lake is approximately 1,300 acre-feet. Through the life of the project, siltation has significantly reduced the reservoir's usable storage capacity. Under current operating criteria utilizing a maximum operating level of 294'6" and minimum operating level of 282.0', the usable storage capacity is 615 acre-feet (Black and Veatch, 2002).

The major components that comprise the Condit Project include the dam, flow line, surge tank, penstocks, and powerhouse (Figure 2.2-1). The dam is constructed between two rock walls of the river canyon, approximately 471' long at the top and 60' long at the bottom; it stands 125' in height. The dam is 96' thick at the bottom and 15' thick at the top consisting of about 30,000 cubic yards of concrete. The flow line consists of an exposed wood stave pipe 13.5' in diameter that runs along the east bank of the river. Its purpose is to convey water from the dam to the surge tank 5,100' downstream. The flow line is constructed of treated Douglas-fir staves supported by regularly spaced wooden cradles and steel bands resting on concrete mudsills. The surge tank is a 40' diameter hollow concrete tower approximately 48' tall. The top of the tank is 5' above the normal reservoir elevation. The surge tank includes outlets for two penstocks and an uncontrolled overflow vent discharging to a spillway. The upper section of the surge tank is octagonal with a peaked tin roof. Two 650' long, 9' diameter penstocks transmit water 160' in elevation from the surge tank to the powerhouse. One penstock is welded steel, and the other is wood stave pipe. The powerhouse is a rectangular building alongside the river, approximately 53' wide by 108' long. The building is a stepped, high-bay design, rising to approximately 60' at the rear (north) elevation and 50' at the front (south) elevation. Like the dam and surge tank, the powerhouse is constructed of steel-reinforced concrete mixed and poured on-site from locally quarried material. The powerhouse holds two turbine-generator units, the main transformer, circuit breakers, and other associated substation equipment with a combined peak output of 15 megawatts (MW). Each project component is described in detail in Chapter 5 of this report.

2.3 UNIQUE HISTORICAL SIGNIFICANCE

The Condit Dam was relatively large for its time but not exceptional. In terms of generating capacity, Northwestern Electric's White Salmon Project (the project's original name) ranked 12th in the west at the time of its completion at 12 MW according to a 1923 industry publication. Although much larger than many hydro power operations, the Condit Project is not unique for its size. A number of operations generated 20 MW or more, with the largest being Pacific Light and Power Corporation's Big Creek Nos. 1 and 2, which was completed the same year (Gallison, 1923).

If anything distinguished Condit from its predecessors, it was the massive flow line. As reported by an article appearing in Engineering News shortly after Condit's completion in 1913:

> "…while not conspicuous on account of its size (20,000 hp.) and general character of equipment, yet has one feature of unusual interest—what is probably the largest wood-stave pipe yet built. There is a mile of this, 13'6" in diameter, serving as a flow line from dam to forebay." (Engineering News, 1913).

The transmission line to Camas was the first to be built through the Columbia River Gorge. It also represented an early use of an aluminum line reinforced with steel. Its construction was complicated by the fact that there was no road along the north bank of the river. Materials and supplies were transported by steamer to various landings where they were hauled to the site by horses or, in particularly rugged places, carried by hand.

Source: PacifiCorp

Figure 2.2-1. Aerial Photomontage of
Condit Hydroelectric Project
August 11, 1989

3.0 HISTORICAL CONTEXT

3.1 HISTORY OF WHITE SALMON RIVER

3.1.1 Natural History

The White Salmon River takes its name from the steelhead and salmon runs that were abundant before the dam occluded passage to the upper river in 1913. The river flows through the southern Washington Cascade Physiographic Region, characterized by steep valleys, separating ridgecrests of similar elevations (Griffin and Churchill, 2001). Springwater fed by runoff from the Avalanche and White Salmon glaciers, two of Mt. Adams' ten glaciers, provides a significant source of water to the White Salmon River. Other snowmelt is collected by Cascade Creek and its tributaries, which contribute to the river's headwaters. As the river descends toward the Columbia, more tributaries contribute to its flow. Significant tributaries include Big Buck Creek at river mile (RM) 5, Rattlesnake Creek (RM 7.5), and Trout Lake Creek (RM 26), all of which join the White Salmon River upstream of Northwestern Lake, a 9,000 linear foot impoundment created by the Condit Dam (Entrix, 1991). Other tributaries include Buck, Mill, Little Buck, and Spring creeks (Griffin and Churchill, 2001).

From its headwaters on the southwestern slope of Mt. Adams to its confluence with the Columbia River, the White Salmon flows for 45 miles. In total, the White Salmon River drains a watershed measuring 386 square miles (Entrix, 1991). The river plunges approximately 6,800' in elevation on its southern journey toward the Columbia River (Griffin and Churchill, 2001). In places, the river's descent is as much as 500' to 700' per mile (McCoy, 2001). Much of the lower half of the river flows through a steep-sided basalt canyon, plunging over numerous falls. Today, the White Salmon River irrigates 4,000 acres of farmland while providing good trout fishing, kayaking, and scenery. Portions of the river above Northwestern Lake have been designated Wild and Scenic, and other portions of the river have been nominated for the federal Wild and Scenic designation. The 3-mile segment below the dam is included within the Columbia River Gorge National Scenic Area (Entrix, 1991).

3.1.2 Native American History

The lower White Salmon River flows through territory long populated by both the Eastern Chinookan-speaking Wishram, White Salmon, and Cascades people, as well as the Echeesh-Keen speaking Yakama and Klickitat people (Griffin and Churchill, 2001 p.26). The Columbia River Gorge and its major tributaries were used as residential and year round subsistence areas and as primary movement corridors by members of all these Native American groups. Both the Upper Chinookan-speaking and Echeesh-Keen-speaking peoples were characterized by locally autonomous villages with each band having a permanent village located along a section of the Columbia and/or White Salmon rivers. Subsistence activities for both groups generally followed a cyclical pattern. Both groups are thought to be similar, with the primary difference between the two being that the Upper Chinookan peoples relied on fish more than their Echeesh-Keen neighbors.

Geographic territorial boundaries between different peoples were crossed regularly for hunting, fishing, gathering, and trading activities (Griffin and Churchill, 2001).

The White Salmon River provided a focal area for harvesting Tule Chinook salmon in the fall (both dog salmon and any late-stage salmon) to add to winter staples for the long winter ahead (Griffin and Churchill, 2001). The Underwood area near the White Salmon's mouth was considered a primary Tule fishing area that attracted many families to the region each fall. This (i.e., winter village occupation) was the phase of the annual land use pattern that Lewis and Clark observed on their journey down the Columbia in 1805 (Griffin and Churchill, 2001).

The first Europeans to arrive in Washington and Oregon were seafarers from Europe and New England searching for Northwest Passage, or seeking wealth. In the 19th century, these maritime explorers were replaced by those who traveled on land. The United States government sent four surveying parties into the western territories. The most famous of these was the Lewis and Clark expedition, which passed through the Columbia River Gorge in October of 1805. Captain Lewis was the first white to record his observations of the White Salmon people. He wrote: "I observed several habitations entirely underground; they were sunk about 8' deep and covered with strong timbers and several feet of earth in conic form. They are about 16' in diameter, nearly circular, and entered through a hole in the top which appears to answer the double purpose of chimney and door" (McCoy, 2001).

Once Euro-Americans began settling in the Pacific Northwest in the mid-1800s, the Native people who had used this area for many millennia were relocated by a U.S. government eager to make these lands available for settlement. The government's method for achieving this objective was moving the tribes from areas desired by eastern settlers to reservations where they could be taught the skills the government felt they needed to become "civilized" (e.g., farming, blacksmithing, construction) (Griffin and Churchill, 2001). When Washington territorial Governor Isaac Stevens discussed the future formation of Indian reservations in the region with the Klickitat, Chief Yocatowit highlighted the importance of the White Salmon River area to the Klickitat people, stating:

> I now wish to speak to our father. I want to go into the country between the White Salmon, Klickitat, and Yakima rivers. There is plenty of fish, roots, berries, game and everything we want. It is also our own country-- the Klickitat's country, and here we wish to go and live. We're willing to go to the White Salmon river, and there and in the adjacent country lay in our stock of winter provisions… (Griffin and Churchill, 2001).

3.1.3 Euro-American History

The first white settler to file a claim on the north shore of the Columbia between the Cascades and the confluence of the Columbia and Snake rivers was Erastus Joslyns, in 1853. Joslyns selected the same site occupied by the White Salmon band, stirring Indian resentment that resulted in a raid by the Yakama and Klickitat Indians in 1856. Joslyns was not able to return to his farm until 1859 when the Klickitat Indians were relocated to a reservation built in 1856 by the U.S. Army (McCoy, 2001).

After the passage of the Donation Land Act of 1850, pioneers commenced laying claim to lands along the north bank of the Columbia River; however, Euro-American settlement along the White Salmon River didn't gain a real foothold until after the end of the Yakama War in 1857. Many of these early pioneers were speculators in townsites and transportation systems (Griffin and Churchill, 2001). Homesteads were established along the banks of the Columbia and White Salmon rivers, wherever soil fertile enough to produce good crops and a means to transport excess supplies to neighboring communities and river ports could be found. Frequently, these sites were desirable to the settlers for exactly the same reason that made them ideal winter villages for their original inhabitants. Desirable qualities included fertile soils and adequate water supply on sites low enough to be protected from the wind, but high enough to be above the flood zone. One example of such a site was the Amos Underwood homestead on the west side of the mouth of the White Salmon River. Amos Underwood operated a ferry that transported local produce across the Columbia River to local markets and established the town site that bears his name (Griffin and Churchill, 2001).

3.2 EARLY REGIONAL ELECTRICAL DEVELOPMENT

Commercial electrical production in the lower Columbia basin predated the Northwestern Electric Company by several decades. Electricity had been the major technological innovation since the early 1880s when its use as a power source for lighting and other applications was pioneered by Thomas Edison, George Westinghouse, Nikola Tesla, and others. Not only did Edison invent the incandescent light which demonstrated a universal application for electricity, he also organized the first power distribution system. Using technology devised by Tesla, Westinghouse successfully developed alternating current as an efficient way to transmit electrical current over significant distances, facilitating the hydroelectric industry in the west.

Commercial electric service was introduced to the west by entrepreneurs Parker F. Morey and Edward Eastham who jointly founded the Willamette Falls Electric Company in Oregon City in 1889. The new company made history in June of the same year by being the first to transmit direct current electricity over a relatively long distance to Portland 14 miles to the north. The same company made history the following year by pioneering the first long distance alternating current transmission (Wolner, 1990). By 1891, the company had been renamed to Portland General Electric and was building a growing business supplying electricity for street lighting and, later, electric trolley operations. By expanding its generating and distribution capacity through new development and acquisition of competitors, Portland General Electric quickly grew in size and influence, providing electricity and trolley service to a rapidly expanding but competitive regional market.

Following the Willamette Falls hydroelectric plant, 36 more hydroelectric plants were built on western rivers by the turn of the century. Most of these produced a small amount of electricity, generally to power lights or mining operations. Until the beginning of the

20th century, electricity was not generally considered a power source for industrial applications, which had relied on oil and gas. Likewise, the lack of electric appliances and agricultural uses for electricity limited residential or commercial demand (Gallison, 1923).

This began to change during the first decades of the 20th century when numerous new uses for electricity such as domestic lighting, industrial motors, electric appliances, and other new inventions became increasingly common. Power to meet these new demands was created by steam and hydroelectric generating stations, themselves utilizing rapidly evolving technological innovations. Prior to the turn of the century, only one hydroelectric project in the west had generating capacity of 7,000 kW, while half of these plants produced less than 1,000 kW with typical production capacity of less than 3,000 kW. As the hydroelectric industry developed, new technology and growing electric demands resulted in exponential growth in generating capacity. By 1913 when Condit was developed, 152 other hydroelectric plants had already been built in the western states, of which 115 were built since 1900. Most of these were considerably larger than their 19th century predecessors; however, only seven plants built after 1900 had generating capacity in excess of Condit's 12,000 kW (Gallison, 1923).

3.3 HISTORY OF CAMAS' CROWN COLUMBIA PAPER MILL

Unlike many of the early hydroelectric plants that were built to operate electric street cars and municipal lighting systems, the Condit Project was originally built to power a single industry, the Crown Columbia Paper Mill, located in Camas, Washington. Predecessors of the Crown Columbia Paper Mill had been located in Camas since 1883 when papermaking operations were relocated from the original mill site on the Clackamas River.

The Clackamas mill was founded as the Clackamas Paper Manufacturing Company by Henry Pittock and H.S. Buck to supply newsprint to Pittock's newspaper, the *Oregonian*. The Clackamas mill's production was hampered by the inadequate supply of rags and the imperfect methods of using straw in the paper making process. Its daily output was limited to only 1,500 pounds of paper, inadequate to supply the growing newsprint demands of the *Oregonian* and other regional newspapers. Pittock chose a site on the northern shore of the Columbia River approximately mid-way between the White Salmon River and Portland as a more suitable and productive site for his mill as well as a community to support the mill (Young, Undated).

With its lake, abundant clean water, adequate wood supplies, as well as a natural supply of waterpower, Pittock and his associates determined LaCamas (as the location was previously called) to be an ideal location to build their new mill. In 1883, they established the Columbia River Paper Company to build the mill as well as the LaCamas Colony Company to plan and build a new company town to support the new mill. The site soon proved adequate, and the new paper mill was built to produce up to 3 tons of newsprint per day, nearly quadruple the output of the Clackamas mill. Daily production was soon doubled to 6 tons, and the Columbia River Paper Company proved to be an immediate and profitable success (Young, Undated).

In November 1886, a fire of unknown origin swept through the Camas mill resulting in a complete loss of buildings, raw material, and finished products. In May 1888, the mill was rebuilt with all of the latest machinery and technology, allowing papermaking operations to resume later that year (Young, Undated).

The paper industry experienced a major financial crisis that peaked in 1892-93, leading to the bankruptcy of numerous mills across the region. By leasing the mill to new management, the Columbia River Paper Company was one of the few survivors of this crisis on the West Coast and productivity and growth were again resumed.

In 1897, Fred W. Leadbetter, Pittock's son-in-law, began leasing the Camas mill from the Columbia River Paper Company, later becoming instrumental in the merger with Crown Paper Company of Oregon City in 1905. This merger greatly expanded the size and capacity of the mill and resulted in a new company, the Crown Columbia Paper Company (Young, Undated).

In 1906, a bag factory was added to the Camas mill, providing the first real employment for women to join the labor force. A year later, the expansion of the mill began in earnest. By 1910, its production capacity had doubled to an annual paper production of 4 million pounds, making it one of the largest paper mills on the Pacific Coast (Foshay, 1913).

On July 14, 1911, the Crown Columbia Paper Company's owners incorporated the Northwestern Electric Company for the purpose of constructing a hydroelectric plant to provide additional power to the expanding paper mill. By 1913, electricity generated by the new hydroelectric plant on the White Salmon River facilitated converting the mill's primary power source from steam to electricity to further increase production capacity. The mill initially required 4,000 horsepower (hp) of electricity, roughly 20 percent of the power generated by the newly completed project (OAHP [Office of Archaeology and Historic Preservation], 1986). By the mid 1930s, the growing mill (then called the Crown Willamette Paper Mill) had increased its power consumption to 10,000 kW (LeFever, 1934).

The following year (1914), the Crown Columbia Paper Company merged with Willamette Pulp and Paper Company, to form the Crown Willamette Paper Company. In 1928, one of the largest companies on the West Coast, the Zellerbach Corporation, acquired the stock of Crown Willamette, and the ensuing merger created the Crown Zellerbach Corporation. Zellerbach's strategy was to create an adequate paper distribution system, while at the same time controlling the production of the paper itself, acquiring capacity through numerous mergers. By the 1930s, Crown Zellerbach was the strongest paper company on the West Coast and the second largest in the United States, with assets totaling more than $102 million. Crown Zellerbach produced more than 2,500 tons of paper per day in twelve mills. By the middle part of the century, Crown Zellerbach's Camas mill would become the largest specialty paper company in the world, manufacturing 400 different paper products (Young, Undated).

The Camas mill would remain part of Crown Zellerbach for nearly 60 years until forcibly acquired by British corporate raider Sir James Goldsmith in 1985. Goldsmith later sold off most of Crown Zellerbach 's paper mills, including the Camas mill, to the James River Corporation of Richmond, Virginia while retaining the 1.6 million acres of company-owned timberland. The James River and Fort Howard Corporations merged in 1997 to become the Fort James Corporation, creating the largest tissue producer in North America. Fort James sold the Camas mill to the Georgia Pacific Corporation, its current owner, in 2000. While the mill at one time produced specialty paper, napkins, and bags, it now produces computer paper, paper towels, and toilet paper (Center for Columbia River History website).

3.4 SUPPLYING THE LOCAL ELECTRIC MARKET

As anticipated by its builders, the supply of electricity provided by the Northwestern Electric Company to the Camas-Washougal area facilitated the tremendous expansion of the Crown Columbia Paper Mill and its successors. With a steady demand for electricity in Camas and a functioning transmission line to get it there, it made obvious sense for Northwestern Electric Company to enter into the distribution of light and power for general industrial, commercial, farm, and residential use to the region. By early l912, Northwestern Electric Company had obtained franchises for distribution of light and power in the cities of Camas and Washougal, in anticipation of the Condit Project's completion. Soon, this new supply of dependable hydroelectric power, augmented by steam-generated electricity as a standby, spurred other industrial development in the area, such as the Washougal Woolen Mills.

To sell and distribute the significant surplus power and electricity throughout the region, Northwestern Electric Company built a substation in Camas to step the voltage down to supply the local market in Camas and Washougal. It also built a 66 kW line to transmit surplus power to Vancouver, Washington, and another to Portland, Oregon, where it constructed additional step-down substations for local distribution to both electrical markets (LeFever, 1934).

Thanks in large part to Northwestern Electric Company's early market lead and favorable electric rates, its entire electrical service area developed to an unusual extent relative to other areas at the time. At the time, its average residential consumption in kilowatt hours was among the very highest in the United States.

By the time that Northwestern Electric Company was merged into Pacific Power and Light on May 31, 1947, Northwestern served 42,286 customers located in the towns and rural areas of parts of Cowlitz and Skamania counties in Washington and Columbia County in Oregon, as well as significant parts of Portland, Oregon, and Vancouver, Washington (PP&L, 1960)

3.5 SECURING ACCESS TO THE PORTLAND MARKET

The growing city of Portland, Oregon, offered a conveniently located and expanding market for the 80 percent surplus power not needed by the Crown Columbia Paper Mill or other local electrical customers. Steps were taken early in 1912 to secure a franchise in the City of Portland. This was contested by the Portland Railway, Light & Power Company and was referred to a public vote by the City Council, the voters approving the franchise by an overwhelming 15,000 votes out of 16,000 votes cast. Accordingly, a franchise for a 25-year period was passed by the Council, approved by the Mayor on October 1, 1912, and accepted by the Company on October 22, 1912. A 50-year franchise permitting the construction of electric lines on Multnomah County roads was then requested and was secured on April 26, 1915.

Properties necessary for the construction of a substation and the operation of a pole yard were purchased in the Albina district of Portland on December 24, 1912. Transmission line rights-of-way (ROW) across the Columbia River at Camas and on the south side of the river were secured; the transmission line from Camas to Portland, the Albina Substation, and the beginnings of a distribution system were constructed, and the first customer was given electric service in Portland in October 1913. To ensure reliability for this electric source, Northwestern also constructed an auxiliary steam-fired electric plant with sufficient boiler capacity for two 3,750 kW turbines. Steam, a byproduct of the electrical production, was sold for heating purposes to the main business sections of the city via a 25-year franchise agreement granted by the Portland City Council. Both the underground steam and electrical distribution lines were installed by Northwestern Electric at the same time (Foshay, 1913).

Unfortunately for Northwestern, the Condit Project's completion coincided with a severe economic downturn on the west coast which lasted from 1913 to 1915, resulting in 20 percent unemployment in Portland and reduced demand for electricity. Fortunately for the plant's builders, Northwestern Electric rates were lower than those of its competitor, Portland Railway Light & Power, allowing the new company to gain a foothold in the local electric market. Eventually, Northwestern Electric captured one-third of the market share (Dierdorff, 1971).

By 1925, when the stock of Northwestern Electric was acquired by American Power and Light, Northwestern Electric had 34,500 kilowatts of generating capacity at three locations—the Condit Project, the Pittock station, and the 15,500 kW Lincoln steam plant on the Willamette River south of the Portland core area. Revenues of Northwestern in 1925 amounted to approximately $2,500,000, obtained from 21,432 electric and 563 steam heat customers. Transmission facilities included 65 miles of 66,000 volt transmission and 310 miles of sub-transmission and distribution lines, including 43 miles of underground line in the Portland business district. In Camas, Washougal, and Portland, its operations dated from 1914, and its Vancouver, Washington, franchise dated from 1921 (Dierdorff, 1971).

3.6 HISTORY OF PROJECT OWNERSHIP

The Condit Project's initial financial backers were lead by paper and banking magnate Mortimer Fleishhacher of San Francisco. Fleishhacher and his brother Herbert are credited with hiring B.C. Condit, the project's namesake engineer, to investigate the hydroelectric potential of the region's rivers in 1910. With the specific objective of providing hydroelectricity to power the Crown Columbia Paper Mill at Camas, Fleishhacher secured water and property rights on at least two potential rivers with power development potential. On July 14, 1911, the owners of the Crown Columbia Paper Mill incorporated the Northwestern Electric Company for the purpose of constructing the hydroelectric plant to provide additional power to the expanding paper mill. The Fleishhachers remained majority shareholders in Northwestern Electric until their sale of the utility's common stock to the utility holding company American Power & Light in the 1920s. On May 23, 1947, Northwestern Electric was merged into Pacific Power & Light after review and approval by the Securities and Exchange Commission, the Federal Power Commission, and the State regulatory bodies of Washington and Oregon (Dierdorff, 1971). Pacific Power & Light was renamed PacifiCorp in 1984 to reflect the emergence of its coal mining and telephone business lines. PacifiCorp acquired Utah Power and Light in 1989. In 1999, PacifiCorp merged with UK-based ScottishPower. Today, the current owner of the Condit Project is one of the West's largest electric utilities (PacifiCorp website).

3.7 RELICENSING AND DAM REMOVAL

The Condit Project was originally licensed in 1968 after enactment of the Federal Power Act. PacifiCorp's first federal license to operate Condit Dam expired in 1993. The company continues to operate under annual licenses from the FERC until the agency issues a new license. In November 1996, FERC issued a final EIS that would require PacifiCorp to install $30 million worth of fish ladders and screens for fish passage. According to PacifiCorp, an operating license requiring fish passage facilities would make the dam uneconomical to operate, forcing the utility to reconsider its application.

In January 1997, PacifiCorp requested that FERC halt the relicensing proceedings to initiate discussions with the interveners in the FERC relicensing process with the intent to reach a Settlement Agreement regarding the available alternatives. These interveners included the Yakama Nation, the Columbia River Inter-Tribal Fish Commission (CRITFC), state and federal agencies, and numerous non-governmental organizations. Over the course of the next 2 years, the settlement discussions primarily focused on the methods and costs of removing the dam and addressing short-term impacts associated with the removal (pers. comm., Miller, 2002)

The Yakama Nation and the CRITFC believe that removal of Condit Dam is the best way to help rebuild salmon runs in the White Salmon River. The dam, which is situated 3.3 miles from the confluence of the White Salmon and the Columbia rivers, blocks salmon passage to spawning areas above it. Rather than adding fish passage facilities, removal of the dam is believed to be the most effective way to allow adult salmon to migrate upstream and juveniles to migrate downstream and would also help return the river to more natural conditions that are beneficial to salmon. Adjacent areas above the dam are relatively undeveloped; as a consequence, the upper portion of the White Salmon River has good salmon habitat.

A Settlement Agreement was signed on September 22, 1999 by PacifiCorp and the interveners. Under the terms of the Settlement Agreement, PacifiCorp would receive an amendment to extend the term of its existing license until October 1, 2006. During this time period, PacifiCorp would continue to operate the project until ceasing operations on October 1, 2006 and begin the process of removing the dam and project facilities. Assuming PacifiCorp is able to meet conditions specified in the Settlement Agreement (such as obtaining required permits, easements, contracts, etc.), PacifiCorp would complete the removal process by December 31, 2007.

Prior to dam removal, the Obermeyer spillway gate, vertical timber lift gate, and five radial gates located on the crest of the dam would be removed. To drain Northwestern Lake, PacifiCorp would excavate a 12’ high by 18’ wide tunnel near the base of the dam at elevation 174’ using drilling and explosives. The drilling would begin at the downstream face of the dam and continue through the dam until within 15’ of the upstream face of the dam. PacifiCorp would then excavate sediment and debris in the area directly upstream of the projected tunnel through the dam using a barge-mounted clamshell crane. Finally, explosives and drilling would be used to blast away the remaining 15’ of concrete. The contents of Northwestern Lake would gush through the resulting tunnel at 10,000 cfs, draining the entire reservoir to stream level within 6 hours.

Concrete excavated from the tunnel would be transported by truck to a disposal area located on Highway 141 about ¾ mile east of the dam. An access road would be constructed from the dam access road to the existing spillway apron deck.

Once the reservoir is drained, excavation would begin on the east end of the dam. PacifiCorp would remove pieces of the dam in a series of top slicing cuts at 10’ intervals. The two upper 10’ horizontal cuts of the dam, as well as sections along the downstream and upstream faces in each cut, would be blasted into 4’ deep by 6’ wide by 10’ high blocks and loaded with a highline yarder-type system onto trucks and hauled off of the dam to the disposal area. PacifiCorp would drill and blast the inner portions of the dam into rubble that would be loaded onto trucks with an excavator and hauled off the dam to the disposal area. As the top slice cuts would proceed below elevation 225’, a crane would be deployed to the spillway slab to hoist concrete from the lower area. As the excavation reaches the level of the drain tunnel, the center portions of the dam adjacent to the tunnel would be excavated down to the bedrock. The edges of the dam along the tunnel and the upstream and downstream faces would be left in place to keep the river flow out as the concrete is removed from within the edges of the dam. When the inner portions of the dam are removed down to the bedrock so that only the edges remain, the edges of the dam would be blasted into blocks and hoisted out of the river channel (FERC, 2002).

PacifiCorp would also remove the remains of the temporary cofferdams used during dam construction and all other major components of the project. These include the flow line, surge tank, and the wooden and steel penstocks. PacifiCorp would also remove the project's 230' long 669 kV transmission line. The powerhouse and associated parking area would be preserved, but the turbines would be removed and the tailrace filled.

Some of the pipeline and penstock materials could be recycled if it would be economical to do so. The remaining materials would be removed and trucked to the disposal area and buried. PacifiCorp estimates that the quantities of waste materials resulting from removal of the dam and appurtenant facilities would include more than 45,000 cubic yards of concrete, about 6,000 cubic yards (stacked) of wood pipe staves, more than 400 tons of steel, and an unknown amount of woody reservoir debris (FERC, 2002).

An access road would be constructed from the area near the top of the excavated dam down to the area of the cofferdams. Other access roads would be constructed for removal of the flow line. PacifiCorp estimates that access road construction would require 2,000 to 3,000 cubic yards of fill material. PacifiCorp states that the fill could be acquired from the spoil area and later back-filled as the construction is restored (FERC, 2002).

4.0 PROJECT HISTORY

4.1 EARLY PROJECT HISTORY

4.1.1 Site Selection

The project's namesake and designer was B.C. Condit, a consulting engineer from San Francisco sent to the Northwest in the summer of 1910 by Herbert and Mortimer Fleishhacher. The Fleishhachers, members of a prominent San Francisco banking and paper family, were financially interested in the pulp and paper industry. They retained Condit to investigate possibilities of hydroelectric power supply for the then called "Crown" mills at Camas, Washington. Condit investigated the Lewis, Klickitat, and White Salmon rivers, purchasing some land and making some preliminary investigation on each river.

The White Salmon River with its steep gradient, large and steady flow, and narrow canyon was determined by Condit to provide a suitable site for hydroelectric exploitation to power the Crown mill. Notice of appropriation of 2,000 cfs of water at the site of the Condit Project was filed on March 16, 1911, and 22 parcels of land aggregating approximately 375 acres were purchased, including rights to build dams, booms, and piers elsewhere on the river, from R.D. Cameron between April 15 and June 24, 1911 (LeFever, 1934).

In addition to the White Salmon River, the neighboring Klickitat River was also under serious investigation as a power source. Soon after notices of appropriation of water were filed and several possible parcels were identified for acquisition, numerous competing claims were filed by potential competitors. A flurry of legal action ensued as newly organized irrigation companies, utilities, and others pursued their own right to the Klickitat's flow. Legal considerations rather than technical ones ultimately steered Northwestern Electric Company to develop the White Salmon and not the Klickitat. When forced to choose between an apparently long legal battle to allow development of the Klickitat site versus the necessity of prosecuting one condemnation suit of comparatively minor importance at the White Salmon site, Northwestern made the expedient choice. Once this decision was finalized in the latter part of 1911, the company stepped up its investigations on the White Salmon site.

4.1.2 Early Legal Challenges

When it became evident that Northwestern Electric Company's construction activities had been transferred to the White Salmon River, Klickitat Irrigation and Power Company, a rival utility, filed suit for the condemnation of Northwestern Electric Company's rights to the use of the waters of that stream. In response, Northwestern completed legal preparations for combating this action, but the suit was dismissed by the plaintiff on the eve of the trial. Klickitat Irrigation and Power Company later endeavored to obstruct Northwestern Electric Company's progress by opposing the granting of transmission line ROW across public lands before the Secretary of the Interior. Klickitat Irrigation and Power Company also attempted to introduce adverse legislation before the

Washington Legislature but was unsuccessful in both undertakings due to the militant opposition of Northwestern Electric Company's attorneys (LeFever, 1934).

The difficulties with the Klickitat Irrigation and Power Company would not be completely resolved until within one month of the project's completion. This was finally achieved through a compromise on February 24, 1913, when Klickitat Irrigation and Power Company quitclaimed all of its interest as an appropriator of the waters of the White Salmon River to Northwestern Electric Company, and Northwestern Electric Company, in turn, quitclaimed its rights to water in the Klickitat River 2 days later to Klickitat Irrigation and Power Company.

4.1.3 Acquisition of Site and Transmission Line ROW

On November 22, 1911, Mortimer Fleishhacher negotiated an agreement to acquire the Wind River Lumber Company's holdings on White Salmon River for Northwestern Electric Company and acquired title to the first 90-acre parcel the following day. This agreement also included all capital stock of both the White Salmon Boom and Improvement Company and Frost Improvement Company.

Having made its decision to develop the project on the White Salmon River and having begun the process of assembling the needed land and water rights, Northwestern Electric initiated the preliminary survey of a transmission line between the White Salmon River and Camas. The first transmission line surveying crew was placed in the field on December 2, 1911, starting at the river, and a second crew was started east from Camas a few days later (LeFever, 1934).

Concurrent with the survey of the transmission line, active work on the purchase of the transmission line ROW, between the Condit plant and Camas, was begun in February 1912. One easement was secured in the Forest Hill section as early as December 23, 1911, and permission to cut trees along the streets of the town of Washougal had also been secured in that month. Purchase of this ROW was practically complete by the end of 1912, and the remaining parcels were secured early in 1913. This required twenty-one condemnation suits to be filed, fourteen of these being settled and seven being pressed to successful conclusions in the Skamania County Courts.

One difficulty encountered in securing the ROW was that the route traversed valuable stands of timber. Since it was necessary for the Northwestern Electric Company to cut this timber out to a distance of 150' to 200' on each side of the line, the value of the lost trees sometimes far exceeded the value of the land required by the ROW. There were instances such as on one tract where Northwestern Electric Company had to cut one million board feet of timber.

Construction of the transmission line was begun in September 1912 and was pressed rapidly to completion, with the result that electric service was first rendered by Northwestern Electric Company in the Camas-Washougal district in May 1913.

4.1.4 Stone & Webster Engineering Corporation Hired

By January 1, 1912, negotiations had been opened with the Stone & Webster Engineering Corporation relative to the design and construction of the dam and powerhouse. On January 19, 1912, Stone & Webster Engineering Corporation submitted a formal proposal and contract to construct the plant on the White Salmon River. The proposal, as accepted by Northwestern, was limited to preliminary engineering because the site for the dam had not yet been thoroughly explored; therefore, its height and type could not then be determined. Stone & Webster Engineering Corporation submitted a more complete and definite proposal in July 1912. This contract was signed by Northwestern Electric Company on August 19, 1912. This contract included and covered all work that was to be done under the contract of January 19 and superseded it regarding all remaining work.

4.1.5 Additional Land Acquisition

With Stone & Webster Engineering Corporation on board, explorations, design and preparation for construction were carried rapidly forward, and it soon became evident that the lands owned by Henry M. Thompson were necessary for the project. The condemnation suits filed on these lands the previous year were therefore reopened in March 1912. The Skamania County suit was bitterly fought but resulted in a victory for Northwestern Electric Company at the trial on September 26, 1912, a Judgment and Decree being issued in its favor on October 21, 1912. Realizing that he was defeated, Thompson agreed to settle before the Klickitat County actions were tried and on October 15, 1912, he conveyed all of his lands and related riparian rights to Northwestern Electric Company.

During construction of the plant and as late as January 1914, additional lands and water rights were acquired on the upper White Salmon which strengthened Northwestern Electric Company's claim to the upper dam site. Also, the quitclaim of water rights of the Klickitat Irrigation & Power Company better assured the flow of water necessary for Condit Plant's operation.

All other lands necessary in the construction of this plant were secured by the end of November 1912, with the exception of two parcels owned by Indian wards of the government, located at the upper end of the reservoir area. Although government permission to flood the lands had already been secured in ample time, title to those last two tracts was not secured until May 1914.

In 1917, all riparian lands between Condit plant and the mouth of the river were purchased, with the exception of two small parcels, later acquired, to protect the Condit plant's operation against claims for an unregulated flow of water in the lower river and to provide for future construction of the economical development possible on the lower river.

4.1.6 Evaluation and Specific Site Selection

Work on the project began in 1912. The first step was to identify a suitable location on the White Salmon River to construct the dam. In hopes of finding a site suitable for a dam of 100’ or more in height, Northwestern Electric Company initially selected a portion of the river known as “The Narrows.” Hydraulic mining methods were employed to find a site on the east side of the river with suitable bedrock, requiring construction of a 12” pipeline to carry water under significant head pressure from a stream high above the site about 0.5-mile away. The compressed water was ejected through a hose nozzle to blast away the overburden to expose the bedrock. The work crew blasted a 6’ diameter tunnel through hundreds of feet of rock to determine if the rock would be able to withstand the tremendous loads required by the dam and reservoir. As one contemporary news account described it:

> From one of these excavations a six-foot tunnel now leads about 175 feet into the hillside, men picking away at the stones and gravel by candle light and hauling out in wheelbarrows. It has all the appearance of a mine. The tunnel is made for the purpose of finding bedrock capable of being drained of all water. The abutment must rest on good foundation. (The Enterprise, 1912a)

Not finding ideal conditions for the dam abutment, the work crew then selected a second location (by an old bridge back of the Cameron farm) and continued evaluation procedures through sluicing and drilling in the bed of the river. Again, after unsatisfactory results, a third alternative location was considered about 1,500’ farther upstream to a rock canyon measuring about 70’ at its base, known as “The Jaws” (The Enterprise, 1912b).

However, head height at this alternative site was limited to 50’, so a site at the Cameron bridge behind the Kuhne orchards was finally chosen several weeks later. To make up for the lower potential head height than would have been facilitated by the Narrows location, a wider dam was designed capable of providing the required power needs (The Enterprise, 1912b).

4.2 PROJECT CONSTRUCTION

Project construction was well documented with photographs; figure pages with historical photographs and diagrams are presented at the end of Chapter 4.0, with individual figures referenced throughout the text.

4.2.1 Human Resources

The labor force varied according to the requirements of the work. For most of the project, the labor force averaged about 900 men; however, this number was increased to about 1,500 men toward the end of the job (LeFever, 1934).

The construction force was organized into various crews, all under the general oversight of consulting engineer, B.C. Condit and Vice President and General Manager of Northwestern Electric Company, Wilbur E. Coman. Condit was responsible for the location and design of the entire system, including power site, transmission line, and steam plant in Portland. J.H. Manning of the Stone & Webster Engineering Corporation managed the hydraulic development (Foshay, 1913). All purchasing was done through Northwestern Electric Company’s Portland office under the supervision of Purchasing

Agent Frank Whipple. All routine correspondence in connection with the day-to-day operations of the project was handled by Burnett Goodwin, stationed in the Northwestern Electric Company's Spalding Building offices.

The survey and ROW crew was headed by E.F. Pearson with J.N. Davis assisting as ROW agent. The line work was assigned to various crews, all under the direction of the General Foreman Charles Miles. L.T. Merwin served as Construction Superintendent in charge of the construction of the transmission line to Camas. Mr. Merwin's Chief Clerk throughout this job was Ducan Montieth. A.M. Lindsay served as foreman of the crew that cleared the transmission line corridor.

In later years, Wilbur Coman served as Vice President of the Northern Pacific Railway in Seattle; E.F. Pearson later served as an electrical engineer for Northwestern Electric Company and as head of the Northwestern division of Pacific Power & Light (PP&L) following the merger; Ducan Montieth achieved a high position with the National Park Service in Washington, D.C.; Frank Whipple became Assistant Purchasing Agent of the Standard Oil Company of California in Los Angeles; Burnett Goodwin became a prominent insurance agent in Portland (LeFever, 1934); and L.T. Merwin ultimately rose to the position of President of Northwestern Electric from 1936 to 1947 after serving as Vice President and General Manager (Dierdorff, 1971).

4.2.2 Temporary Facilities

Once the dam site was selected, construction of support facilities could begin. A road was laid out and built through the Kuhne and Cameron properties to connect with the Trout Lake road to facilitate immediate construction. An impressive array of temporary facilities was also constructed to house and feed the large work force, manufacture concrete, and transport materials.

4.2.2.1 Camps

Four separate camps were constructed in 1912 to house and feed the workers, supervisors, and engineers. The first two camps were located near the dam (Figures 4.2-1 and 4.2-2), Camp No. 3 was located above the powerhouse (Figure 4.2-3), and Camp No. 4 was located in Underwood by the rail depot. Camp buildings included offices, warehouses, cement and tool sheds, quarters for married foremen, and sleeping quarters for 1,100 men in four separate camps (Figure 4.2-4). These camps were also supplied with temporary fire protection and domestic water supply, roads, lighting, and even telephone service for sixteen phones. Two of the camps had stables for winter use with a combined capacity of 170 horses (Stone & Webster Engineering Corporation, 1912-1913). Camp No. 4 also included a lumberyard, shops, and storage buildings, all clustered along the bank of the Columbia River, making the site ideal for deliveries by boat as well as by rail (Figure 4.2-5).

The local newspaper included the following account of a temporary camp that was built to house workers at a nearby orchard:

Besides the main quarters for the crew there are now about two dozen buildings on the Adams property for the use of engineers, clerks, foremen and their families. The temporary quarters are all boarded up and tar papered for the winter, with supplies of wood beneath. It is a veritable village, with a plank road leading past to the lumber mill. Theodore Adams gives permit to erect these buildings on his land with the provision that when the work is completed the buildings be left. (The Enterprise, 1912d)

These temporary buildings were generally simple frame structures covered with rubberoid roofing and tar paper suitable for use in the heavy snows and rains common to the Cascade Mountains (Stone & Webster Engineering Corporation, 1912-1913). Despite their temporary nature, these facilities provided a true home and workplace for the large force of laborers, engineers, and administrative personnel engaged in the 12-month construction project. For example, a 900 square-foot bunkhouse housed 13 engineers. The bunkhouse was divided into six 10' square double rooms plus one 70 square foot single room separated from one another by 8' partitions. All seven rooms opened onto a central 10' by 23' hall heated by a single, centrally located stove. Internal plumbing consisted of a single sink mounted on one wall.

Meals were shared in a mess house in each camp. In Camp No. 3 located on the hillside above the powerhouse, the mess hall sat 250 men at seven long tables measuring 33' to 35' each in length. Attached to the 36' by 80' dining room was a 478 square-foot kitchen, a pair of store rooms, and a small bunk room with beds for four waiters. Figure 4.2-6 illustrates one mess hall specially decorated for a holiday turkey feast. Life in the camp was supported by a full-time doctor, a barbershop, and general supplies store.

4.2.2.2 Machine Shop

A machine shop was constructed to fabricate parts and perform repairs. The long, narrow building was designed to house four forges, each with an anvil, a drill, threader, shaper, lathe, and emery. Materials were stored in a 12' by 20' store room, and air quality was enhanced by a roof-mounted 5 hp electric exhaust fan.

4.2.2.3 Diversion System and Power Plant

One of the first objectives of the project was construction of a temporary power plant to generate electricity for the jobsite. Since no electrical utility existed anywhere close to the project site, electrical power to run the lights, motors, and pumps for construction and temporary domestic use had to be provided by an on-site source through construction of a temporary hydroelectric plant. This required a smaller version of many of the same hydroelectric facilities planned for the Condit Project itself, including a small cofferdam, diversion flume, turbines, and generator.

Work began on this system in late May 1912 with excavation of the north portal of the upper tunnel. Workers utilized hydraulic excavation to blast away the soil overburden. This was achieved with the aid of diverting a stream high above the dam site to the dam through a system of wooden pipelines to the hydraulic nozzle. Meanwhile, tunnel crews were excavating their way through solid rock, and other crews were framing the open channel diversion flume and temporary powerhouse farther downstream.

Following substantial progress on these facilities, work began on the temporary diversion structures. These consisted of a cofferdam that crossed a narrow portion the river channel to a vertical rock pillar standing above the river bed (Figure 4.2-7). A crib constructed of logs (Figure 4.2-8) weighted with rocks was installed between the rock pillar and a wooden bellmouth built at the entrance to the first tunnel (Figure 4.2-9).

The cofferdam was a wood and stone structure that was boarded over to form a spillway. This dam rerouted the river's flow away from the natural channel to a wooden flume that led through two tunnels to a "frog" (i.e., the point where the water is diverted) below the dam; one branch discharged into the river while the other continued through Tunnel No. 3 to the temporary power plant. The power flume was provided with a spillway, and the flow to the temporary plant was maintained at an elevation of 6' by Tainter gates in both diversion and power flumes. These gates were raised or lowered according to the flow in the flume (PacifiCorp, Untitled).

The diversion channel required excavating the base of the cliff forming the west bank of the river to carve three short tunnels through rock outcrops and erect two sections of wooden flume between (Figure 4.2-10). The first tunnel was connected to a second tunnel farther downstream with a long section of open-topped wooden flume. This flume was built of large wooden planks held in place by massive wooden timbers. By early July, this section of flume became the first part of the temporary power system to be completed (Figure 4.2-11). While work progressed on the tunnels, construction of the lower section of flume was initiated.

Every part of the diversion system was heavily constructed. The sills of the flume were tamped in place with crushed rock, and the sides were box-shaped so that they could be ballasted. The flume was built to carry 1,500 cfs and was provided, at the tunnel which pierces the rock underneath the dam, with a gate that could be closed at any time if the flow became so great as to endanger the temporary power plant below (PacifiCorp, Untitled).

By late July, the flume between Tunnels Nos. 1 and 2 was complete, as was the bellmouth at the entrance to the diversion tunnel; the frog in the diversion flume was still under construction, as was the temporary power plant (Figure 4.2-12). In early August, work had progressed throughout the system so that the discharge end was nearly complete, and Tainter gates were installed at the frog to control the flow on August 5 (Figure 4.2-13). This allowed the diversion flume to be partially flooded the following day. All that remained to be completed on the temporary system was completion of the temporary power plant and cofferdam. Both were completed by August 12 (Figures 4.2-14 and 4.2-15) and the system proved successful at diverting the river past the dam site and using the newly harnessed water power to generate electricity for the construction project (Figure 4.2-16).

The diversion system was fully tested by floods. While construction work was at its height and the ground was covered with snow in late 1912, a downpour caused the river to rise rapidly to about 3,500 cfs, submerging the flume for 48 hours under 4' of water (Figure 4.2-17). The water poured over the cofferdam, discharging through the sluice over the sides of the flume where the water had reached its maximum velocity. It was not necessary, however, to close the temporary gate. With a change of weather, the river dropped a little and with it the pool above the dam, and conditions became normal. The ballasting of the flume took care of the situation as planned (PacifiCorp, Untitled).

Key components of this temporary diversion and hydroelectric system included a 257' long diversion channel consisting of 229 linear feet of 9' x 9'3" timber flume and 28' of 11'6" x 11' rock tunnel, equipped with a trash rack, 100' regulating spillway, and controlled by Tainter gates. At the downstream end of the tunnel, the water turned a right-hand 54" vertical S. Morgan Smith wheel installed in a forebay. At 11' of head, this water wheel produced 250 hp, driving a 150 kW three-phase 60-cycle 440-volt generator with exciter. A step-up transformer raised the line voltage to 6600 volts to transmit through a 1.25-mile long transmission line to the step-down plant with a 440 volt distribution system (Stone & Webster Engineering Corporation, 1912-1913).

4.2.2.4 Crusher Plant

Construction of the dam itself required the mixing and pouring of 29,620 cubic yards of concrete in what at the time was a geographically remote mountain canyon. To the good fortune of the Stone & Webster Engineering Corporation, ancient volcanic activity had cached a mountainside of the raw material directly above the dam site. To utilize this material, a huge gravity-fed rock crusher and concrete plant was constructed on the hillside immediately above the dam site, high on the west bank of the river.

Construction of this plant was itself a significant undertaking. Excavation work had already begun below the site of the crusher plant in June (Figure 4.2-18). Site work for the crusher plant began in early July with clearing and digging being conducted by work crews armed with shovels and other hand tools (Figure 4.2-19). By mid-August, construction of the crusher plant was underway (Figure 4.2-20), and by early September, sufficient work had progressed to install the rotary screen in the rock crusher (Figure 4.2-21). At the same time, work had also commenced on the quarry located above the crusher operation (Figure 4.2-22). By mid September, one concrete mixer had been installed in a temporary location at the dam site, while farther up the slope, major system components such as the crusher, gate screen and pulverizer as well as the rock and sand bin were completed (Figures 4.2-23 through 26).

The completed crusher and concrete plant was primarily comprised of massive wooden timbers supporting the iron crushing apparatus; the huge plant climbed the steeply sloping hillside in a series of terraces. The plant was sized to supply 330 cubic yards of concrete per day, with storage capacity for 500 cubic yards of sand and 500 cubic yards of rock. Concrete production capacity was limited by the output of the sand machinery. Fed by gravity, a 42' long, 18" wide belt conveyor was also used to secure better distribution of sand in the bins. Mechanical components included a No. 6 Gates crusher, a 48" x 12" scalping screen, two 42" x 36" Type A Jeffery Swing Hammer Pulverizers, two single-screen Newaygo separators, and a collection of electric motors to power this equipment (Figures 4.2-27 and 4.2-28). The concrete itself was mixed using two 31' power driven tilt Smith mixers at a ratio of 1 part cement, 3 parts sand, and 5 parts crushed rock (Stone & Webster Engineering Corporation, 1912-1913).

4.2.2.5 Delivering Supplies

In 1911 and 1912 when the Condit Dam was being planned and constructed, the White Salmon River valley was relatively undeveloped aside from orchards and logging operations. The nearest railroad access was about 3 miles downstream in Underwood; thus, a complex of storage sheds for supplies was erected at Underwood, creating "the appearance of a busy construction camp" (Figure 4.2-29) (The Enterprise, 1912d).

A new road had to be constructed from the Underwood supply complex to the proposed construction site, including construction of a new 115' bridge spanning the White Salmon River below the site of the powerhouse. Like the road itself, this bridge had to be constructed with sufficient strength to support all of the powerhouse equipment (Foshay, 1913). Construction on the bridge began in early August (Figures 4.2-30 and 4.2-31). The span was supported by a parallel pair of trusses beneath the narrow roadway. These were constructed of heavy wooden timbers and steel tie rods. The trusses were hoisted into place on August 24 (Figures 4.2-32), and the bridge was completed 5 days later (Figure 4.2-33). A separate pedestrian bridge was also built at a lower elevation.

Material and supplies for the entire job were hauled from Underwood; in the early part of the work, teams and chain-driven motorized trucks were used, each truck being equivalent to 12 teams. Each team made two trips a day. When weather prevented the use of trucks, the force averaged 80 teams (LeFever, 1934). The heaviest single loads were the lower halves of the stators of the generators, which weighed 17 tons each (Figure 4.2-34). Donkey engines hauled the wagons up the grade out of Underwood; the rest of the way they were pulled by 16 horse teams. When the pipe sections for the lower part of the penstocks arrived in Underwood, a heavy fall of snow threatened to delay getting them to the project site, but sledges were improvised and time was saved by hauling over the snow (PacifiCorp, Untitled). Along the route of the flow line itself, Stone & Webster Engineering Corporation constructed a narrow gauge railroad presumably to haul wooden staves, stanchions, and other materials used to build the massive wooden flow line.

4.3 PROJECT COMPONENTS

4.3.1 Dam and Intake

Before any work could begin on the dam itself, the river had to be completely diverted around the site of the future dam so that the work crews could excavate the site to clean bedrock. After approximately 3 months of work during the spring and summer of 1912, the temporary diversion system was nearly complete, allowing work on the dam itself to begin. Dam construction began with erection of a steam-fired wooden derrick on the river bank directly above the dam site in early August (Figure 4.2-35). By August 12, the temporary cofferdam was completed, successfully diverting the river past the dam site. The diverted flow was directed through the turbines of a temporary power plant that was completed the following week on August 17. With a source of electricity at the jobsite for the first time, the crews lowered electric pumps into the remaining pools of water in the riverbed below the diversion structure (Figures 4.2-36 and 4.2-37). After several days of pumping, the portion of the riverbed slated for dam construction was finally dry on August 22 (Figure 4.2-38).

The next step was to prepare the site for concrete pouring once the concrete plant was operational. This required excavating loose material from the footing and abutment sites (Figure 4.2-39). Excavation of the dam abutments was accomplished in early September with the aid of a bucket operated by the previously constructed steam derrick (Figure 4.2-40). At the same time, workers used hydraulic mining methods to scour the outcrops at the bottom of the dam site to facilitate adhesion of the concrete dam footing to the underlying river bottom (Figure 4.2-41).

Once this was accomplished, construction could begin on the wooden formwork for the base of the dam. The dam's design called for two 60" sluice pipes to penetrate the dam to allow water passage through the dam during construction when the river rose at wetter times of the year. These pipes were also intended to discharge accumulating silt during the operational phase of the project. The concrete forms for these pipes basically consisted of two wood-stave pipes constructed with flared "bellmouths" at the upstream end. These pipes were supported by separately poured concrete cradles that were held in place during their construction with carefully placed river rocks.

The concrete plant was finally operational by mid-September, allowing the sluice-pipe cradles to be poured on September 15 (Figure 4.2-42). With the completed cradles in place, work began on the pipes themselves, as well as on the formwork for the dam foundation (Figure 4.2-43). By late October, the sluice-pipe bellmouths were complete (Figure 4.2-44) but the forms for pouring the base of the dam were still under construction as were the chutes for directing the concrete from the mixing plant.

With the formwork complete by early November, the forms were filled with concrete, completing the base of the dam, including the two sluice pipes. Timing was critical with the onslaught of rain and snow and the resulting rise in the river level. On November 15, the river overtopped the cofferdam (as discussed in Section 4.2.2.3), and the two sluice pipes succeeded in conveying water through the dam as intended, about 12' below the level of the rising formwork (Figure 4.2-45).

Since the dam was constructed of solid concrete, the most significant component of the construction process was the quarry and crushing and mixing operation needed to produce nearly 30,000 cubic yards of concrete. The crusher and concrete plant were placed on the west side of the river directly below the quarry, which was 400' above the river. The location of the quarry and the steep slope down to the dam site permitted a design in which the rock was handled by gravity alone under its own weight. The quarry rock consisted of shattered basalt, a suitable material for both the sand and rock aggregate used in the concrete mixture.

Both air drill and hand drill gangs worked in the quarry. The excavated rock was dragged by "Bagley Scraper" to the crusher chute, after which it was passed through the various operations including gyratory rock crushers entirely by gravity. An engineer of that era described the innovative mechanical process, claiming that after "the material entered the rock crusher it was not touched by human hands again" (OAHP, 1986). Below the crusher, revolving screens separated the sand and small rock from the large rock sending it directly to the sand and rock bins, while a portion of the rock went to the hammer mill for further reduction to gravel or sand.

This material was distributed by gravity-fed chutes to two concrete mixers. These machines were installed about 150' above the crest of the dam from which height 80 percent of the concrete was poured into place by gravity through a system of wood and steel chutes to a distance of about 283' from the west abutment. Of the remaining 20 percent, part of the concrete was brought from the crusher plant by cableway to a hopper over the east abutment and there sluiced into place, and part was chuted into a hopper at the middle of the dam and then placed by derrick. The plant demonstrated a continuous capacity of 10,000 cubic yards a month with two mixers working about 10 hours a day. The record run for a day of 10 hours was 720 cubic yards (PacifiCorp, Untitled).

Volcanic boulders quarried above the crusher were fed with the aid of gravity and a steam shovel into the crusher through massive chutes. After being mixed with appropriate proportions of sand, water, and concrete, the concrete mixture was poured down from the mixing plant to the forms on the west side of the river, while an immense bucket carried the concrete over to the east side where it was deposited into the waiting forms. This operation is described in the following contemporary account:

> The great pile of lava rock 400' above the dam is being cut down and run through the crushing plant for the mixing of the concrete. Tons of it are used up in a day. Men with picks and drills and dynamite tear up and make loose the rock and it is swept by the steam shovel into a chute to the main crusher. So much of the rock has been taken out that a blast of dynamite a few days ago cracked a huge chunk weighing many tons on the east face and for a time it was feared it would slide down and carry out the expensive crushing plant. It considerable (sic) excited those working below. However, the great cables which were swung around it, and men picking it away day and night, have reduced the danger to a minimum. (The Enterprise, 1912d)

The concrete making, form construction, and pouring operations at the dam proceeded continuously through the rest of 1912 and on into the early part of 1913. The different sections of the dam were poured as a series of steps, each roughed up between pours to improve bonding with the previous pour (Figures 4.2-46 and 4.2-47). Concrete was distributed to different forms with the aid of a "concrete distributor" consisting of a hopper mounted to a sliding track attached to flexible steel tube (Figure 4.2-48).

By late February, the concrete work for the dam had been completed to the top of the spillway, allowing work to begin on the headworks and trashrack (Figure 4.2-49). The huge steel nipple was installed in the headworks allowing connection to the flow line on March 3 (Figure 4.2-50) followed 2 days later by installation of the gate valve controls to the two sluicepipes. With the valve controls in place, a gate was installed at the entrance to Diversion Tunnel No. 2, and both sluice gates were closed on March 9, allowing the water to rise behind the newly finished dam (Figure 4.2-51). By March 13, all five headwork gates were complete and the first water passed over the crest of the dam on March 21 (Figure 4.2-52). Finishing touches included the headworks building completed on March 30 and the flashboards which were overtopped for the first time on April 26 (Figure 4.2-53).

4.3.2 Flow Line

Work on the flow line was initiated in mid July 1912 even before the temporary facilities were complete (Figure 4.2-54). Early flow line work consisted of excavating nearly one linear mile of hillside along the east rim of the river gorge. Work consisted of clearing and rough grading with much of the work conducted by shovel and wheelbarrow (Figure 4.2-55). By mid-August, a steam shovel joined the project, providing greatly expanded excavation capacity (Figure 4.2-56). Most of the rough grading was complete by the end of September, allowing ties to be laid for a temporary railroad to be constructed along the route of the flow line (Figure 4.2-57). When complete, this railroad would allow a steam locomotive to haul equipment and supplies, such as lumber and the pre-constructed wooden support cradles, along the flow line route.

In addition to shovels and the steam shovel, the flow line crew used a "Bagley Scraper" hauled by a steam-fired winch to complete the grading work during October (Figure 4.2-58). At the same time, carpenters constructed wood-timber trestles (Figure 4.2-59) over low areas along the flow line route to level the grade of the future pipe, and the first of the cradles began to be delivered to the site (Figures 4.2-60 and 4.2-61). By mid-November, site grading and trestle construction was complete allowing completion of the wooden mud sills and support stringers (Figure 4.2-62).

Like the river channel it parallels, most of the flow line route is straight or gently curving; however, there is a single bend in the river approximately mid-way between the dam and the powerhouse. This required a pipe bend to be constructed of steel to negotiate the 40 degree radius turn, and the steel pipe bend needed to be anchored in place to prevent movement caused by water pressure with a massive concrete thrust block structure. By early December, the forms were in place, and crews began sluicing concrete into the forms from a chute constructed from the roadway above (Figure 4.2-63).

With the grading complete, the steel bend secured in place, and the stringers installed, work on the flow line itself could begin in earnest; by December 10, the Pacific Coast Pipe Company of Seattle had completed the first section of the massive pipe (Figure 4.2-64). Workmen working inside the pipe slid a circular wooden form to support the staves as they were laid from outside. Meanwhile, other workmen encircled the staves with curved steel rods holding the entire pipe in compression. As each section was completed, the form was moved to the next section to be assembled (Figure 4.2-65).

A major winter storm pounded the denuded construction site in late December, scouring the site and raising the river level. The over-saturated banks failed on December 29, partially burying the newly constructed flow line in mud and debris (Figure 4.2-66). Fortunately, the pipe did not rupture as a result of the incident.

Not only was this pipe notable for its massive size, the quality of its materials and construction were equally impressive as noted in this contemporary account:

> The stave stock is what is known in the lumber world as No. 2 Douglas or Washington fir, and is nearly all absolutely clear. It is kiln dried, and planned with beveled edges so that when fitted together the pipe forms a tight circle. It comes from a part of Northwestern Washington which is fast being cut and the timber is so good that a great amount of waste does not result, but to get this million feet it is probable that at least 3,000,000 feet of standing timber were cut. In other parts of the State the ratio of stave stock to the cut is higher, in some cases running as high as one to six or seven. This lumber came from mills each being able to supply only a small amount of the grade required.
>
> While the theory of laying and fitting stave pipe is simple, there is a great knack in fast and workman-like placing of staves which comes only with experience. One gang erected 180 lineal feet in one day, and on many days 100 feet were erected, while the average in all kinds of weather was not less than 80 feet.
>
> The weight of water in the pipe when full is something like 4 tons per lot, static load, which is more than the weight per foot of length of the heaviest locomotive. Every means was taken, therefore, to make the foundations perfect. The roadbed is all on solid ground the total excavation being 130,000 yards. (PacifiCorp, Untitled)

When completed in early March of 1913, the flow line consisted of wood stave pipe, 13’6” in diameter and over 1 mile in length, extending along the gorge from the headworks on the eastern alignment of the dam to the forebay near the powerhouse. More than 1,600,000 board feet of timber were used. The pipe itself consumed nearly 1,000,000 board feet, including 476,000 board feet in the cradles and 210,000 board feet in the sleepers or mud sills. Ninety-four staves comprised the circumference of the pipe. The total length of staves is nearly 90 miles. It was supported by 1,108 cradles, resting on seven heavy mud sills running the full length of the line.

4.3.3 Surge Tank

The future site of the surge tank was surveyed in mid-July (Figure 4.2-67) but actual site work would not begin for another few months until mid-September. Teams of draft horses hauled scraper buckets across the circular construction site to excavate the hole for the forebay foundation (Figure 4.2-68). Excavation was finished in late September and construction work continued throughout the fall. The first concrete was poured for the foundation in late October (Figure 4.2-69); by the end of November, the complicated formwork for the concrete to be poured for the forebay was nearly finished. The surge tank, serving as a reservoir or forebay and consisting of the outlet for the massive flow line and the intake to the two penstocks, was well under construction by mid-December (Figure 4.2-70). When complete, the forebay would serve as the foundation for the surge tank, a hollow concrete water tower built directly above the forebay. The wooden forms for the 40' tall surge tank were nearly complete by early March (Figure 4.2-71), facilitating the pour to complete this key project component. Following the concrete work, the distinctive wood-frame roof structure was added to the top and a wooden spillway sluice, and supporting timber trestle connected the surge tank to the river below in case of overflow.

4.3.4 Penstocks

Work on the two penstocks to connect the surge tank to the powerhouse was undertaken concurrently with the surge tank site and concrete work. Unlike the relatively flat site of surge tank, however, the route of the penstocks descended a steep slope. Instead of relying on horse-drawn scrapers for much of the work, the pick, shovel, and wheelbarrow were the primary work implements. In one photograph taken on September 12, twenty-five workmen display their construction equipment on the steeply sloping job site (Figure 4.2-72). As with the surge tank, excavation of the penstock corridor was nearly complete by the end of September (Figure 4.2-73). By late November, both steel nipples were installed in the forebay, allowing connection to the penstocks (Figure 4.2-74). The concrete support cradles for both parallel penstocks were being built in early December, setting the stage for the pipeline crews to assemble the two parallel wood stave penstocks using methods that closely resembled those used on the larger flow line (Figure 4.2-75).

4.3.5 Powerhouse

Work on the powerhouse began in late July 1912 (Figure 4.2-76), with preliminary site work such as clearing and grading as well as installation of a wood-fired steam derrick and an incline railway down the steep embankment to the construction site for the powerhouse (Figure 4.2-77). The derrick was complete by mid-August, facilitating excavation of the site into the bedrock forming the riverbank (Figure 4.2-78). Excavation continued through the fall of 1912 as countless loads of excavated material were hoisted by derricks to an incline tramway which deposited it on the hill above the powerhouse. Other derricks reclaimed it and dumped it into the crusher, where it was broken for concrete aggregate. The rock and sand were fed into chutes and sent back down the hill to the mixer, which fed the concrete into an elevator hopper. The elevator raised it to various heights and sluiced it to the many structural powerhouse forms (PacifiCorp, Untitled). This required construction of a separate concrete crushing and mixing operation to supply the powerhouse and adjacent facilities (Figure 4.2-79).

In one of the most dramatic deliveries of the entire construction project, the giant lower sections of the draft tube were delivered by truck to the site on October 7. By the end of October, the completed powerhouse excavation facilitated installation of all four draft tubes. Since the outlets were below the river level, a riprap wall was constructed to protect the site from the current (Figure 4.2-80). With the draft tubes and concrete forms in place, concrete from the newly completed concrete plant was poured for the powerhouse sub-structure. By mid-November, the solid concrete slab of the powerhouse surrounding the draft tubes had been completed as high as the first floor and the ironwork started to support the superstructure (Figures 4.2-81 and 4.2-82).

In early December, the generator units were installed along with other equipment (Figure 4.2-83). At the same time, work continued on the steel structural work so that by December 8, the girders extended has high as the roof, and the structural work for the entire building was finished 10 days later (Figure 4.2-84). With the structure in place, the 40-ton traveling hoist was installed on tracks supported from the structural ironwork on December 30 (Figure 4.2-85). At the same time, the top portions of the draft tubes were connected to the penstocks. With the equipment installed and the structure in place, forms were erected and the concrete curtain walls poured in place.

4.3.6 Transmission Line

The construction of the transmission line from the Condit plant to Camas was begun in September 1912 and completed by April of the following year. Preliminary surveys had already been made for this line, and nearly all of the ROW purchased. The clearing of this ROW, varying in width from 15’ to 30’, through densely wooded sections in some portions of the line, was the first work undertaken after the final survey was determined.

The first crew camp was established at Washougal, with most of the men housed in the Commercial Hotel. While this work was underway, equipment was gathered and fabricated for use in a mobile camp consisting of tents, cots, bedding, stoves, and full commissary outfit. The first move was made by pitching camp on Forest Hill, thence eastwardly every 10 miles or so, depending on suitable sites and difficulty of the construction work. Following the camp at Washougal, camps were erected at Forest Hill, Prindle, Butler (now called Skamania), Cascade, Stevenson, Collins, and Hood. During the major part of this transmission line work, there were 60 men in camp and 20 horses.

Construction of the transmission line between Camas and the project site on the White Salmon River offered some notable logistical difficulties. Most sections of the rugged country traversed by the 48-mile transmission line corridor had no roads; those that were available were in poor condition, especially during the winter months when most of the work was completed. During the winter of 1912-1913, there was constant rain or snow for 60 days, but at no time throughout the job did work stop on account of weather.

Instead of relying on roads for access and deliveries, the work crews made movement by river steamer and barge the usual method of progressing from camp to camp, as described in this contemporary account:

> The commissary problem for both man and beast was quite a problem, as it will be recalled that there was no such thing as the North Bank highway in those days, and most of the major camp movement had to be done by river boat. The old Bailey Gatzert was then in service and much of the movement was done on this boat.

Of course, this mode of transportation was not without its own set of difficulties as well:

> Some material was lost occasionally by theft, but more frequently by losing overboard in loading and unloading at the river's edge. Off-shore at Prindle, for instance, lies what was once a fine camp range, and at Hood a 6000 lb. reel of aluminum wire rolled nonchalantly down the sandy bank and into the river. It lies there still, although divers were sent in search of it without success. (PacifiCorp, Untitled)

The Seattle, Portland & Spokane Railroad ROW running along the river bank was also used by the transmission line builders. Hundreds of feet of block and tackle were used to deliver the massive transmission poles to high rocky points overhanging the railroad along the transmission line ROW. The men climbed the steep slope from the railroad grade to pole position to deliver the insulators, which weighed 3,500 pounds each, in specially fabricated canvas saddles to haul each insulator up the slope to the pole locations.

The crews experienced exasperating delays in the receipt of material, particularly insulators and conductor wire. The line had to be constructed "going and coming" because surveys were completed, holes dug, poles erected, and cross-arms placed on the eastward movement of the construction gang, and it was not until this part of the work was finished and the crews at the farther end and camped at Hood that insulators and conductor wire were received. The whole camp then started west again, placing insulators and stringing wire.

Due to the rough topography of the region, spans varied greatly in length from 200' to 1,200'. The use of steel-reinforced aluminum conductor wire consisting of a core of stranded steel wire surrounded by nine strands of aluminum was the first of its kind to be used in the Northwest. The steel provided the strength and the aluminum served as the conducting material, providing a strong but very light conductor that was much used in later years on other transmission lines in the west.

Figure 4.2-1. Camp No. 1 under construction east of dam site, June 24, 1912

Figure 4.2-2. Camp No. 1 dam site in foreground, July 9, 1912

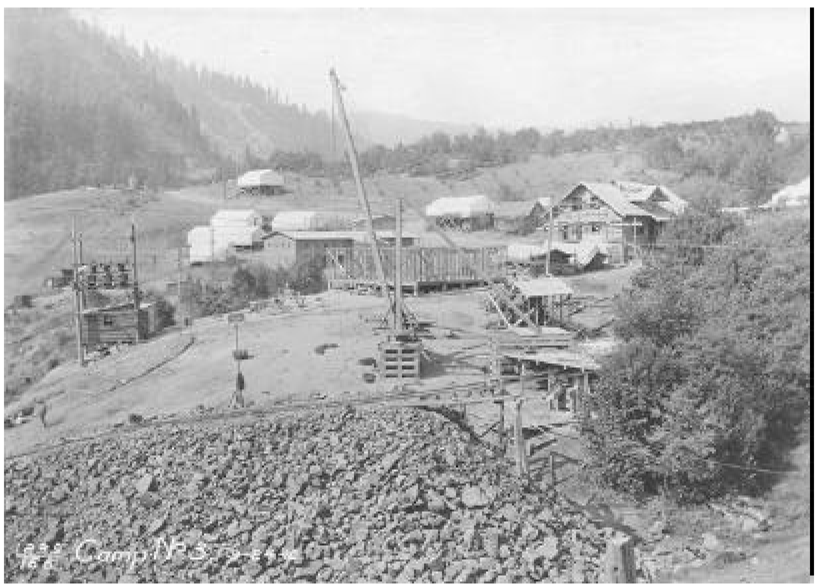


Figure 4.2-3. Camp No. 3 (above powerhouse) under construction, September 24, 1912

Figure 4.2-4. Upper camp (Camp No. 2) partly complete, August 10, 1912

Figure 4.2-5. Lower camp (Camp No. 3) complete, July 26, 1912


Figure 4.2-6. Holiday meal at camp mess hall, date unknown

Figure 4.2-7. Cofferdam by bellmouth of flume mostly constructed, July 9, 1912

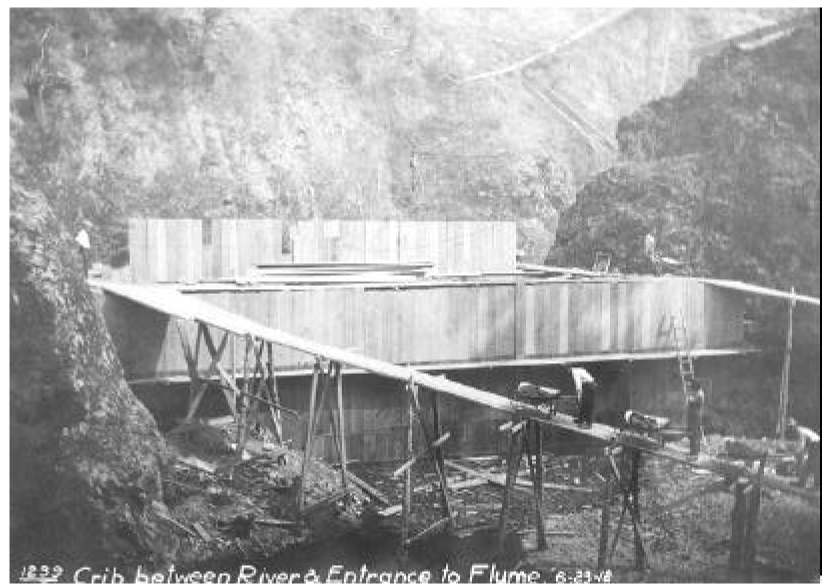


Figure 4.2-8. Crib between river and flume entrance under construction, June 23, 1912

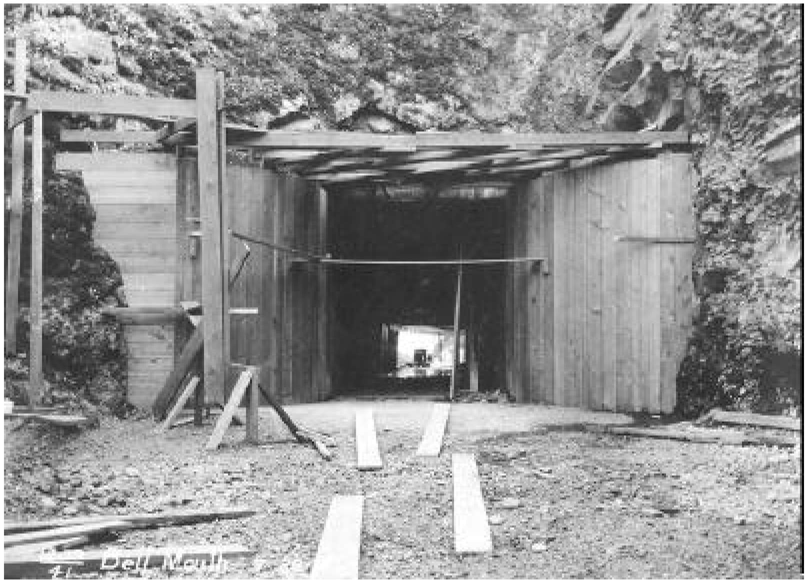


Figure 4.2-9. Bellmouth of diversion tunnel complete, July 26, 1912

Figure 4.2-11. Diversion flume between Tunnel Nos. 1 & 2 complete, July 9, 1912

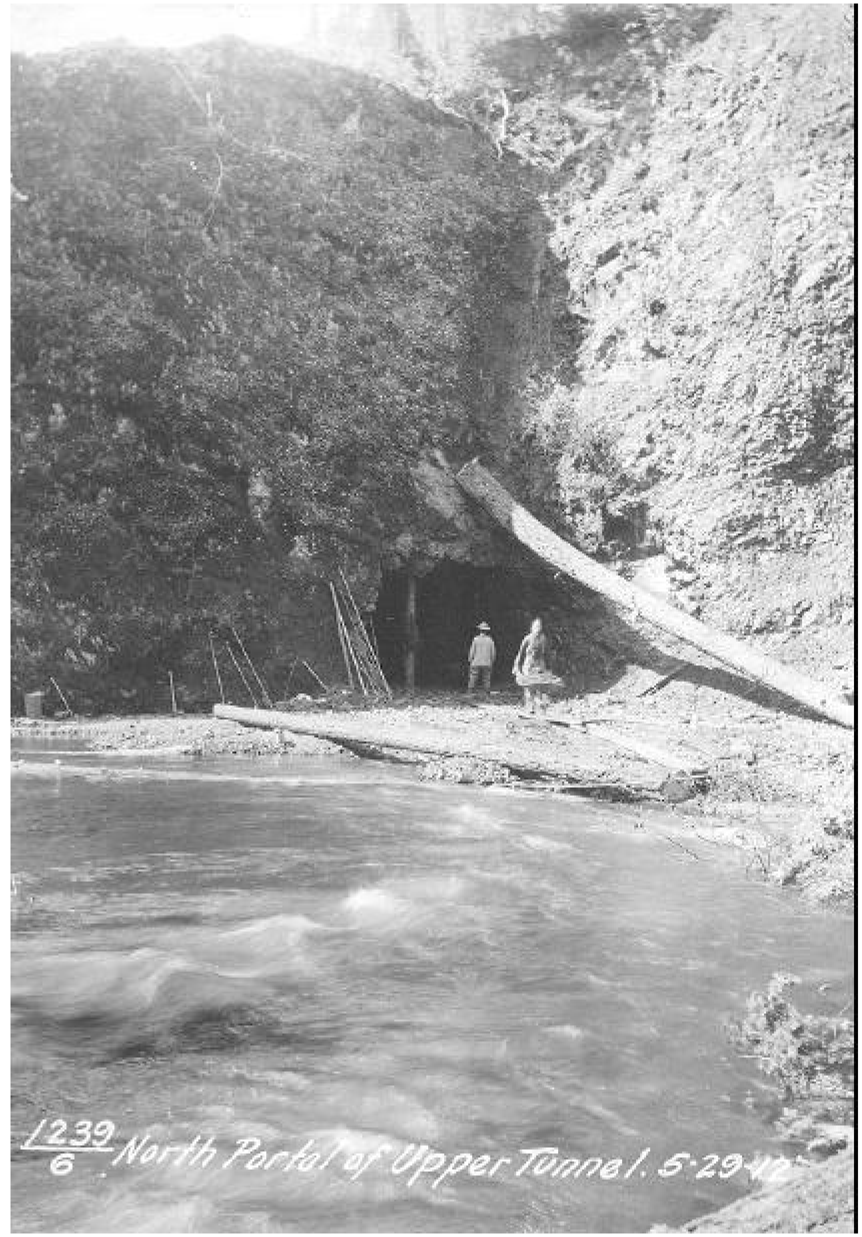


Figure 4.2-10. Excavating north portal of upper tunnel under construction, May 29, 1912

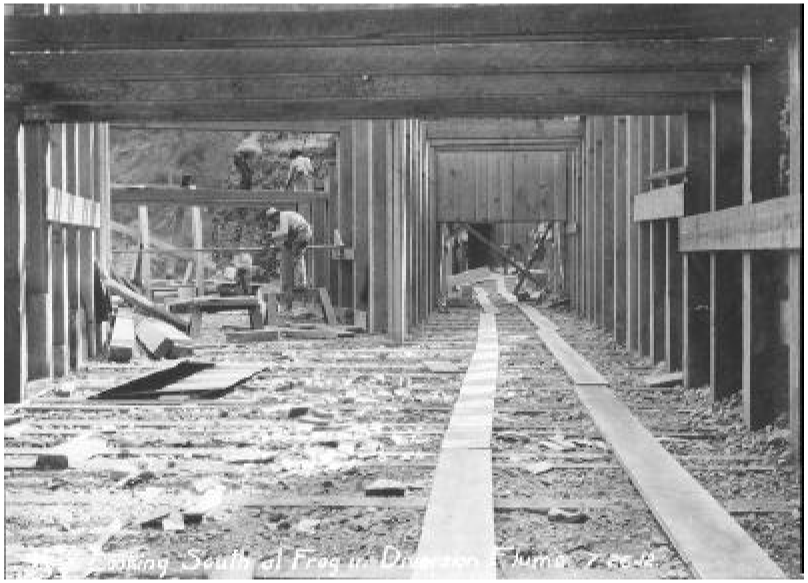


Figure 4.2-12. Frog in diversion flume under construction, July 26, 1912

Figure 4.2-13. Diversion flume discharge end nearly complete, August 12, 1912

Figure 4.2-14. Temporary powerhouse partly complete, July 26, 1912


Figure 4.2-15. Cofferdam No. 2 under construction, August 5, 1912

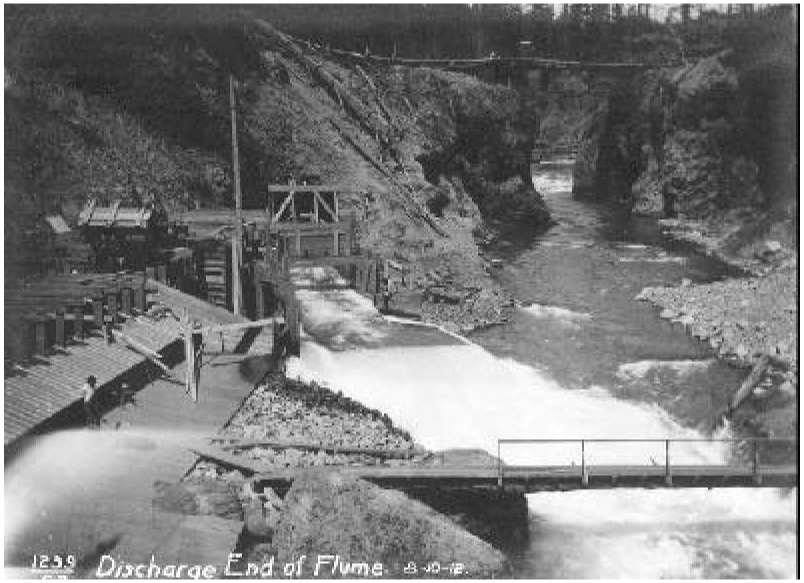


Figure 4.2-16. Diversion flume in use, August 10, 1912

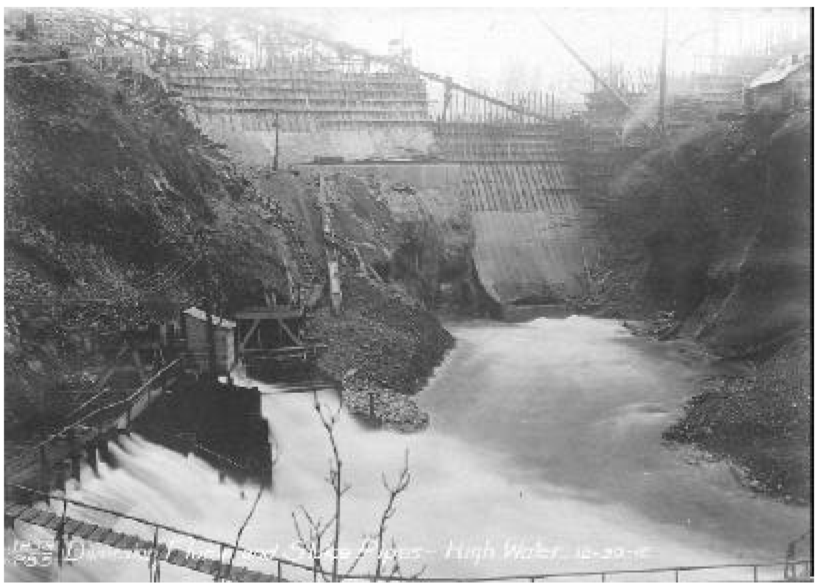


Figure 4.2-17. Flume submerged by high water, December 30, 1912

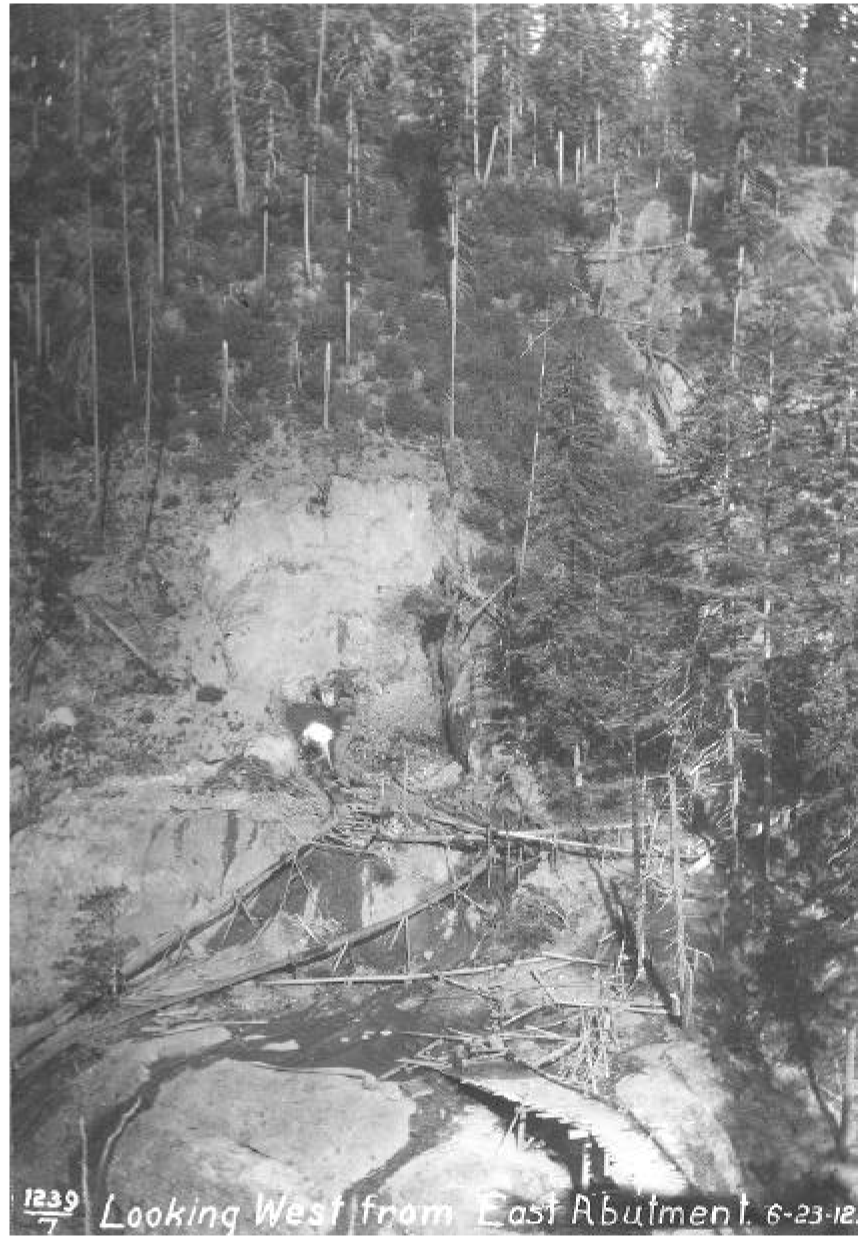


Figure 4.2-18. Using hydraulic methods to excavate west dam abutment below site for crusher plant, June 23, 1912

Figure 4.2-19. Site work for crusher plant started, July 9, 1912

Figure 4.2-21. Rotary screen installed at crusher plant, September 7, 1912

Figure 4.2-20. Construction started on crusher plant, August 17, 1912

Figure 4.2-22. Quarry platform complete, August 22, 1912

Figure 4.2-24. Rock crusher, gate screen, and pulverizer, September 13, 1912

Figure 4.2-23. Crusher plant under construction, August 29, 1912

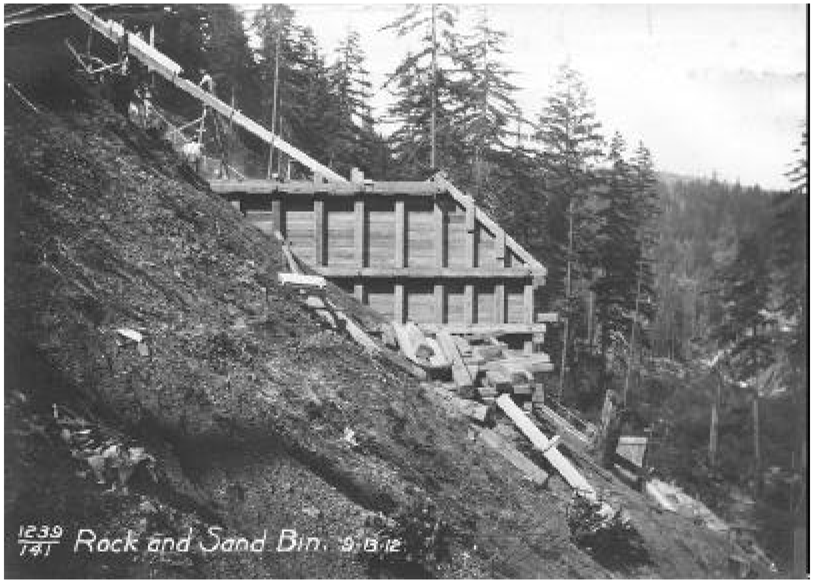


Figure 4.2-25. Rock and sand bin nearly complete, September 13, 1912

Figure 4.2-26. Rock quarry in progress, September 8, 1912

Figure 4.2-27. Upper part of crusher plant, September 13, 1912

Figure 4.2-28. Sand belt conveyor under construction by crusher, September 24, 1912

Figure 4.2-29. Camp No. 4 –Underwood, December 5, 1912

Figure 4.2-30. Construction started on new Skamania Bridge, August 11, 1912

Figure 4.2-31. Skamania Bridge under construction, August 13, 1912

Figure 4.2-32. Bridge trusses hoisted into place, August 24, 1912

Figure 4.2-33. Skamania Bridge complete, August 29, 1912

Figure 4.2-34. Bottom section of draft tube delivered by truck, October 7, 1912

Figure 4.2-35. Derrick at dam site erected, August 3, 1912

Figure 4.2-36. Pumps installed at dam site, August 19, 1912

Figure 4.2-38. Draining of dam site completed, August 22, 1912

Figure 4.2-37. Draining water from dam site with electric pumps, August 20, 1912

Figure 4.2-39. Preparing foundation site for dam, August 29, 1912

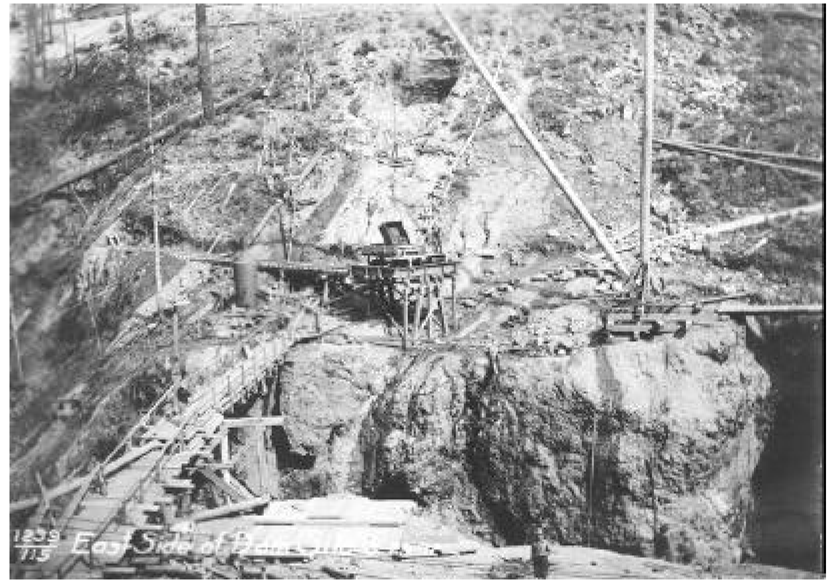


Figure 4.2-40. Steam derrick excavating dam site, August 29, 1912

Figure 4.2-41. Hydraulic scouring of outcrops at base of dam, September 3, 1912

Figure 4.2-42. Sluice pipe cradles poured at dam site, September 15, 1912

Figure 4.2-43. Wooden sluice pipes under construction, September 13, 1912

Figure 4.2-44. Bellmouth of sluice pipes completed, October 20, 1912

Figure 4.2-45. Water flowing through sluice pipes in base of dam, November 15, 1912

Figure 4.2-46. Pouring different parts of the dam simultaneously, November 15, 1912

Figure 4.2-47. Dam sections being poured, November 30, 1912

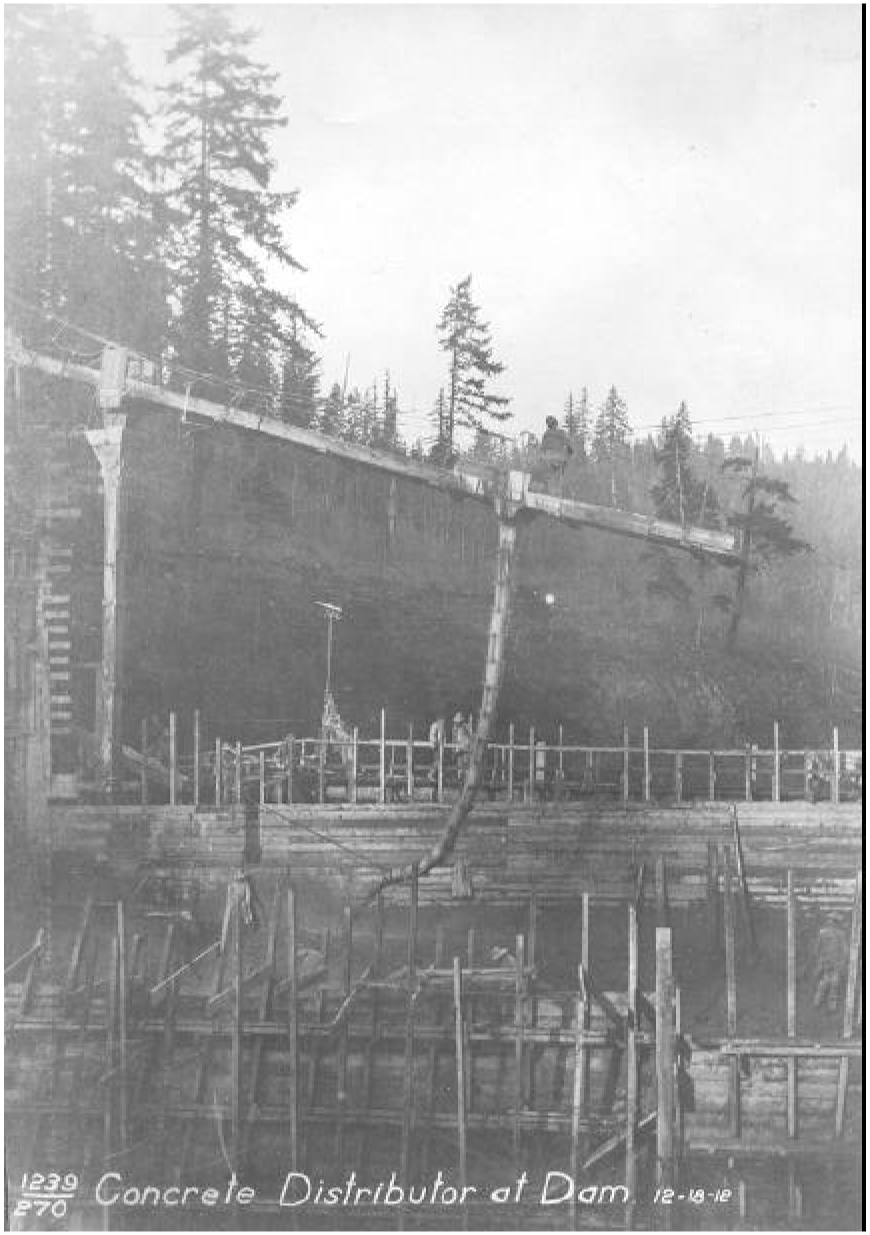


Figure 4.2-48. Concrete being poured at dam via moving “concrete distributor”, December 18, 1912


Figure 4.2-49. Headworks under construction, February 25, 1913

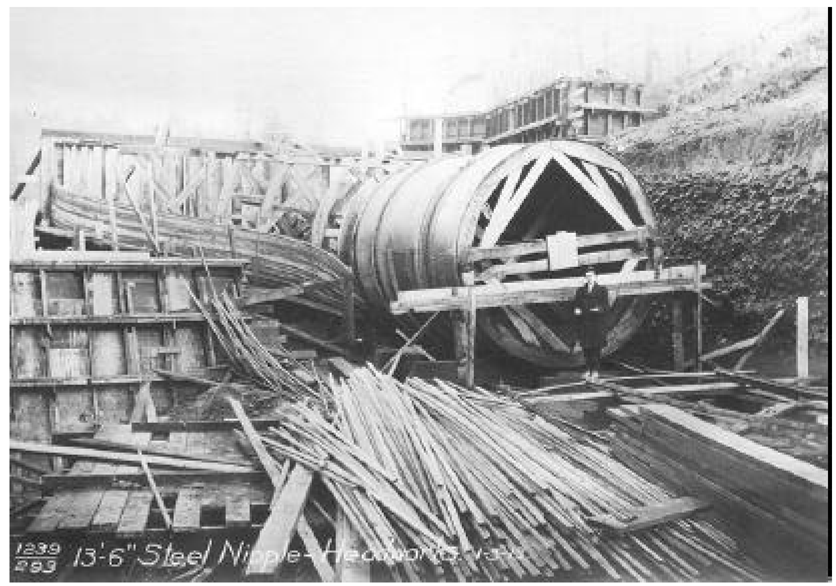


Figure 4.2-50. 13’6” steel nipple installed at headworks, January 3, 1913

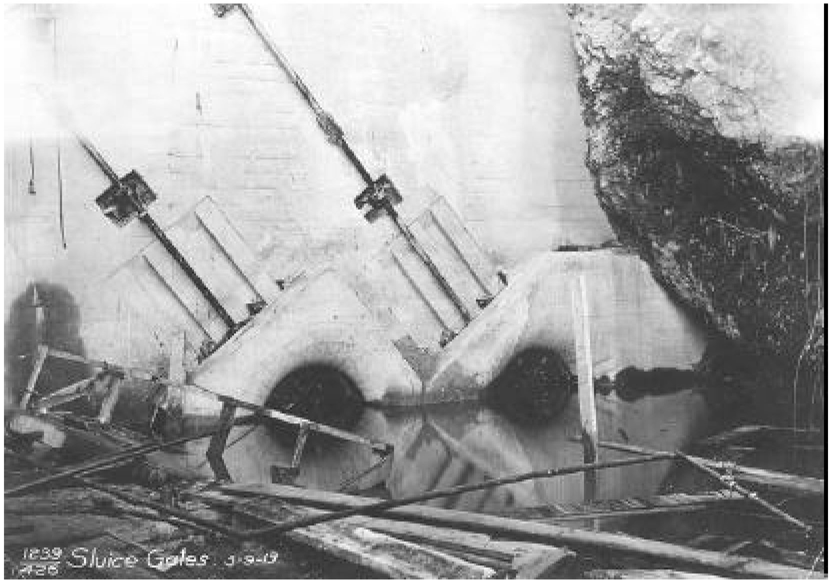


Figure 4.2-51. Sluice valves closed, March 9, 1913

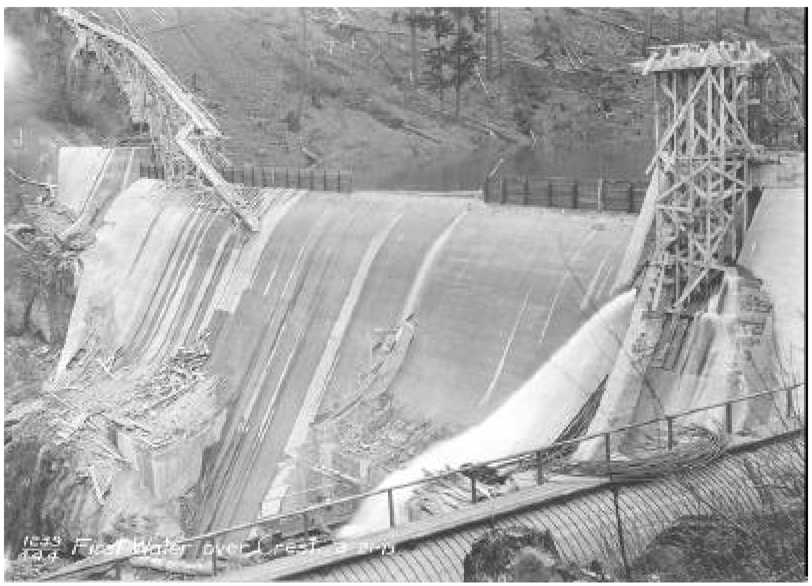


Figure 4.2-52. First water overtops crest of dam, March 21, 1913

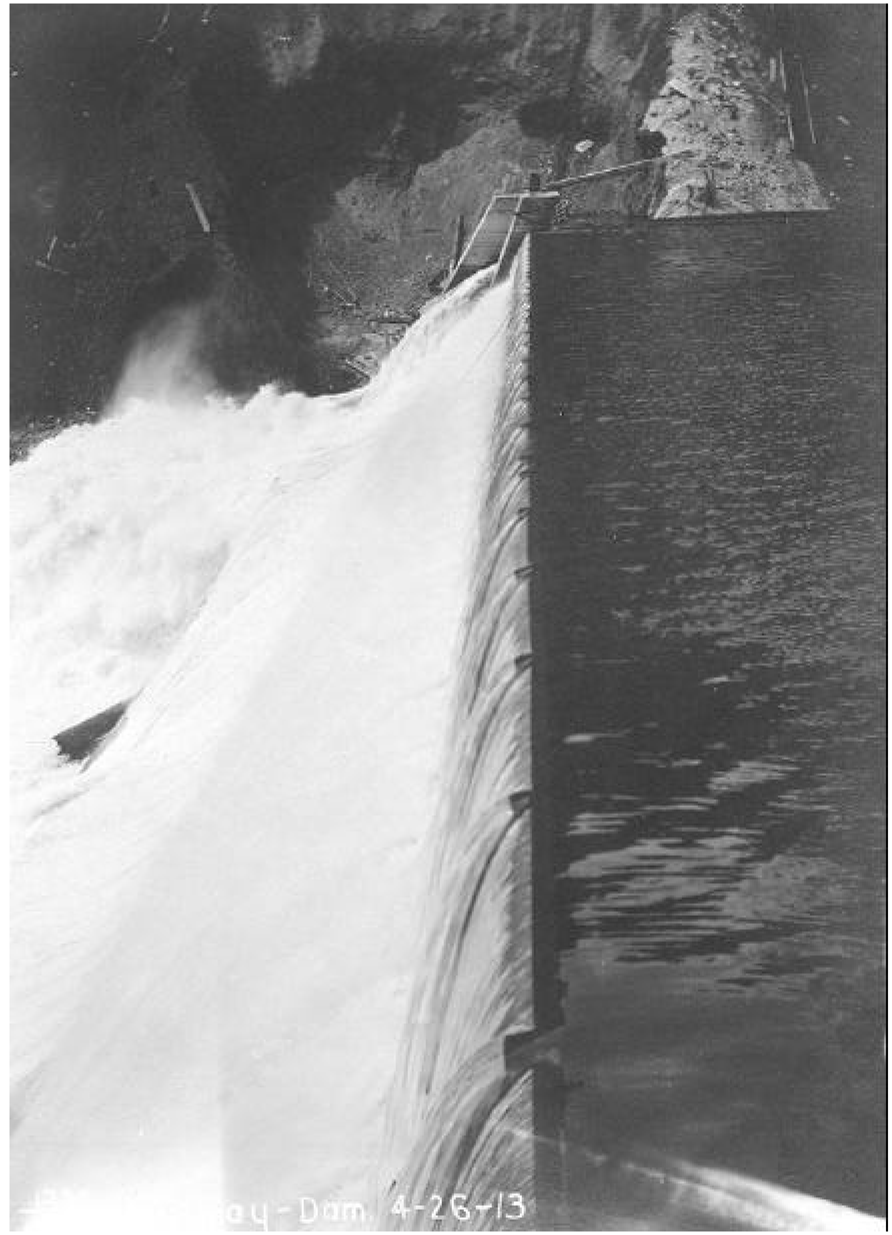


Figure 4.2-53. First water overtops completed flashboards, April 26, 1913

Figure 4.2-54. Site work started for flow line, July 15, 1912

Figure 4.2-55. Wheelbarrows used in flow line construction, September 15, 1912

Figure 4.2-56. Flow line excavation by steam shovel, August 13, 1912

Figure 4.2-57. Laying railroad ties along flow line grade, September 26, 1912

Figure 4.2-58. "Bagley scraper" hauled by winch used to excavate portions of flow line, October 13, 1912

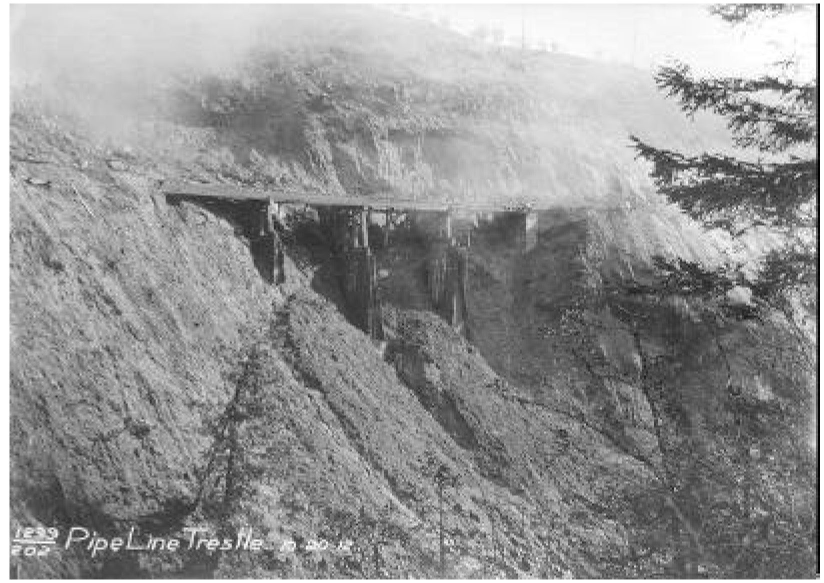


Figure 4.2-59. Flow line trestles under construction, October 20, 1912

Figure 4.2-60. First wooden pipe support cradles built for flow line, October 19, 1912

Figure 4.2-61. Locomotive moving supplies along flow line track, December 4, 1912

Figure 4.2-62. Stringers installed for flow line, October 7, 1912

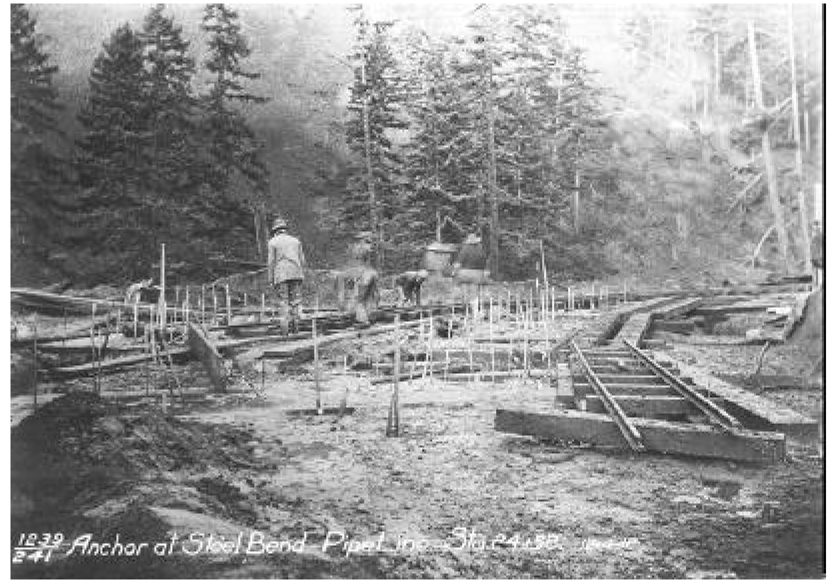


Figure 4.2-63. Start of concrete thrust block to anchor steel bend in flow line, December 4, 1912

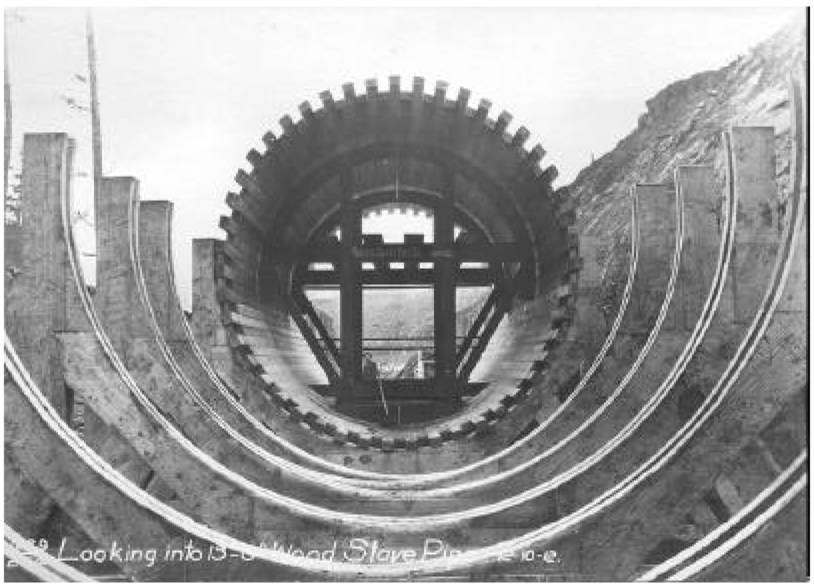


Figure 4.2-64. First section of flow line built, December 10, 1912

Figure 4.2-65. Flow line under construction, December 14, 1912

Figure 4.2-66. Landslide partially buries flow line, December 30, 1912

Figure 4.2-67. Surge tank site identified, July 15, 1912

Figure 4.2-68. Excavation of surge tank site by horse-drawn scraper, September 12, 1912

Figure 4.2-69. Concrete poured at surge tank foundation, October 20, 1912

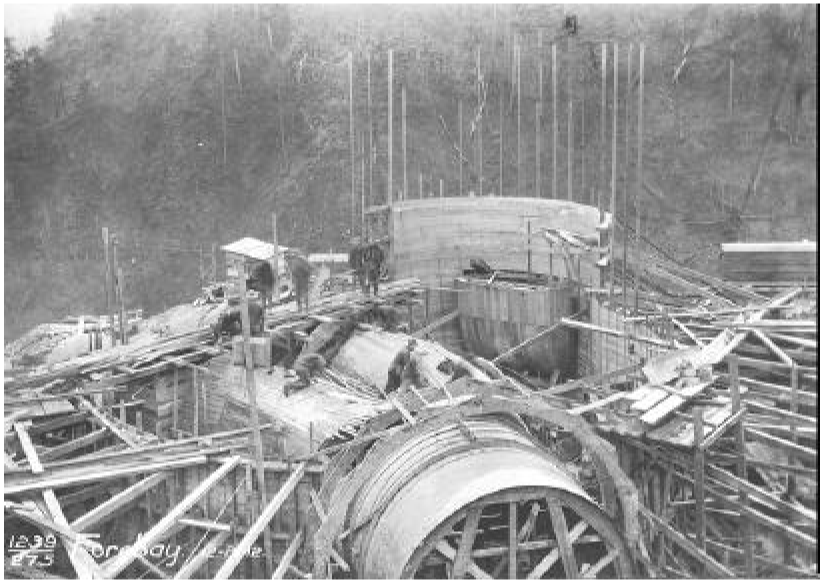


Figure 4.2-70. Surge tank under construction, December 21, 1912

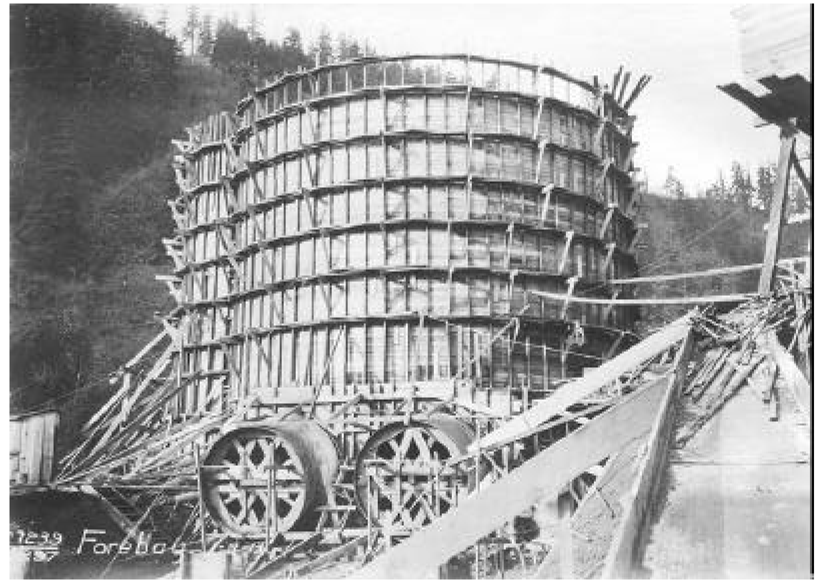


Figure 4.2-71. Surge tank formwork nearly complete, January 3, 1913

Figure 4.2-72. Excavation of penstocks demonstrates manual nature of methods employed, September 12, 1912

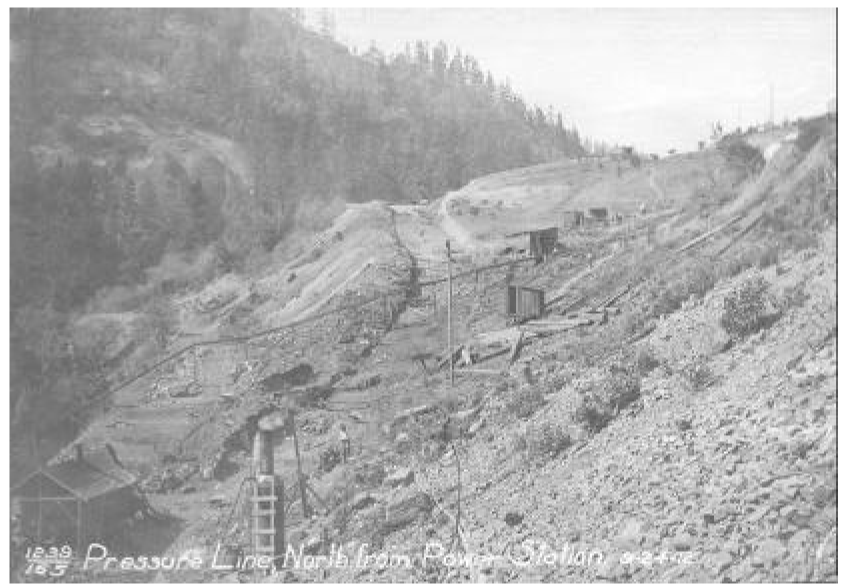


Figure 4.2-73. Site excavation for penstocks nearly complete, September 24, 1913

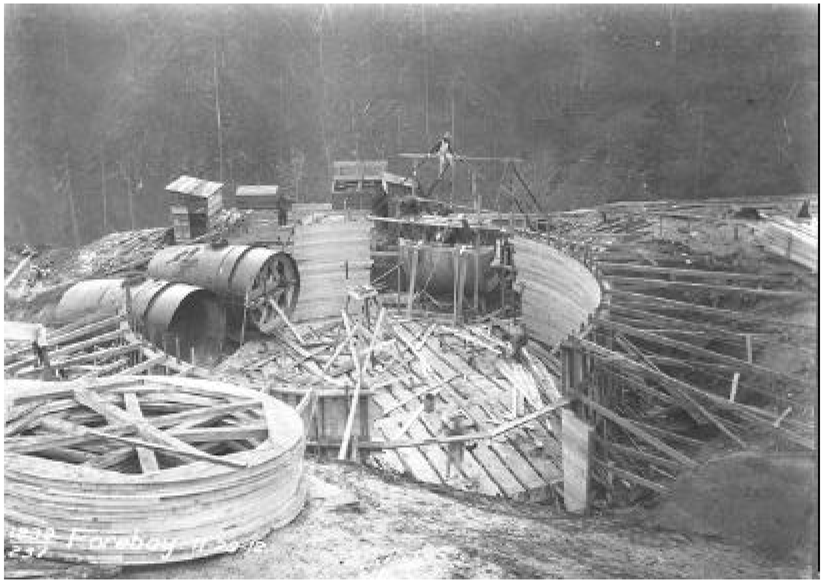


Figure 4.2-74. Building concrete forms for forebay. Both steel nipples for penstocks complete, November 29, 1912

Figure 4.2-75. Pipeline construction, December 10, 1912

Figure 4.2-76. Powerhouse site work initiated, July 26, 1912

Figure 4.2-77. Wood-fired steam derrick completed at powerhouse site, August 11, 1912

Figure 4.2-78. Excavation of powerhouse site underway, August 29, 1912

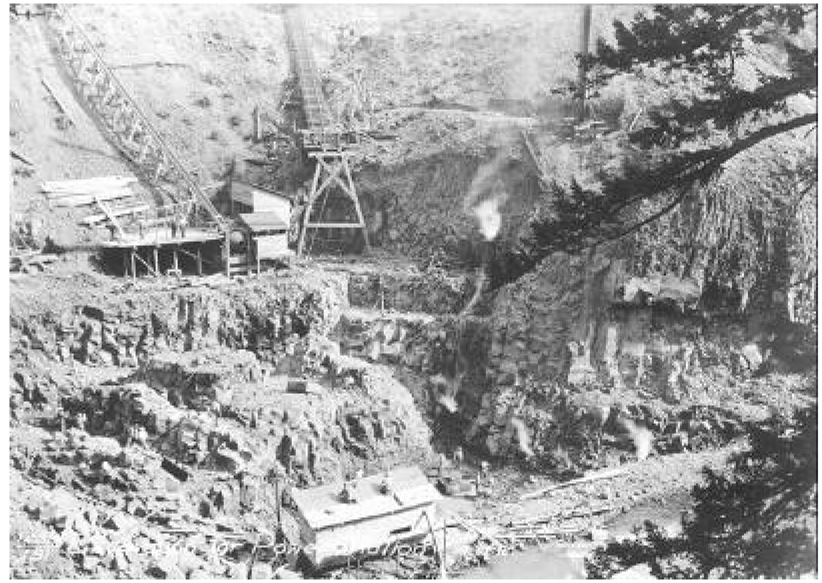


Figure 4.2-79. Construction of concrete mixing plant for powerhouse, October 13, 1912

Figure 4.2-80. Forms installed for powerhouse and tailrace diversion wall, November 5, 1912

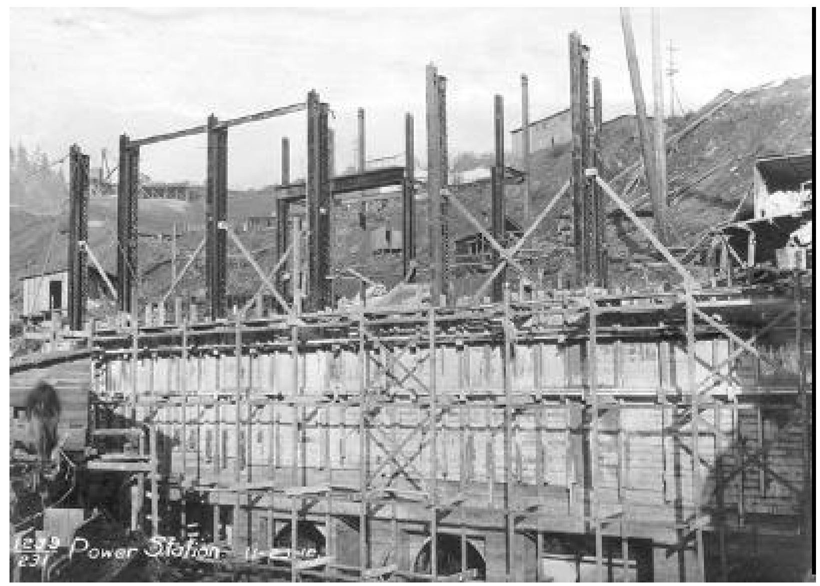


Figure 4.2-81. Steelwork initiated for powerhouse, November 23, 1912

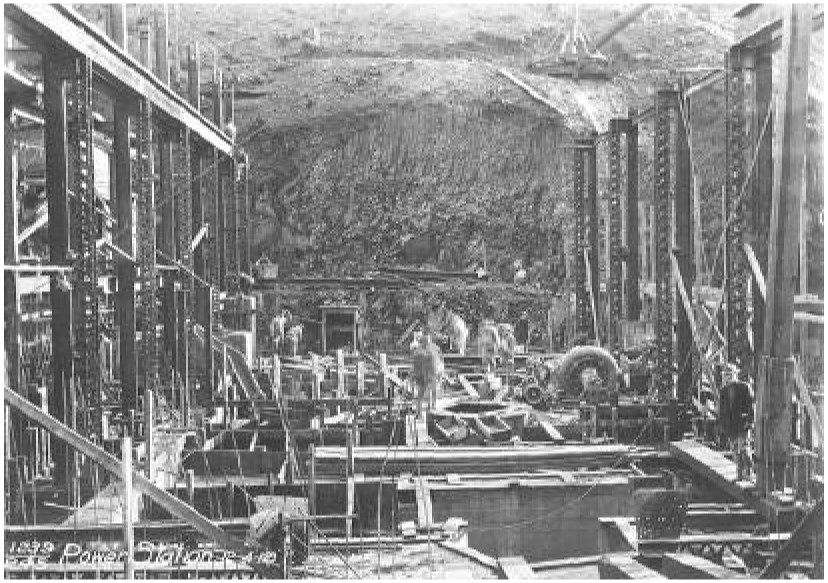


Figure 4.2-82. Generator installed in powerhouse, December 4, 1912

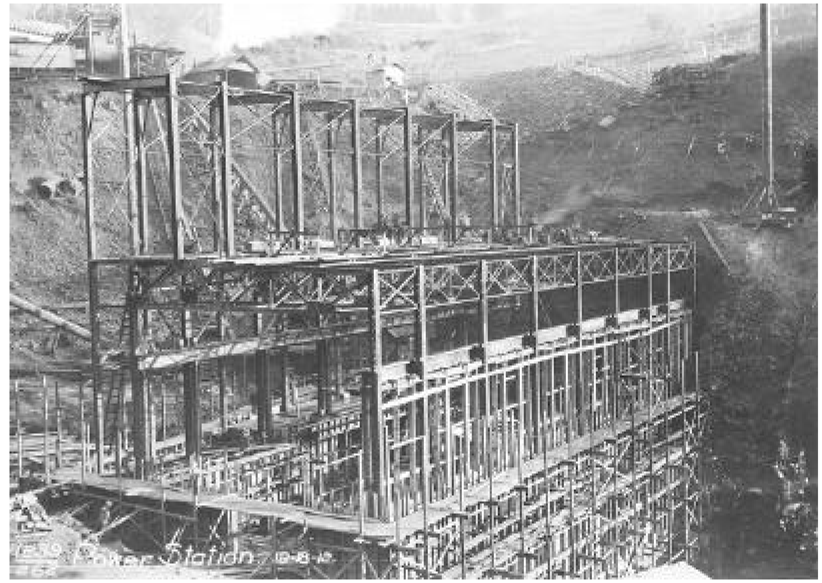


Figure 4.2-83. Structure for powerhouse completed, December 18, 1912

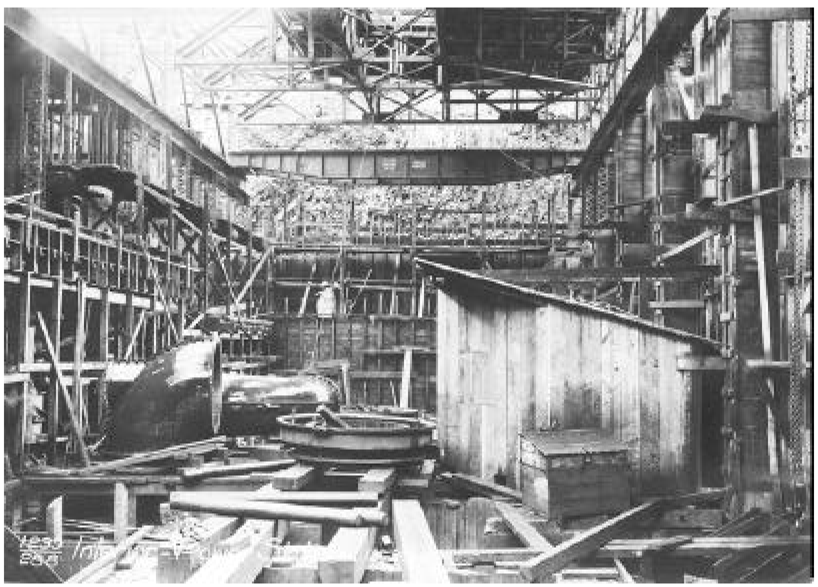


Figure 4.2-84. Gantry crane and tops of draft tubes installed in powerhouse, December 18, 1912

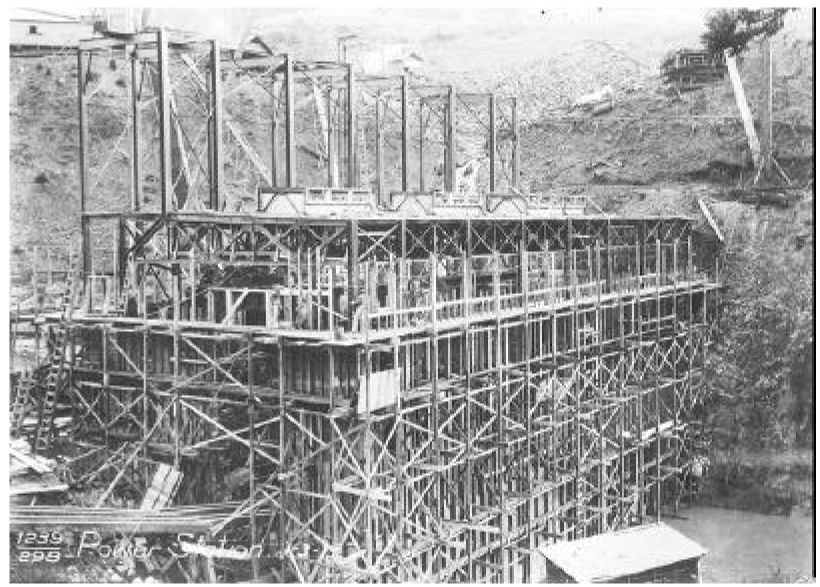


Figure 4.2-85. Formwork for powerhouse nearly complete, January 3, 1913

INDEX TO CONSTRUCTION PHOTOGRAPHS

(i.e., Chapter 4 photographs)

Photographs by Stone & Webster Engineering Corporation, PacifiCorp Archives

5.0 RECORDATION OF PROJECT COMPONENTS

The Condit hydroelectric system is shown on Figure 5.0-1. Note: the remaining figures, which are primarily photographs, are presented on figure pages included at the end of Chapter 5.0. The major features of each component of the Condit Hydroelectric Project are summarized in Table 5.0-1 and described below.

Table 5.0-1: Major Features of Project Components.

COMPONENT	SUMMARY OF SIGNIFICANT FEATURES	
	Original Features	**Existing Features**
Dam and Intake	▪ Gravity section dam with Ogee cross section 15' thick at top, 88' thick at bottom;	▪ Post-tensioned gravity section dam with Ogee cross section 15' thick at top, 96' thick at bottom;
	▪ Concrete construction, 471' long at top, 60' long at bottom, 125' high;	▪ Other than spillway apron extension, basic dam dimensions unchanged;
	▪ 5' high wooden flashboards along entire 250' long free-flow spillway;	▪ Obermeyer crest gates; 10 steel gate panel and air bladder sections (10' high). ▪ Five radial (tainter) gates, 10'x10'; and two fixed-wheel vertical lift gates: 6'x12' and 6'x14';
Flow Line	▪ 5,100' long, x 13.5' diameter wood stave pipe construction,	▪ Unchanged (other than stave replacement)
	▪ Steel support bands (approximately 2' apart) and steel compression bands (5"-6"apart)	▪ Unchanged
	▪ 9'-2" high wooden support cradles on wood sills and Concrete anchors at 4'-6"' intervals.	▪ Treated wooden box support cradles on Concrete sills at 10' intervals.
Surge Tank	▪ 42' diameter concrete base;	▪ Unchanged
	▪ 40' diameter by 48' high round concrete storage/surge chamber;	▪ Unchanged
	▪ Corrugated metal siding on 12-sided top structure with peaked roof and ball finial;	▪ Unchanged
	▪ Six-light sash windows in each face.	▪ Unchanged
 Penstocks	▪ Concrete and wood overflow flume. ▪ Two 650' long, 9' diameter pipes descend 160' vertical.	▪ All-concrete overflow flume. ▪ Dimensions unchanged
	▪ 2 wood-stave pipes supported by concrete anchors.	▪ One welded steel and one wood stave pipe replacement pipes;
Powerhouse	▪ Rectangular plan 53' x 108';	▪ Unchanged
	▪ Block form stepped massing (elevations 60' north & 50' south);	▪ Unchanged
	▪ Flat tar-and-rock surfaced roof with monitor windows;	▪ Unchanged
	▪ Concrete foundation and unpainted concrete walls;	▪ Unchanged
	▪ Original wooden board double doors; and	▪ Re-hung as sliding doors.
	▪ Double hung and fixed wooden framed multi-light windows.	▪ Unchanged

Source: PacifiCorp 2001

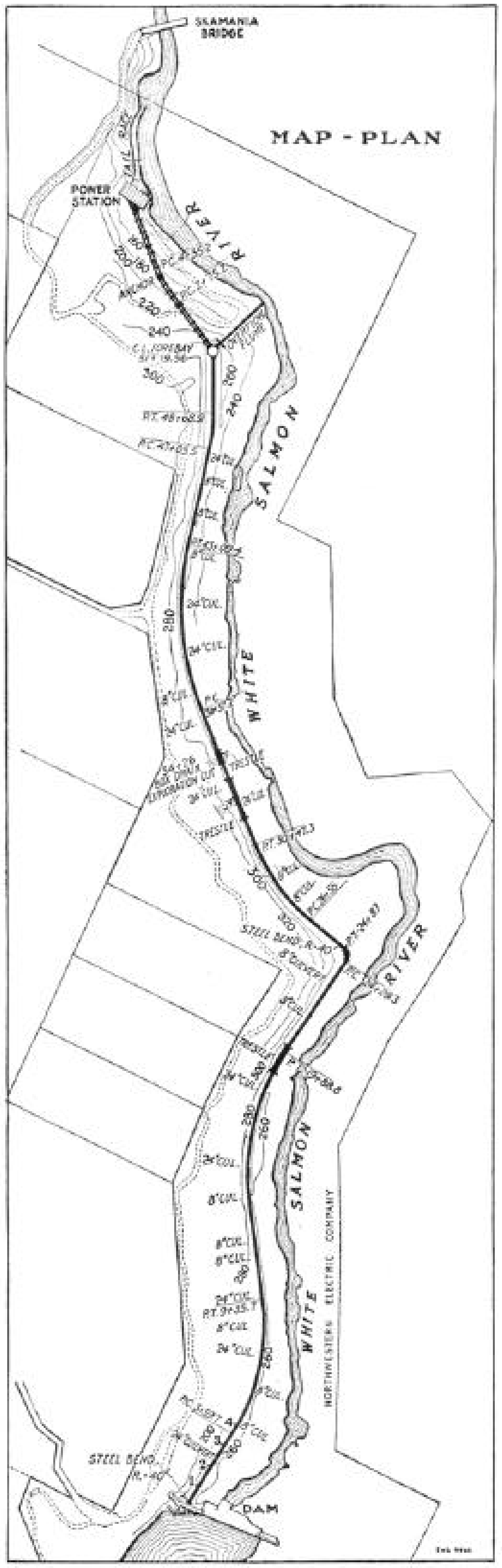


Figure 5.0-1. Contemporary site-map of project components (Source: Engineering News, 1913)

5.1 DAM AND INTAKE

5.1.1 Original Design and Construction

The Condit Dam was designed in 1912 and completed in early 1913. The dam is constructed of solid concrete and contains nearly 30,000 cubic yards of the material between two rock walls of the river gorge. The top of the dam measures approximately 471’ in length, of which the spillway and log and trash sluice comprised 250’. At its narrowest point at the bottom, the dam tapers to 50’ in length (Stone & Webster Engineering Corporation, 1912-1913). From its base to the spillway, it stands 125’ in height and is 88’ thick at the bottom and 15’ thick at the top, with an ogee cross section characteristic of medium head developments of the time (OAHP, 1986). The dam as originally built is shown in Figure 5.1-1.

This dam form sustains the water load entirely by the weight of the masonry. The interface between the concrete and the bedrock was considered ideal. The bedrock is very rough, lower on the upstream side, clean and jagged with the concrete keying into potholes everywhere.

The drawings indicate that a 2’ wide zone of crushed rock drain was placed between 6’ and 12’ downstream of the heel to reduce hydraulic uplift. Eight tile pipes were embedded in the concrete to carry the water from the crushed rock drain to the downstream face of the dam (Black and Veatch, 2002).

At the base of the dam are two 60” diameter discharge conduits. These were used during dam construction to maintain river flow in conjunction with the diversion flume. They were also intended to pass silt deposits expected to settle out in the relatively placid waters of Northwestern Lake; however, there is no record that they were ever used for this purpose. The two gate assemblies, manufactured by the Coffin Valve Company, are 66" diameter sluice gate valves with circular bronze mounted flanges. They are designed to be operated under 120 feet of hydrostatic pressure. Each slide gate has manually operated hand wheels mounted on floor stands located in the headworks building. The gates are connected to the hand wheels and stands by 187' long 3¾" gate stems that extend diagonally downward along the upstream dam face.

The flow line intake at the dam's east abutment was screened to prevent debris from entering the flow line and generating units by a steel trash rack located on the upstream side of the intake. Comprised of near vertical bars spaced about 2" on center, the trash rack was constructed at a skew aligned with the intake's current to assist in gathering and moving debris to a trash sluiceway to pass over the dam (pers. comm., Barney, 2002)

The flow is controlled by five slide gates adjacent to the east abutment of the spillway. The flow line intake gates were originally constructed of wood, set in brass gate seats, and controlled by steel shafts. Control stands with limit switches and electric control devices were manufactured by the Coffin Valve Company. The operating mechanism is housed in a rectangular single-story structure with a flat roof, sash windows, and corrugated metal siding built on the dam crest directly above the five gates. A small rectangular portal penetrated the top of the dam at the west end of the headworks to provide fish passage in conjunction with the original wooden fish ladder.

Most of the crest of the structure was originally designed as an open-crested spillway. On top of this were wooden flashboards that added 5' to the elevation of the dam and intended to fail in the event of unusually high water as an automatic safety mechanism. An opening on the western abutment of the spillway provided the dam operators a way to sluice floating logs trapped upstream of the dam. The flashboard construction was particularly well adapted to the flow conditions of this river, which, like other Washington streams, is subject to short periods of comparatively high water throughout much of the year. To save as much of the flashboard structure as possible during these high water periods, the flashboard pins were designed to fail in sections, the middle section first, the section on the west side next, and the section on the east side last. The design anticipated the maximum flood being 20,000 cfs, which would take out all of the flashboards and leave a free crest (PacifiCorp, untitled).

5.1.2 History of Modifications

Modifications to the Condit Dam began shortly after the project was completed. The first significant change was loss of the original wooden fish ladder that washed out during a flood in 1914. The ladder was immediately rebuilt, only to be washed out a second time in 1918. This time, Northwestern Electric Company and the Washington State Fish Commission agreed not to rebuild it. Instead, Northwestern Electric agreed the following year to help finance construction of a fish hatchery on the lower Columbia River as mitigation for the loss of fish passage.

Nevertheless, in 1925, a third attempt at fish passage was made with an experimental fish elevator by John N. Cobb, the Director of the University of Washington's College of

Fisheries. Following a series of conferences with fish agencies from the states of Oregon and Washington, hydroelectric utilities, and irrigators held in Seattle in May 1924 to address the problem of fish blockage by dams, Professor Cobb proposed a collaborative experiment among biologists and engineers. The purpose of the experiment was to devise a new means of two-way fish passage over dams greater than 30' in height. Funding was shared by both states and the Northwest Electric Light and Power Association.

After considering numerous dams for the experiment, the Condit Project was selected due to the convenient shape of the dam and banks, the river's spring and fall migratory runs, and the accessibility to rail and other transportation. The method of fish conveyance attempted, called a skip hoist, consisting of a galvanized wire basket running on a 62" track. The basket was raised and lowered like an elevator on the track by a rope powered by a 5 hp electric motor and 6 to 1 friction drive. A box was fabricated to replicate the entrance to the former fish ladder. The fish would enter the box and then be picked up by the basket, which had been raised from the bottom after an interval of time. Then the basket would be raised up the track and tilted at the top so that the fish would slide out into a waiting tank that replicated the reservoir.

The trial experiment was complicated by lack of water in the river below the dam, which forced the researchers to transport their salmonid subjects in the rumble seats of their cars to the base of the skip hoist. Although many of the fish died in the process, Professor Cobb's experiment proved conclusively that "if the fish can be induced to enter such a fishway, they can be lifted to almost any height desired." Cobb's report also concluded that fish should be lifted without water and emphasized that "an experienced biologist, who is familiar with the habits of the fish sought to be lifted, is called in before work on the dam is started" (Cobb, 1924). The dam as modified by these changes is shown in Figures 5.1-2 and 5.1-3.

The spillway was another portion of the dam to undergo significant and frequent change during life of the project. The first significant changes to the spillway were made in August 1927 to raise the maximum reservoir operating level 5 vertical feet from elevation 290' to elevation 295'. The increased reservoir level achieved as a result of the taller flashboards doubled the storage capacity of Northwestern Lake (LeFever, 1934). This was accomplished by the replacement of some of the original flashboards with two vertical lift gates, five steel radial gates, and the replacement of a 187' section of the original 5' wooden flashboards with 10' wooden flashboards on the spillway. This modification, completed by December 1927, improved control as well as increased capacity. The motor-operated radial gates allowed the dam operators to control flood waters from the powerhouse. The previous design included no flood gates, so high flow regulation was primarily accomplished by successive failure of sections of flashboards that were designed to trip at different water pressures (LeFever, 1934).

In 1963, the previously replaced flashboards were again replaced on the spillway with new 10' wooden flashboards (Figure 5.1-4); however, these were destroyed during a major flood in February 1996. In consultation with OAHP, the older technology was replaced by a modern Obermeyer system. In place of sacrificial wooden boards controlled by a cable and winch, the Obermeyer system consists of remotely adjustable pneumatically controlled inflatable pillows supporting steel gate panels. As part of these changes, the west slide gate formerly used as a log sluiceway was removed and plugged with concrete to elevation 297'6". This work was completed October 31, 1997.

Other major changes to the dam since construction included a spillway extension and a variety of structural and drainage improvements. As part of the 1927 retrofit that replaced the flashboards, a new spillway apron was constructed below the tainter gates. This apron extended the spillway to the edge of the outcrop to prevent hydraulic undercutting of the dam and created a visually dramatic cascade.

Throughout much of the Condit Project's history, a double log boom consisting of two sets of logs chained together to form continuous parallel booms extended across Northwestern Lake immediately upstream of the dam. These log booms were intended to protect the flashboards from damage caused by floating debris and to prevent boats from getting too close to the spillway. The log boom was also the site of unauthorized use as a floating foot bridge and was replaced by a boat barrier safety boom comprised of a cable and rubber floats when the Obermeyer Gates were installed (pers. comm., Barney, 2002).

In 1972, the aging dam was retrofitted with 22 post-tensioned cable tendons anchored into the bedrock foundation to provide additional safety against extreme flood conditions or severe earthquake events. This modification converted the dam from a gravity section dam to a post-tensioned gravity section dam. Drainage improvements were also made by installing six drains in the diversion tunnel and 13 drains into the two low-level sluiceways, which were also equipped with valves and pressure gages to monitor seepage and uplift pressures. At the same time, the flashboard tripping winch was relocated to a higher level on the east abutment to ensure proper operation during flood conditions.

An isonometric diagram of the dam as designed (and its subsequent modifications) is presented in Figure 5.1-5.

5.1.3 Existing Configuration and Condition

The dam, spillway, and intake are integral (Figures 5.1-6 and 5.1-7). The dam stands 125' high above the riverbed with a thickness measuring between 15' at the crest and 96' at the rollway. Its crest is 471' long of which 187' is comprised of uncontrolled spillway topped by ten sections of 10' high Obermeyer crest gates. Other system components include five 10' by 10' radial gates and one 6' wide vertical slide gate, a gated intake structure, diversion tunnel, and two low-level sluice gates. A concrete operating deck at elevation 297'6" is located over the gated section of the spillway (Black and Veatch, 2002).

Only one of the two original sluice gates remains optional on the dam crest. This is the "trash sluice," a 6' wide timber vertical lift gate at the east end of the spillway adjacent to the intake structure. The vertical gate is 12' high with an ogee crest at Elevation 283.0'. This gate is hand operated. The west vertical lift gate, the "log sluice," and its motor operator were removed, and the flow passage permanently closed with a reinforced concrete plug to elevation 297'6" in 1996, as logs can now safely pass over the Obermeyer gates (pers. comm., Brower, 7/16/2002).

The remaining portion of the spillway crest consists of ten Obermeyer crest gate sections forming a damming height of 10', installed in 1996 (Figure 5.1-8). Fully inflated, the crest is at elevation 295.0' and fully deflated; the crest is at elevation 285'. The crest gate installation consists of ten steel gate panel and air bladder sections. The easternmost gate panel and air bladder section operate independently from the other gate panel and bladder sections; the gate panel has its own dedicated air supply and return pipes. The remaining gate panel and bladder sections operate in unison and are connected to a separate set of air supply and return pipes in a manifold arrangement. The new spillway crest gates are operated from a new control building on the east non-overflow dam section. The control building houses control and air supply equipment (Black and Veatch, 2002). Other than the Obermeyer crest gates, the most noticeable addition to the dam was the 1927 spillway apron that extends the overflow past the dam on a raised rock bench and redirects it nearly parallel to the face of the dam on the eastern side of the river channel (Figure 5.1-9).

There are five 10' by 10' radial (Tainter) gates, numbered 1 to 5 from east to west (Figure 5.1-10). Gate Nos. 1 and 2 are operated by the same hoist simultaneously using either local power or remotely from the Hydro Control Center (HCC) located at PacifiCorp's Merwin Project on the Lewis River. Gate Nos. 3, 4, and 5 are operated locally. Emergency power for the radial, slide, and intake gates is provided by a 20 kW propane-fueled generator. The east vertical lift gate, radial Gate Nos. 1, 2, and 3, and half of radial Gate No. 4 discharge down the spillway ogee to a raised apron or chute section along the east bank just below the flow line. The chute portion of this spillway is at approximately elevation 241.0'. The remaining part of radial Gate No. 4, radial Gate No. 5, and the easternmost crest gate section discharge down a deep spillway section with a toe elevation of approximately 186.5', near the middle of the dam. The remainder of the crest gate sections discharge down the spillway with the toe elevations varying between elevations 232.0' and 262'6" (Black and Veatch, 2002).

The flow line intake is integral with the dam, located adjacent to the left abutment. The intake configuration includes five 9'6" square openings with individually controlled vertical slide gates. The gates are of wood with brass bearing plates and are raised and lowered by valve stands in the gatehouse, connected by a drive shaft so that they can be operated either by machinery or by hand. The intake gates are operated by screw-type operators powered by electric motors. The controls are enclosed by the headworks building (PacifiCorp, 2002).

A boat barrier safety boom is in place across the reservoir upstream of the dam. Two new trash log booms extend upstream from each side of the easternmost spillway crest gate section to new anchor block locations on the east and west abutments. The trash booms keep large debris from accumulating on the trash racks or against the spillway gates (Black and Veatch, 2002).

5.2 FLOW LINE

5.2.1 Original Design and Construction

The flow line consists of a 5,100' long pipe, measuring 13.5' in diameter. At the time of its construction, this was considered the largest wood stave pipe in the world (OAHP, 1986). Running along the east bank of the river, the flow line transmits water from the dam to the surge tank under an average head of 30'. The flow line was constructed of wood staves supported by circular steel support bands and held in place by massive wood cradles set in concrete anchors.

The original design for the flow line called for a circular pipe comprised of ninety-four 4" x 6" staves. The original specifications called for a total of 2,004 tons of #2 clear or better Washington fir ranging from 10' to 32' in length. Each stave was planed with beveled edges on two sides rather than the traditional tongue-and-groove joint. The butting joint was made tight by steel plates acting as dowels pressed into slots cut in the ends of each stave. Because of the pipe's large diameter and the low head, it was necessary to brace the pipe against flattening (OAHP, 1986). This was accomplished by using 20'6" long ¾" round two-piece steel bands held together with nuts, washers, and malleable cast iron shoes spaced approximately 4'6" apart. The entire pipe was secured with 579 massive vertical wood timber cradles spaced 5' to 10' on center on 7½" by 1' wood mud sills. Each cradle stood 9'2" high above the mud sill. In addition, a number of steel reinforced concrete cradles were used, each standing 10'2" high by 17' wide (Engineering News, 1913).

The cradles are secured to the hillside with 3' wide concrete anchors standing 9'9" high. Two portions of the flow line measuring a total of 350 linear feet are supported by trestle structures. The timber for the 4" by 6" staves was shipped from Seattle, while most of the other coarse lumber was processed and provided by the Westfall company near the dam site (The Enterprise, 1912d).

The flow line generally runs parallel to the gently curving river; thus, the flow line itself has numerous and nearly continuous curves. Near the midsection of the flow line, a sharp bend in the river requires a comparable bend in the flow line accomplished with a 63' section of steel pipe with a 40' radius bend. The steel bend is comprised of 13 partially overlapping sections of 3/8" steel plate riveted together (Engineering News, 1913). The steel bend is encased in a massive solid concrete thrust block to anchor the line against movement.

The entire course of the flow line is cut into the river bank high above the east side of the river. Drainage along the 5,100' long traversed hillside is accomplished with 24 corrugated iron culverts that allow stormwater collected from drainage ditches that parallel the flow line to cross under the massive pipe and flow into the river. These culverts range in size from 8" to 24" in diameter (Engineering News, 1913).

At either end of the flow line are 12.5 ton riveted ¾" steel plate thimbles providing watertight connections to the dam and surge tank. Each thimble is inserted 2'8" into the wooden portion of the pipe, secured by steel bands spaced at 2.4" intervals. The upstream end of the flow line is vented by a 3' diameter vent pipe standing nearly 18' above the top of the pipe (Stone & Webster Engineering Corporation, 1912-1913).

5.2.2 History of Modifications

The most significant modification to the flow line in terms of design occurred a decade after the flow line was initially completed. Wooden box cradles were added in 1923 to replace the original cradles that were rotting due to their direct contact with the muddy substrate. The replacement design supports a narrow walkway and rails on top of the flow line (Figure 5.2-2).

The design for the wood stave pipe itself has not been changed since its original construction, although approximately 4,000 linear feet of the original flow line was replaced in September 1962 following a 320' rupture of original flow line on May 14 of that year (Figures 5.2-3 through 5.2-5). The anchors and most cradles and steel bands were reused, but the staves were replaced with select structural grade Douglas-fir with 8 pound empty cell creosote treatment (Goodwin, 1962).

Recent changes have been limited to repairs and maintenance upgrades. Examples include replacement of numerous top spreader timbers, the addition of steel columns to support deteriorating concrete bents at the second trestle, and other repairs and structural replacements (Black and Veatch, 2002).

5.2.3 Existing Configuration and Condition

The flow line's configuration has remained unchanged since the box cradles were installed replacing the original cradles in 1923 (Figure 5.2-6). It is reputed to be in better condition than most wooden flow lines of its type. Small leaks are common, and the wood is weathered, with some foundation, but its overall condition is sound (Black and Veatch, 2002).

5.3 SURGE TANK

5.3.1 Original Design and Construction

The surge tank is located upslope from the powerhouse between the flow line and the pressure pipes. Due partially to its size, and partially to control flows to the penstocks, the surge tank was considered the project's "forebay." It serves as a giant pressure regulation valve between the flow line and the penstocks whenever an excessive internal pressure is set up (OAHP, 1986). Its purpose is to prevent water hammer during load rejection by spilling excess water out of the overflow vent.

The base of the surge tank is a reinforced concrete sub-structure constructed below the grade of the hilltop with a Y-shaped interior to distribute water from the flow line into two 9' penstocks without change of velocity. Directly above the forebay is a 40' diameter concrete superstructure standing 26' high and consisting of reinforced concrete nearly 2' thick. Together, the combined height of the substructure and the superstructure measures approximately 48' tall. The top of the tank is 10' above the crest of the dam and 5’ above the normal reservoir elevation. A curving metal staircase was designed to ascend the exterior wall to the top of the structure but does not currently exist and was likely never built.

The upper section of the surge tank has a 12-sided wall clad with 22 gauge corrugated iron. Each wall section has a single window consisting of six 12” by 16” fixed 3-over-3 lights. The surge tank is topped by a peaked 12-sided tin-covered wood roof. An 8” ball finial decorates the peak.

On the side of the surge tank facing the river is an uncontrolled overflow vent designed to discharge excess water during changes in load at the powerhouse greater than the capacity of the system (PacifiCorp, Untitled). As designed, excess water overflows the surge tank through this vent and runs down the outside of the structure to a concrete and wood spillway. The upper 69 linear feet of this spillway is constructed of reinforced concrete poured during the original construction. The concrete portion of the spillway originally connected to 151 linear feet of wooden flume that descended 82’ toward the river at a 41 percent grade. The wooden flume had 6’ high walls and was 12’ wide, supported on mud sills and trestles (Stone & Webster Engineering Corporation, 1912-1913).

5.3.2 History of Modifications

The only significant change to the surge tank since its 1913 completion was replacement of the wooden flume with the current concrete flume in 1927 (Figure 5.3-1).

5.3.3 Existing Configuration and Condition

The surge tank appears today much as it always has (Figure 5.3-2). The concrete and corrugated metal exterior show signs of age but are structurally sound. The concrete flume that replaced the wooden original in 1927 appears today as an extension to the original concrete spillway.

5.4 PENSTOCKS

5.4.1 Original Design and Construction

Two 9’ inside-diameter penstocks convey water from the surge tank down a steep gradient to the powerhouse. Each parallel pipe is approximately 650’ in length. The head pressure increases from approximately 30’ to 153’ as the water descends 160’ in elevation to the powerhouse.

Both pipes were originally constructed of wood staves supported by circular steel support bands and held in place by reinforced concrete cradles and anchors. The original penstocks were circular pipes comprised of sixty-four 3? ” by 6” staves. The original specifications called for a total of 355.5 tons of #2 clear or better Washington fir averaging 16’ in length, although the staves themselves ranged from 10’ to 32’ in length. Holding the pipes together were ¾” and ? ” round two-piece steel bands held together with nuts, washers, and malleable cast iron shoes spaced approximately 5” to 6” apart.

Both pipes were held in place with concrete cradles spaced on 30" centers and crushed rock ballast, with longitudinal and transverse drains (Stone & Webster Engineering Corporation, 1912-1913).

The upper ends of each wood stave penstock connected to 10.5 ton riveted ? " steel plate thimbles. At the lower end of each penstock near the powerhouse, the wood stave portions joined buried steel sections that enter the ground inside concrete encasements just upstream of the powerhouse. Where they joined, the wood staves were lapped 30" on the steel, and the bands were placed as close as possible. The inside of the steel pipe was the same diameter as the inside of the wood pipe. This produced a slight flare in the staves, allowing the bands to be cinched up, making the joints absolutely tight.

5.4.2 History of Modifications

The materials comprising both pipes have been replaced subsequent to their original construction, but their design and configuration have changed little. The eastern penstock was replaced with welded steel, which replaced the original wood stave penstock in 1962 (Figure 5.4-1). The other is wood stave pipe replaced in-kind in 1968.

5.4.3 Existing Configuration and Condition

Neither penstock has been modified since 1968 other than occasional wooden plugs hammered into the wood-stave pipe to plug leaks. The entire length of both pipes is above grade and is visible. The steel pipe was determined to be in excellent condition during the most recent inspection (Figure 5.4-2). The wood stave penstock has minor sags and bends and is supported by deteriorating concrete saddles, but the penstock itself is tight and functional (Black and Veatch, 2002).

5.5 POWERHOUSE

5.5.1 Original Design and Construction

The powerhouse is located directly on the riverbank at a curve in the river overlooking the Powerhouse Bridge. The powerhouse is rectangular in plan, approximately 53' by 108' in size. In elevation, the building is a stepped, high bay design, the south façade facing the river rises 50' above the water level, and the rear façade is 60' above grade. There is approximately 25' of height differential between the taller and shorter portions of the building as a result of the high voltage room located atop the northern 1/3 of the generating room.

The building is constructed of poured-in-place, reinforced concrete on a concrete foundation. The powerhouse is distinguished by a flat roof, recessed rectangular sash windows, pilasters, and entablature. The building is oriented toward the river to the south (Figure 5.5-1). The lower section of the south façade has six large bays of upper and lower windows. Each of the upper and lower window sections consists of three sets of double-hung windows. The central portion of the lower window has 4-over-7 sash configuration while the center section of the upper window is configured 4-over-3. These are flanked on both sides by 2-over-7 sidelites on the lower windows and 2-over-3 above.

The upper portion of the building has a significantly simpler southern façade design consisting of four double-hung main windows with a narrower window and door below that opens onto the tar and gravel roof of the lower portion of the powerhouse. The building's north façade is also more utilitarian in appearance than the side facing the river. The ground floor contains five double banks of 4-over-1 windows, and the mezzanine level has a mix of window types. The original plans specified the use of "metal frames and sashes and wire glass approved by the Board of Fire Underwriters" (Stone & Webster Engineering Corporation, 1912-1913). There are no window penetrations in the upper (high voltage) floor.

The interior of the powerhouse houses hydroelectric generating equipment. The generating room is the largest space on the first floor. Its interior measures 100' in length, 30' in width, with a ceiling height of 40'. Smaller spaces on this floor include the low voltage switch room, measuring 30' by 20'; the oil pipe room measuring 18' by 7'; and a 5' by 10' store room. The switchboard floor contains the switchboard gallery, two sets of 5' by 7' isolated transformer chambers. A 54' by 12' machine shop is located on the storeroom level. A mezzanine perched above the turbines contains two 7' by 20' wire rooms, and a 7' by 40' store room with stair opening. The high voltage floor contains the 20' by 40' by 100' high voltage room.

Power is generated by two double overhung horizontal, Francis, Type KHD, Quarter turn discharge turbine generator units. Two turbines power each generator. One turbine is located on either side of its generator, the shaft extending through the discharge pipes of the turbines. Each turbine generator unit has a nameplate rating of 4.8 MW at 179' of head pressure. The turbines have a 10,000 hp capacity under a 177' head. The 17-blade turbines have a runner diameter of 51.75", and rotate at 360 rotations per minute (rpm). The peak plant output is 15 MW. Each generator is powered by a pair of horizontal Francis-type double overhung turbines manufactured by the Allis-Chalmers Company of Milwaukee, Wisconsin. Their combined rating is 9,000 hp when operating within a range of 165' to 180' of head pressure. Maximum water use per turbine is 365 cfs per turbine, or 730 cfs per generator unit. The pressure change within turbine inlet is 78 pounds per square inch (psi) but only 6.5 psi at the outlet.

The pair of turbines and their generator shafts are horizontally supported on two outboard bearing stands that flank each side of the generator. The shaft extends through the scroll case of the turbines, and rest against thrust bearings; while these bearings carry no weight in the operation of the units, either unit can be taken down and the other unit can operate the generator when necessary. Thus, during a repair to one turbine unit, only half of the capacity of the generator will be lost (Foshay, 1913).

The exciters include one turbine-driven and one motor-driven exciter, each rated at 125 kilowatts. The motor exciter is powered by a 200 hp, 2,200 volt motor. The single overhung Francis-type exciter has a power rating of 250 hp. The transformers include three banks of 2,000 kilovolt water-cooled transformers manufactured by General Electric, located in concrete compartments behind the generator units. The transformers step up the voltage from 2,300 volts to a line voltage of 66,000 volts for transmission to the city of Portland. The switching apparatus, also manufactured by General Electric, and auxiliaries are also located in the powerhouse. The powerhouse also includes a 40-ton traveling crane for handling heavy equipment in the powerhouse. This crane spans a 40’ gantry and is operated by a 22 hp, 220 volt motor. Powerhouse equipment is summarized in Table 5.5-1.

Table 5.5-1: Specifications of Hydroelectric Generation Equipment.

Equipment	Description
Turbines	9,000 hp double Francis turbines manufactured by Allis Chalmers Company of Milwaukee, Wisconsin under 160’ head. There are two turbines to each generator unit. The 17-blade turbines have a runner diameter of 51.75”, and rotate at 360 rotations per minute (rpm). The turbines have a 10,000 hp capacity under a 177’ head.
Generators	Two double overhung horizontal, Francis, Type KHD, Quarter turn discharge turbine generator units, each with a nameplate rating of 4.8 MW at 179’ of head pressure. The peak plant output is 15 MW (2,300 volt, 3 phase, 60 cycle, 360 rpm).
Exciters	One 250 hp single overhung Francis-type turbine exciter and one 125 volt General Electric exciter (1,000 amp, 850 rpm, last patent date 1910) drawn by a 200 hp 2,200 volt motor.
Transformers	Three banks of 2,000 IVA General Electric water-cooled transformers. Located in concrete compartments behind generator units. The transformers step up voltage from 2,300 to a line voltage of 66,000 volts.
Air Compressor	220 volt General Electric compressor.

Source: OAHP, 1986; pers. comm., Becker & Barney, 2002

5.5.2 History of Modifications

The Condit powerhouse building has undergone little change since its completion in 1913. Most of the changes resulted from equipment maintenance or upgrades, starting with a 73,000 volt, 600 amp oil switch that was installed at the powerhouse in 1927. In the 1940s (pers. comm., Becker), the substation originally located in the upper portion of the powerhouse was replaced with a new outdoor substation located on the hillside north of the powerhouse (Figures 5.5-2 and 5.5-3).

In the early 1980s, both generator units were rewound; however, this modification did not affect generating capacity. In 1986, a 45 kW emergency power generator was installed at the powerhouse to provide power for shutdown and restart of units should loss of station service occur. At the same time, a soundproof office enclosure was installed on the mezzanine’s previously open deck.

Minor changes completed in the early 1990s included repairing existing windows with in-kind materials, adding interior lights, adding rooftop ventilation fans, and removing the hinged doors at two openings - one replaced with louvers for ventilation and the other replaced with roll-up doors. Both of the original doors were retained on sliding tracks following consultation with OAHP. Two sidelights were also replaced with sheet metal ducts. The most recent change occurred in 1999 when both turbine runners were replaced in the No. 1 generator (pers. comm., Barney, 10/9/02).

5.5.3 Existing Configuration and Condition

The powerhouse appears much as it always has (Figures 5.5-4 through 5.5-6). The only obvious exterior changes include the insulators that are no longer connected to high tension connections that protrude from the upper north wall of the building and the ventilation louvers on the north end of the building. With the exception of the office sound enclosure on the mezzanine, most of the interior remains unchanged. The most recent inspection report determined the powerhouse building to be clean as well as maintained (Black and Veatch, 2002).

Figure 5.1-1. View of the concrete gravity dam as constructed, prior to 1927 modifications. Note original fish ladder

Figure 5.1-2. View of the tainter gates and flashboards added in 1927

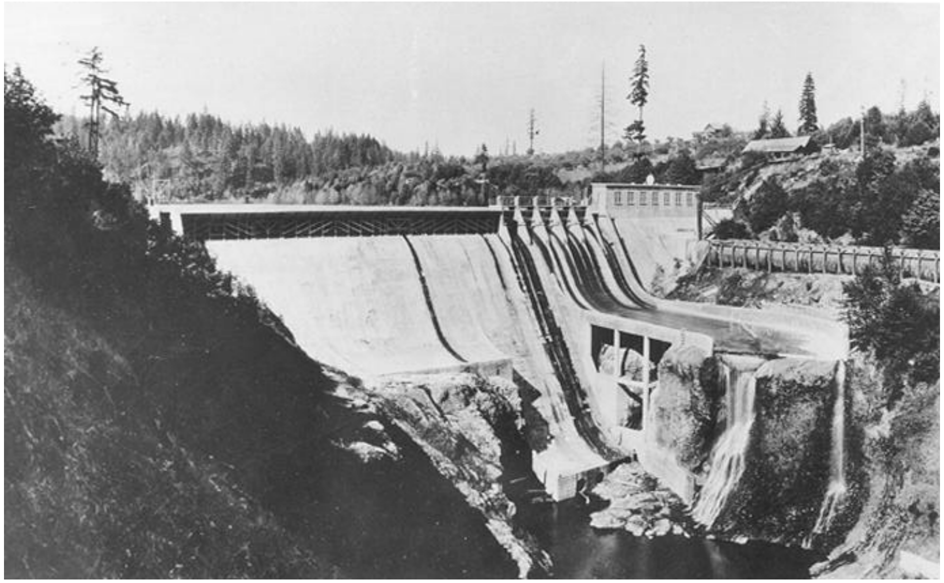


Figure 5.1-3. View of the dam in 1928 after installation of Tainter gates, extended flashboard, and spillway apron

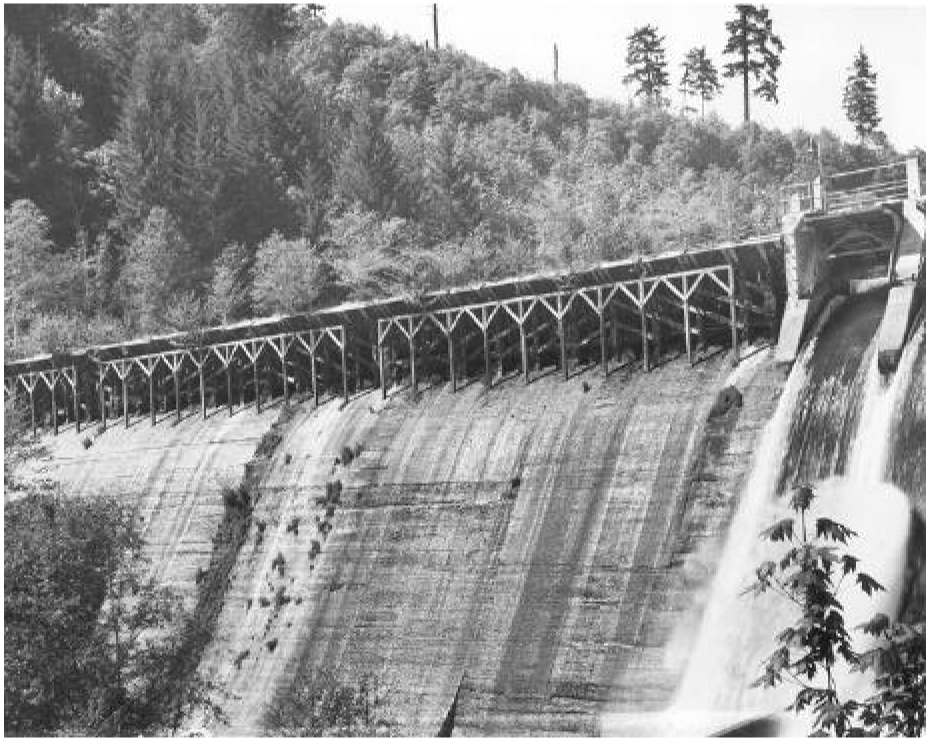
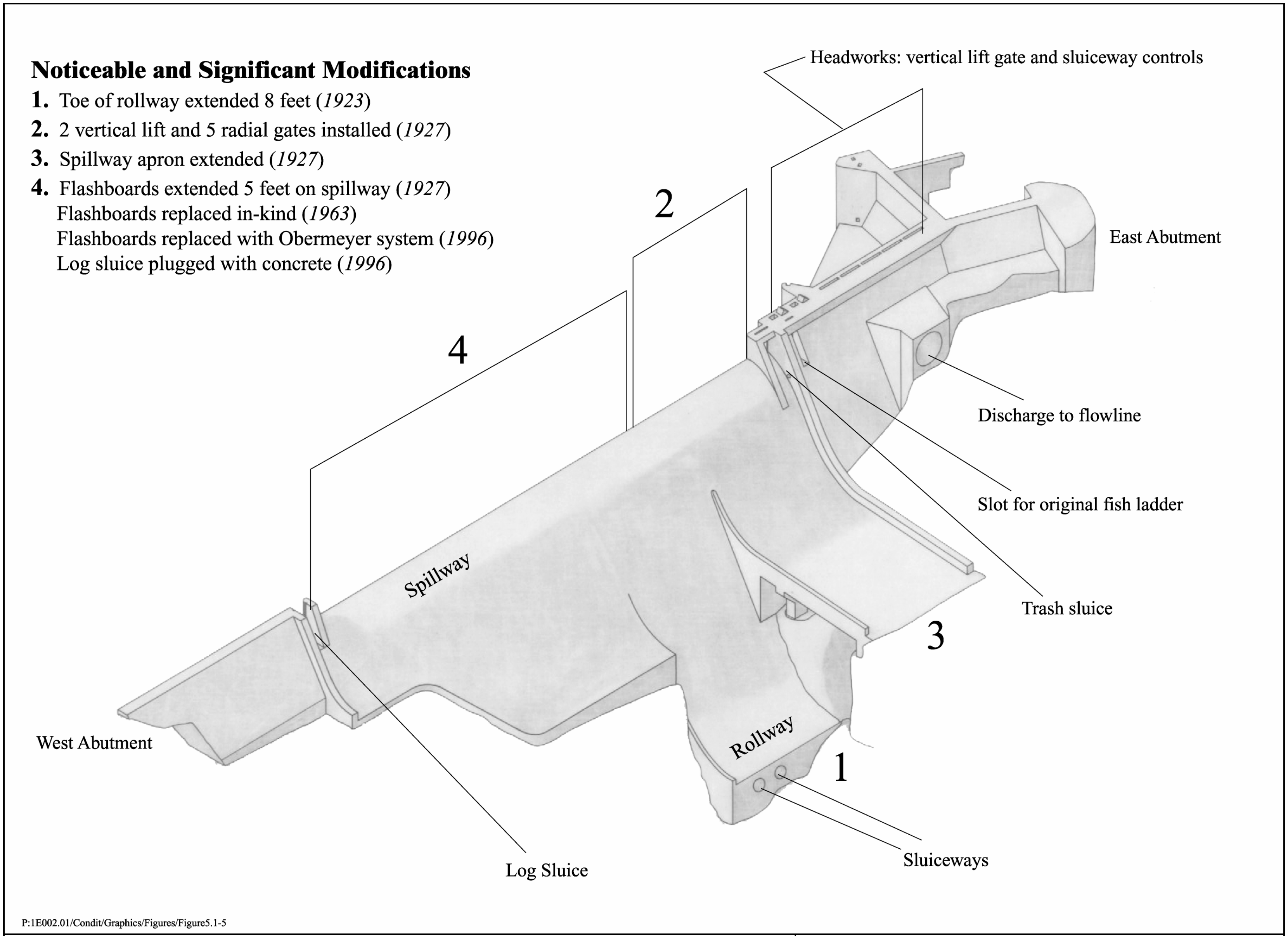


Figure 5.1-4. Newly replaced flashboards on the Condit Dam, 1962



Source: Stone and Webster	Figure 5.1-5 Condit Dam as Designed and Modified

Figure 5.1-5. Isonometric Diagram of Condit Dam as originally designed and subsequent modifications

Figure 5.1-6. View of Condit Dam from above, July 2002

Figure 5.1-7. View of Condit Dam from below, July 2002

Figure 5.1-8. View of Obermeyer System in use on dam spillway, July 2002

Figure 5.1-9. Closeup of apron cascade created by 1927 apron addition, July 2002

Figure 5.1-10. View of Tainter gates added to dam spillway in 1927, July 2002

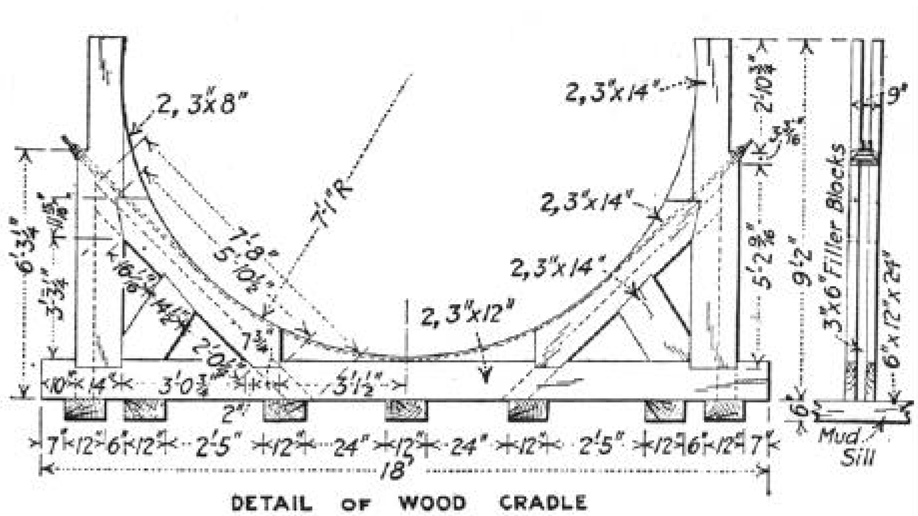


Figure 5.2-1. Detail of original wood cradle design (Engineering News, 1913)

Figure 5.2-2. Detail of box cradles replacing original design in 1923. Note walkway and steel rail on top of flow line.

Figure 5.2-3. Leaks in flow line offered warning of impending pipe implosion, October 1961

Figure 5.2-4. Remains of flow line following rupture, May 1962

Figure 5.2-5. Flow line being rebuilt with new timber, late October 1962

Figure 5.2-6. View of flow line from dam headworks, July 2002

Figure 5.3-1. View of surge tank and concrete overflow section showing construction of 1927

Figure 5.3-2. The surge tank as it appeared in July 2002

Figure 5.4-2. Penstocks as they appeared in 2002. 1962 steel penstock on right, 1968 wood-stave penstock on left

Figure 5.4-1. Newly completed steel penstock with original penstock and surge tank in background, November 1962

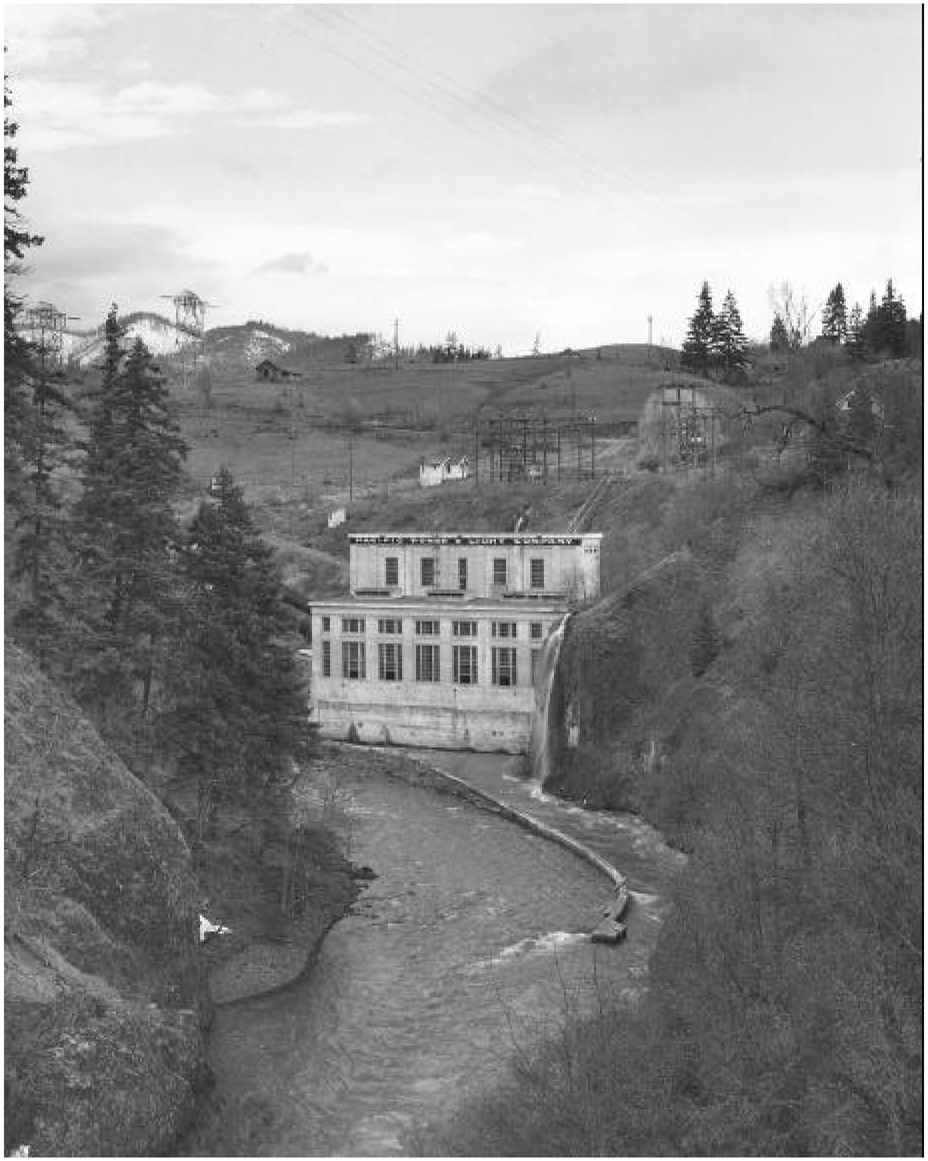


Figure 5.5-1. View upstream toward powerhouse, circa late 1940s

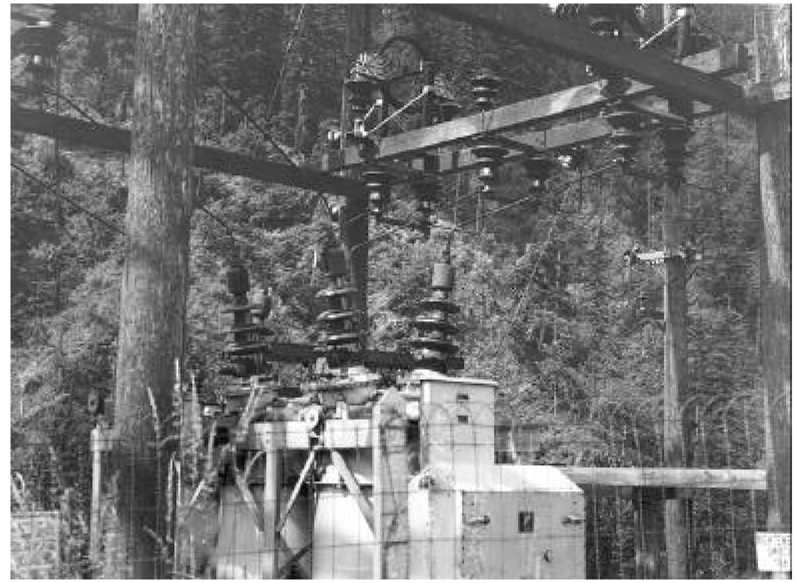


Figure 5.5-2. General view of PEM oil circuit breaker and Niagra Ct's 250/125-5, June 1947

Figure 5.5-3. General view of outdoor switch yard structure, circa 1947 Surge tank and original wooden penstocks in background

Figure 5.5-4. Upstream view of powerhouse, July 2002, with penstocks in foreground

Figure 5.5-5. View of powerhouse from below tailrace, July 2002

Figure 5.5-6. Interior view of powerhouse showing turbines and generators, July 2002

INDEX TO HISTORICAL AND DESCRIPTIVE FIGURES

(i.e., Chapter 5 photographs)

All Photographs by Tom Jordan unless noted with an asterisk (*), in which case photographer unknown, PacifiCorp Archives.

6.0 CONCLUSIONS

The Condit Project's historical significance stems from its contribution to regional development, to engineering and technology, and very possibly to the environmental history of the Northwest. As one of the early large hydroelectric projects in the region, Condit played an important role in the historical development of the lower Columbia River Valley, especially the Camas-Washougal area and to a lesser degree, Portland and Vancouver through provision of electricity to households, businesses, and particularly the Crown Columbia Paper Mill in Camas. This occurred at a time when numerous small electrical producers competed for market share by building their own distribution systems while promoting electricity as a new form of illumination and mechanical power. Later, electricity generated by the conveniently located Condit Project was used as a power source during the construction of the Bonneville Dam by Bonneville Power Administration (BPA) and, thus, indirectly contributed to the growth and development of the Northwest power pool and the near universal distribution of power in the Pacific Northwest.

From an engineering and technology perspective, Condit could not boast the tallest dam, the most remote location, or the largest generating capacity of its day, although it exceeded those characteristics of most other hydroelectric projects of its generation. What impressed most contemporary observers about Condit were the innovative construction practices employed. The manner in which gravity was employed in the concrete manufacturing and delivery to supply the dam's appetite for nearly 30,000 cubic yards of concrete is especially notable. Likewise, the challenging terrain successfully traversed by the crews installing the transmission line to Camas was another example of noteworthy ingenuity. The most distinguishing single feature of the Condit Project was the monstrous size and length of the flow line. At 13'6" in diameter and nearly a mile in length and constructed almost entirely of wood, the flow line bears more resemblance to a wood-stave subway tunnel than a means of water conveyance. At the time of its construction, it was considered the largest in the world and even today remains an impressive site to behold.

From an environmental perspective, the Condit Project has been problematic since 1914 when floodwaters destroyed the original fish ladder only a year after the dam's completion. Subsequent attempts included the experimental skip hoist developed by the University of Washington, which generated considerable technical interest due to the innovative technology being attempted. Despite these repeated attempts, the dam's owners never succeeded in restoring fish passage past the massive concrete impoundment, a mere 3.3 miles from the river's mouth. As a result of this environmental failure, the dam is slated for removal only 6 years shy of its centennial. From an historical perspective, the very concept of dam removal for the sake of habitat restoration represents a radical departure from the longstanding practice of harnessing the power of nature for the purpose of societal and economic gain. Few dams in the United States have been removed for this purpose to date, but there appears to be growing public sentiment to reevaluate the value of power projects in light of increasing understanding of their consequences when measured in environmental terms. Whether as consumers of affordably generated hydroelectricity, recreationists drawn to the flat waters impounded by dams, users of water for irrigation or transport purposes, or those concerned with the health of wild fish stocks, nearly everyone in the region is directly or indirectly affected by the region's hydroelectric dams. It is not surprising then that proposals to remove dams on the Snake, Elwha, or White Salmon rivers would stir such impassioned controversy. As one of the first large dams to come down with a blast of high explosives and a torrent of silt, Condit's demise promises to be a major spectacle and lightning rod for debate. Whether it also becomes an historical turning point heralding an era of dam removal or simply an isolated case of failed cost-benefit analysis is up to history to decide.

7.0 LITERATURE CITED

7.1 DOCUMENT SOURCES

Black & Veatch. 2002. Condit Hydroelectric Project Independent Consultant Safety and Inspection Report, FERC Project No. 2342. October 2002.

Cobb, John N. 1924. *Progress Report on Fishway Work*. Director College of Fisheries, University of Washington, Seattle, Washington. Report available in PacifiCorp files, Portland, Oregon.

Dierdorff, John. 1971. How Edison's Lamp Helped Light the West: the Story of Pacific Power & Light Company and Its Pioneer Forbearers. Oregon: Pacific Power & Light Company.

Donnel, Camilla Thomson. 1913. "Early Days at White Salmon and the Dalles." Washington Historical Quarterly 4. April 1913. pp. 105-115.

Engineering News. 1913. 'A 13½.-Foot Wood—Stave Pipe,' Volume 70, Number 15, October 9, 1913, pp. 686-687.

Entrix, Incorporated. 1991. Condit Hydroelectric Relicensing Project Instream Flow Study and Gravel Enhancement. Prepared for Pacific Power and Light Company, Portland, Oregon. December 1991.

FERC (Federal Energy Regulatory Commission). 1980. Order Requiring Studies. August 29, 1980.

FERC (Federal Energy Regulatory Commission). 2002. Draft Supplemental Environmental Impact Statement, Condit Hydroelectric Project, FERC No. 2343. Office of Energy Projects Division of Environmental and Engineering Review. Washington DC. January 2002.

FERC and Washington State Historic Preservation Officer. 2002. Memorandum of Agreement for Managing Properties that may be affected by PacifiCorp's surrender for the Condit Hydroelectric Project in Klickitat and Skamania counties, Washington. June 30, 2002.

Foshay, Wilbur B. 1913. "Hydroelectric Plant on the White Salmon River." Electrical World 62. August 9, 1913. pp. 275-279.

Foshay, Wilbur B. 1913. 'The White Salmon River Development', Journal of Electricity. Power and Gas, Volume 30, Number 26, June 28, 1913, p. 599.

Gallison, Norman S. 1923. Thirty-Four Years of Hydroelectric Development in the West, Journal of Electricity And Western Industry, Volume 50, February 1, 1923, pp. 91

Goodwin, Perry F. 1962. "Condit Plant – Main Penstock Rebuild." Construction estimate submitted by National Tank & Pipe Co. to George L. Beard, April 4, 1962, Portland, Oregon.

Griffin, Dennis and Churchill. 2001. Archaeological Frontiers, Cultural Resource Survey and Traditional Cultural Property Study of the Lower White Salmon River, Klickitat/Skamania Counties, WA. Prepared for Yakama Nation and PacifiCorp, October 15, 2001.

Journal of Electricity and Western Industry. 1923. 'Northwestern Electric Company Will Build Transmission Lines,' Volume 50, Number 9, May 1, 1923, p. 342.

Keller, David Neal. 1989. Stone & Webster 1889-1989: A Century of Integrity and Service. New York.

Lamar, Lyndon. 1916. Hydroelectric Power, Volume I. New York; McGraw—Hill Book Company, p. 442.

LeFever, O.L., 1934. "History Organization and First Construction and Operations Activities of Northwestern Electric Company." Unpublished Northwestern Electric Company report dated November 2, 1934.

NPS (United States Department of Interior, National Park Service). Undated. National Register of Historic Places Multiple Property Documentation Form, Hydroelectric Power Plants in Washington State, 1890-1938.

OAHP (State of Washington Office of Archeology and Historic Preservation). 1986. National Register of Historic Places Nomination Form for the Condit Hydroelectric Project. Prepared by Lisa Soderberg. October 23, 1986.

Overstreet, R.M., 1913. "White Salmon River Power Development." Engineering Record 68. October 11, 1913. pp. 396-398.

Pacific Builder and Engineer. 1914. 'White Salmon Power Plant,' Power—Factory Number, January14, 1914, p. 6.

Pacific Search. 1978. "How Green Will My Valley Be." October 1978. pp. 18-20.

PacifiCorp. Untitled. Unidentified article on Condit Hydroelectric Project circa 1913. Provided by Brower, Dennis, Operator, Condit Dam, PacifiCorp, July 16, 2002.

PacifiCorp Electric Operations. 1991. Application for New License for Major Project on Existing Dam; Exhibit C. Portland, Oregon. December 1991.

PacifiCorp. 2001. Cultural Resources Management Plan, Condit Hydroelectric Project. Prepared by J. Sterrett, EDAW, Inc. for PacifiCorp, Portland, Oregon. January 25, 2001.

PP&L (Pacific Power and Light Company). 1963. Notice of Application for License. Portland, Oregon. April 11, 1963.

PP&L (Pacific Power and Light). 1960. *Company History and General Information*. Portland, Oregon. December 1960.

Rushmore, David B. 1923. Hydroelectric Power Stations. New York: John Wiley and Sons, Inc., p. 79.

Stone & Webster Engineering Corporation. 1912-1913. Construction documents for White Salmon Project, prepared for Northwestern Electric Company, 1912-1913, on file with PacifiCorp, Portland, Oregon.. Documents include original construction drawings, cost accounting records, and construction photographs.

Thompson, Albert J. 1923. "Memories of the White Salmon and Its Pioneers." Washington Historical Quarterly 14. April 1923. pp. 108-126.

Wolner, Craig. 1990. Electrifying Eden, Portland General Electric 1889-1965. Oregon Historical Society Press, Portland, Oregon.

Wood, Robert L. 1967. Across the Olympic Mountains: The Press Expedition, 1889-1890. University of Washington Press, Seattle, Washington.

Young, Lori-Ann S. Undated. *The Paper Mill and the City of Camas: Is Camas Still a Mill Town?* Washington State University (History 469 student paper) published on Center for Columbia River History Website, accessed 9/26/2002: http://www.ccrh.org/comm/camas/student%20papers/camas%20mill.htm

7.2 NEWSPAPER ARTICLES

The Columbia Basin Bulletin. 2002. 2002 "Report Calls Condit Removal Best Option", *by Barry Espenson.* Weekly Fish and Wildlife News, February 1, 2002.

The Enterprise. 1912a. *Work At Narrows: Long Tunnel - Now Sluicing at Site Farther Up Valley*. White Salmon, WA. March 15, 1912, page 1.

The Enterprise. 1912b. *Another Dam Site: Sluicing and Drilling at Jaws of the White Salmon River*. White Salmon, WA. April 5, 1912, page 1.

The Enterprise. 1912c. *Dam Site Selected: Northwestern Will Build Big Dam on White Salmon at Once.* White Salmon, WA. April 26, 1912, page 1.

The Enterprise. 1912d. *Rushing Work At The Dam: Concrete Fill Goes On Apace -- 750 Men On The Job*. White Salmon, WA. November 29, 1912, page 1.

The Enterprise. 1913a. *Dam Gates To Close Shortly: Big Wooden Tunnel Gets Close to Surge Tank at Power End*. White Salmon, WA. March 11, 1913, page 1.

The Enterprise. 1913b. *Water Turns Big Turbines: River Capable of Many Uses - Municipal, Public, Domestic*. White Salmon, WA. March 28 ,1913, page 1.

The Independent. 1912. *News From Trout Lake.* Goldendale, WA. December 2, 1912, page 9.

The Klickitat County Agriculturist. 1913. *Klickitat Intelligence*. Goldendale, WA. March 29, 1913, page 1.

7.3 INTERNET SOURCES

American Rivers Website, accessed 09/15/01; URL= http://www.americanrivers.org/damremovaltoolkit/conditdam.htm

American Whitewater Website, accessed 09/15/01; URL= http://www.americanwhitewater.org/archive/article/4/

Center for Columbia River History Website, accessed 09/15/01, 9/26/02; URL= http://www.ccrh.org/curr/conditdam.html

Columbia River Inter-Tribal Fish Commission Website, accessed 09/15/01; URL= http://www.critfc.org/text/29APR97.HTM

High Country News Website, accessed 09/15/01; URL= http://www.hcn.org/servlets/hcn.URLRemapper/1997/oct27/dir/Sidebar_Dam_decons.htl

Obermeyer Hydro, Inc. Website, accessed 09/15/01; URL= http://www.obermeyerhydro.com/condit.html

PacifiCorp Website, Accessed 10/2/02: http://www.pacificorp.com/Navigation/Navigation3877.html

U.S. Department of the Interior Website, accessed 09/15/01; URL= http://www.doi.gov/news/archives/pacifi.html

7.4 LETTERS AND PERSONAL CORRESPONDENCE

Barney, Richard, Civil Engineer, PacifiCorp; telephone interview with Mike Usen, Planner, EDAW, Inc. Seattle Washington, October 9, 2002

Barney, Richard, Civil Engineer, PacifiCorp; written comments provided to Mike Usen, Planner, EDAW, Inc. Seattle Washington, November 14, 2002

Becker, Tom, Condit Hydroelectric Plant Operator, PacifiCorp; telephone interview with Mike Usen, Planner, EDAW, Inc. Seattle Washington, November 21, 2002

Brower, Dennis, Operator, Condit Dam, PacifiCorp, interview with Mike Usen, Planner, EDAW, Inc. Seattle Washington, July 16, 2002.

Central Designs Organization to Pacific Power and Light Company, 1985.

de Luccia, Robert, Vice President & Chief Engineer; letter to George Y. Harry, Jr., Director of Research, Oregon Fish Commission, Clackamas, OR, August 30, 1956.

Marshall, A.R., Colonel, U.S. Army Corps of Engineers, Portland, OR; letter to M.F. Thomas, Federal Power Commission, San Francisco, CA, April 9, 1974.

McCoy, Keith, local historian; telephone interviews with Mike Usen, Planner, EDAW, Inc. Seattle Washington, December 18, 2001 and January 22, 2002.

Miller, Gail, PacifiCorp; written comments provided to Mike Usen, Planner, EDAW, Inc. Seattle Washington, November 14, 2002

ATTACHMENT A

Condit Hydroelectric Project
White Salmon River
Skamania and Klickitat Counties
Washington

PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

~~[Note: Photos provided separately; not bound with this document]~~

Tom Jordan, Photographer July 16th & 17th 2002

1. VIEW OF THE DOWNSTREAM FACE OF THE DAM FROM ACROSS THE WHITE SALMON RIVER LOOKING NORTHEAST. THE CAMERA POSITION IS APPROXIMATELY 50' ABOVE THE WATER. THIS VIEW SHOWS THE OBERMEYER GATES AT THE WESTERN PORTION OF THE DAM CREST AND THE TAINTER GATES AT THE EASTERN END, ADJACENT TO THE HEADWORKS STRUCTURE (THE CORRUGATED STEEL SIDED BUILDING LOCATED IN THE UPPER RIGHT HAND CORNER OF THE IMAGE). THE TWO SLUICEWAY COVERS ARE BELOW THE ROLLWAY AT THE TOE OF THE DAM. WATER CASCADES FROM THE SPILLWAY APRON (ADDED IN 1927).

2. INTERIOR VIEW OF THE HEADWORKS BUILDING LOOKING EAST. THIS VIEW SHOWS THE CONTROLS (GEARS AND WHEELS) FOR THE VERTICAL INTAKE SLIDE GATES ILLUMINATED BY SOUTH-FACING WINDOWS. THE HEADWORKS BUILDING IS A LONG NARROW CORRUGATED STEEL SIDED STRUCTURE THAT PROVIDES WEATHER PROTECTION TO THE INTAKE AND SLUICEWAY CONTROLS.

3. VIEW OF FLOW LINE, DAM, AND HEADWORKS TAKEN FROM THE WALKWAY ON TOP OF THE FLOW LINE LOOKING NORTH. THIS VIEW SHOWS THE UPSTREAM END OF THE FLOW LINE WHERE IT JOINS THE INTAKE JUST BELOW THE HEADWORKS BUILDING (THE CORRUGATED STEEL SIDED BUILDING). THE TAINTER GATES (ADDED IN 1927) AND TRASH SLUICE AND FORMER FISH LADDER OPENING ARE VISIBLE IN THE LEFT SIDE OF THE IMAGE.

4. VIEW OF THE UPPER PORTION OF THE FLOW LINE FROM THE HEADWORKS LOOKING SOUTH. THE STEEL NIPPLE IS VISIBLE IN THE LOWER LEFT CORNER OF THE IMAGE. THE 1927 SPILLWAY APRON IS VISIBLE IN THE LOWER RIGHT CORNER.

5. GENERAL VIEW OF THE UPPER PORTION OF THE FLOW LINE FROM THE HEADWORKS LOOKING SOUTH. THE STEEL NIPPLE, VERTICAL STEEL VENT PIPE, AND CONCRETE PORTION OF THE INTAKE ARE VISIBLE IN THE LOWER LEFT CORNER OF THE IMAGE. THE ELEVATED FLOW LINE IS SUPPORTED BY A LARGE TIMBER FRAME STRUCTURE AND METAL SUSPENSION RODS.

6. PHOTOGRAPH TAKEN FROM THE WALKWAY ON TOP OF THE FLOW LINE LOOKING SOUTH. THE FLOW LINE BENDS 90° TO FOLLOW THE COURSE OF THE WHITE SALMON RIVER. THE BEND IS ACHIEVED WITH A SECTION OF RIVETED STEEL PIPE HELD IN PLACE WITH A CONCRETE THRUST BLOCK.

7. VIEW OF THE FLOW LINE AND SURGE TANK LOOKING SOUTH. THIS VIEW SHOWS THE WOODEN WALKWAY, STEEL RAILS AND RAIL CART ON TOP OF THE FLOW LINE.

8. VIEW OF THE FLOW LINE AND SURGE TANK LOOKING SOUTHWEST FROM ABOVE. THE WOOD STAVE PORTION OF THE FLOW LINE IS ATTACHED TO A STEEL NIPPLE THAT IS INTEGRAL TO THE SURGE TANK INTAKE. THE SURGE TANK IS COVERED BY A WOODEN ROOF STRUCTURE CLAD WITH CORRUGATED STEEL.

9. VIEW OF THE WEST SIDE OF THE FLOW LINE AND SURGE TANK LOOKING SOUTH. THIS VIEW SHOWS THE HEAVY WOODEN TIMBER BOX STRUCTURE AND STEEL SUSPENSION RODS SUPPORTING THE FLOW LINE.

10. VIEW OF POWERHOUSE FROM SERVICE ROAD LOOKING SOUTH. THE LOWER PORTION OF THE BUILDING HOUSES THE TURBINES AND GENERATOR EQUIPMENT. THE UPPER PORTION WAS BUILT TO HOUSE THE HIGH-TENSION APPARATUS. THE PENSTOCK IN THE FOREGROUND WAS CONSTRUCTED OF STEEL IN 1962; THE OTHER, A WOOD STAVE PIPE CONSTRUCTED IN 1968, IS OBSTRUCTED FROM VIEW BY THE STEEL PENSTOCK. BOTH REPLACED THE ORIGINAL WOOD STAVE PIPES.

11. VIEW OF THE POWERHOUSE LOOKING NORTH. THE PHOTO IS TAKEN APPROXIMATELY 150’ DOWNSTREAM FROM THE POWERHOUSE WITH THE TAILRACE DIVERSION WALL IN THE FOREGROUND. THE CAMERA IS LOCATED ON TOP OF A 4’ HIGH CONCRETE TAILRACE DIVERSION WALL. THE LARGE GLASS WINDOWS ARE PUNCHED OPENINGS IN THE CONCRETE BUILDING’S SOUTH ELEVATION. THE INSCRIPTION ON THE POWERHOUSE READS “PACIFIC POWER AND LIGHT COMPANY.”

12. VIEW OF THE POWERHOUSE LOOKING NORTH. THIS IMAGE SHOWS THE MINIMAL FLOW IN THE RIVER ON THE LEFT, AND THE OUTFALL FROM THE TAILRACE ON THE RIGHT.

Condit Photo 1

Condit Photo 2


Condit Photo 3

Condit Photo 4


Condit Photo 5

Condit Photo 6

Condit Photo 7

Condit Photo 8

Condit Photo 9

Condit Photo 10

Condit Photo 11

Condit Photo 12

ATTACHMENT B

Condit Hydroelectric Project
White Salmon River
Skamania and Klickitat Counties
Washington

HISTORICAL RECORD DRAWINGS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

~~[Note: Drawings provided separately; not bound with this document]~~

Stone and Webster Engineering Corporation, 1912-1913
PacifiCorp Drawing Files

F38242	ELEVATION-UPSTREAM DAM FACE, DRAWN DECEMBER 4, 1912.
F38239	ELEVATION-DOWNSTREAM DAM FACE, DRAWN DECEMBER 4, 1912.
F38241	ISOMETRIC VIEW-DAM, DRAWN MARCH 5, 1913.
H38247	CONCRETE CRADLE AT HEADWORKS-FLOW LINE, DRAWN JANUARY 7, 1913.
F28627	PLAN & ELEVATION-STAIRS-FOREBAY, DRAWN JANUARY 2, 1913.
F28443	GENERAL PLAN & ELEVATION-STEEL PIPES, DRAWN SEPTEMBER 5, 1912.
F38285	SPILLWAY FLUME-FOREBAY, DRAWN MARCH 5, 1913.
F38411	WHITE SALMON POWER STATION-FRONT ELEVATION, DRAWN SEPTEMBER 3, 1912.
F38243	GENERATOR FLOOR PLAN POWER STATION, DRAWN NOVEMBER 1, 1912.
F38411	WHITE SALMON POWER STATION-FRONT ELEVATION, DRAWN SEPTEMBER 3, 1912.
F38246	CROSS SECTION-POWER STATION, DRAWN DECEMBER 12, 1912.

NO.	DATE	DESCRIPTION	CHECK'D	INSPECT.	CORREC	APPROVED

TABLE OF CHANGES USE ONLY PRINTS SHOWING LATEST CHANGE

ELEVATION-UP-STREAM FACE-DAM

WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

F38242.

SCALE 1/8" = 1'-0"
DEC. 4-1912
ENG. JOB ORDER 1239

CHECKED	INSPECT'D	CORRECT	APPROVED
2-16-13		3-10-13	
G.R.S.		F.B.G.	

F38242

F 104
1239

NO.	DATE	DESCRIPTION	CHECKED	INSPECTED	CORRECT	APPROVED

TABLE OF CHANGES — USE ONLY PRINTS SHOWING LATEST CHANGE

ELEVATION DOWN-STREAM FACE-DAM
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

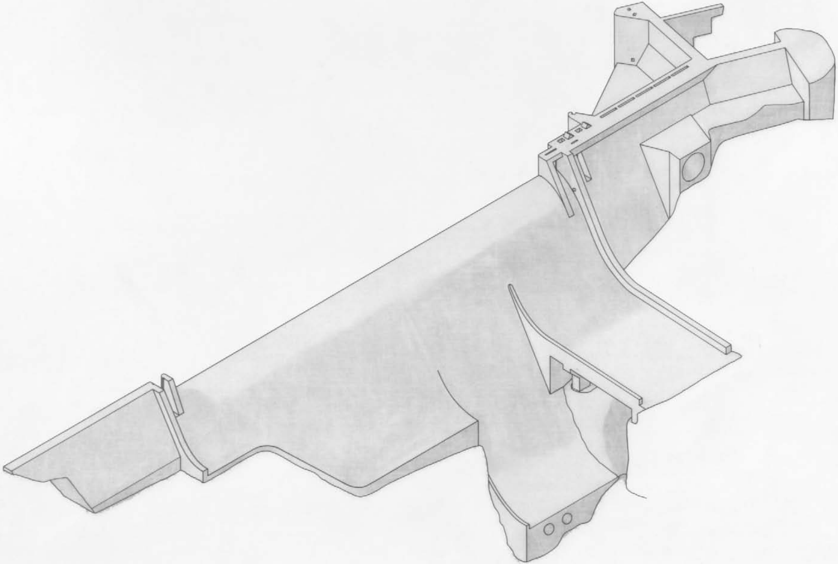
SCALE $\frac{1}{8}$" = 1'-0"
DEC. 4 - 1912
ENG. JOB ORDER 1239

CHECKED	INSPECTED	CORRECT	APPROVED
2-16-13		3-13-13	
G.R.S.		T.B.G.	[illegible]

F38239

F38239

F103
1239

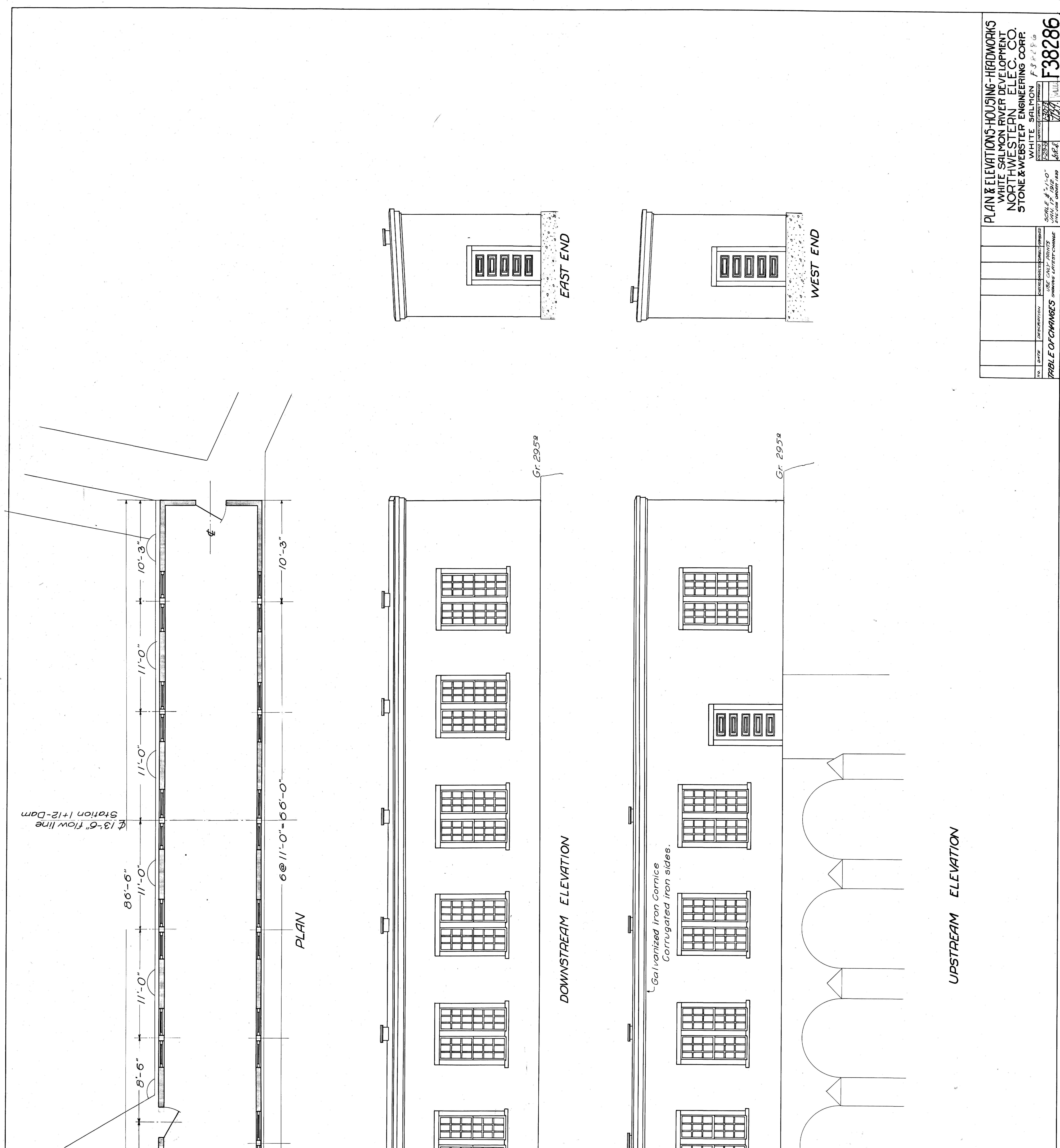


ISOMETRIC VIEW – DAM
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELECTRIC CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

NO.	DATE	DESCRIPTION
TABLE OF CHANGES		

F38241

CONDIT
F-38286-00
PLAN & ELEVATIONS - HOUSING - HEAD



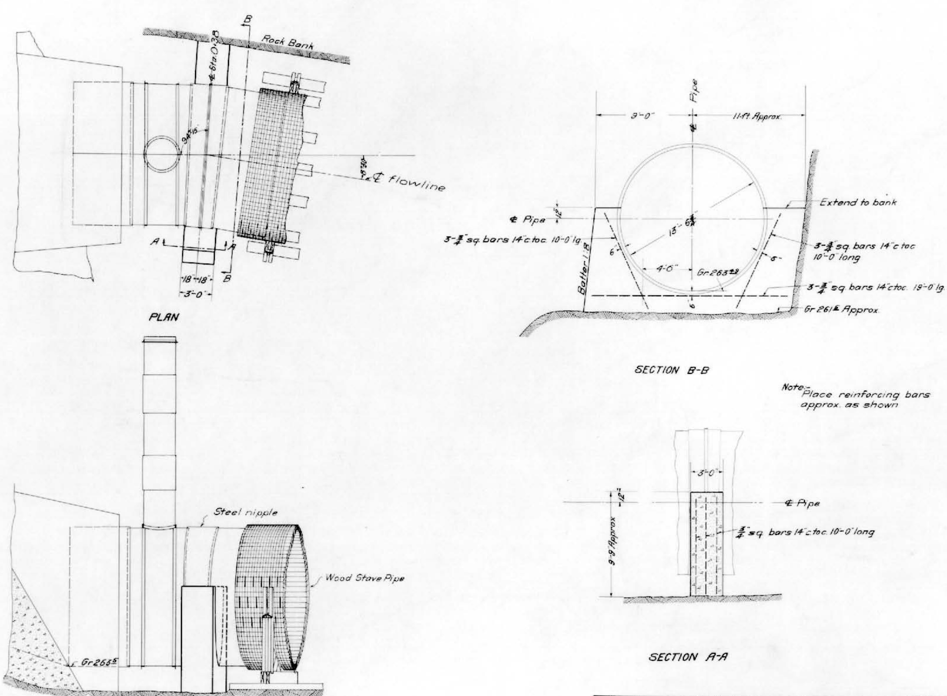


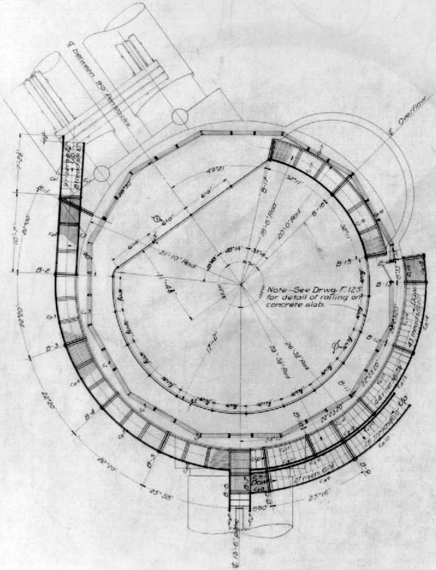
TABLE OF CHANGES	USE ONLY PRINTS SHOWING LATEST CHANGE					

CONCRETE CRADLE AT HEADWORKS - FLOW LINE
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

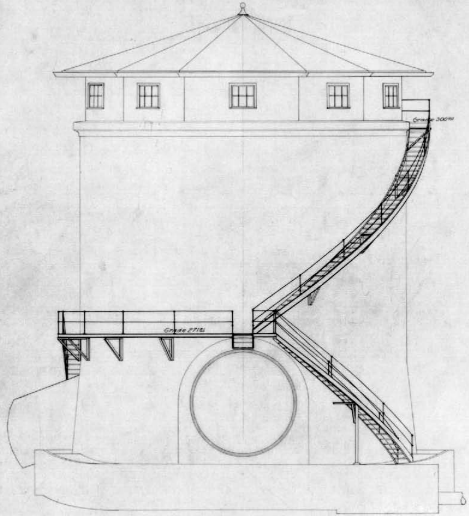
SCALE ¼" = 1'-0"
JAN. 7, 1913
ENG. JOB ORDER 1239

H38247

H-126
1239



PLAN



ELEVATION

1	2-8-13	Spacing of ...		
NO.	DATE	DESCRIPTION		

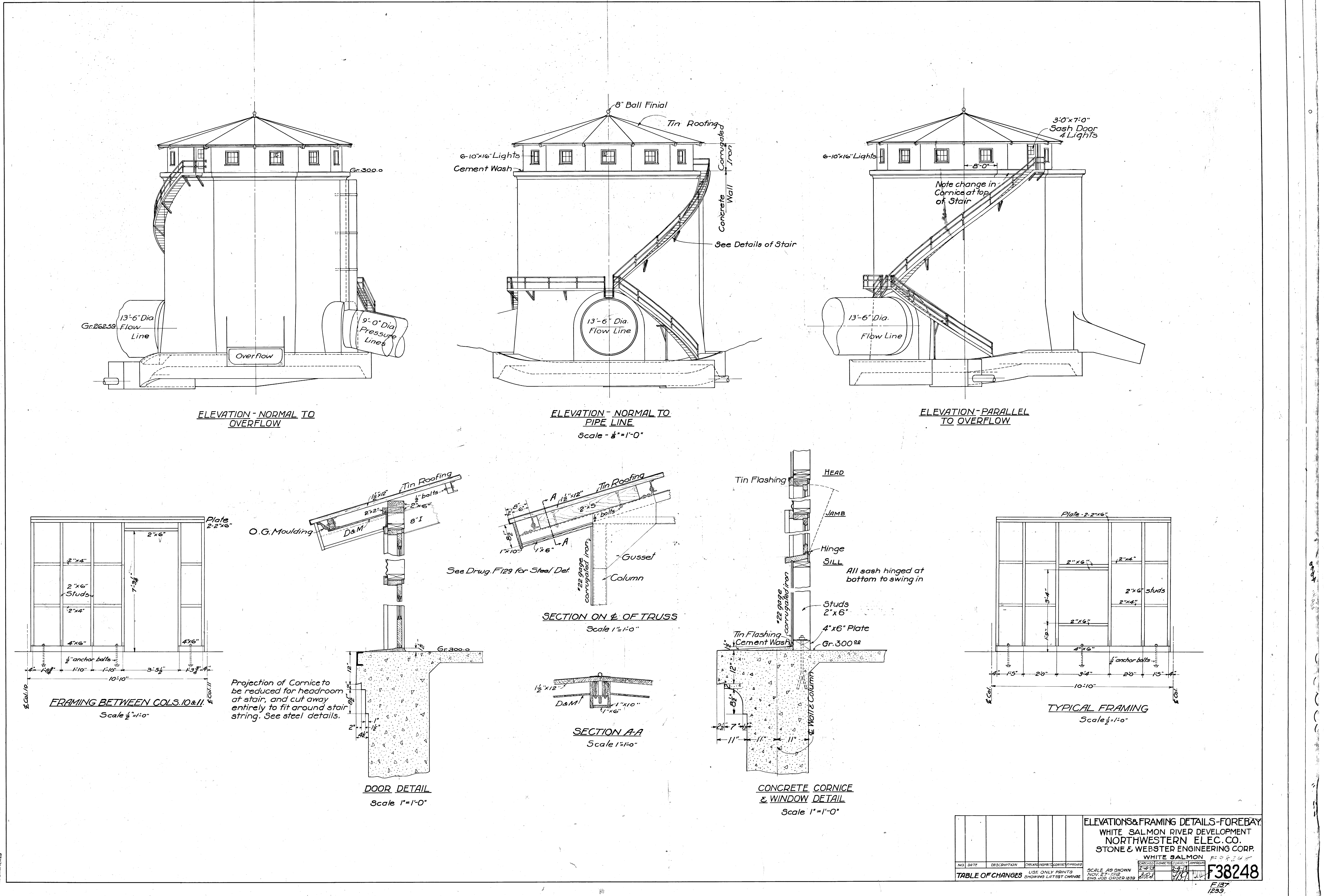
TABLE OF CHANGES

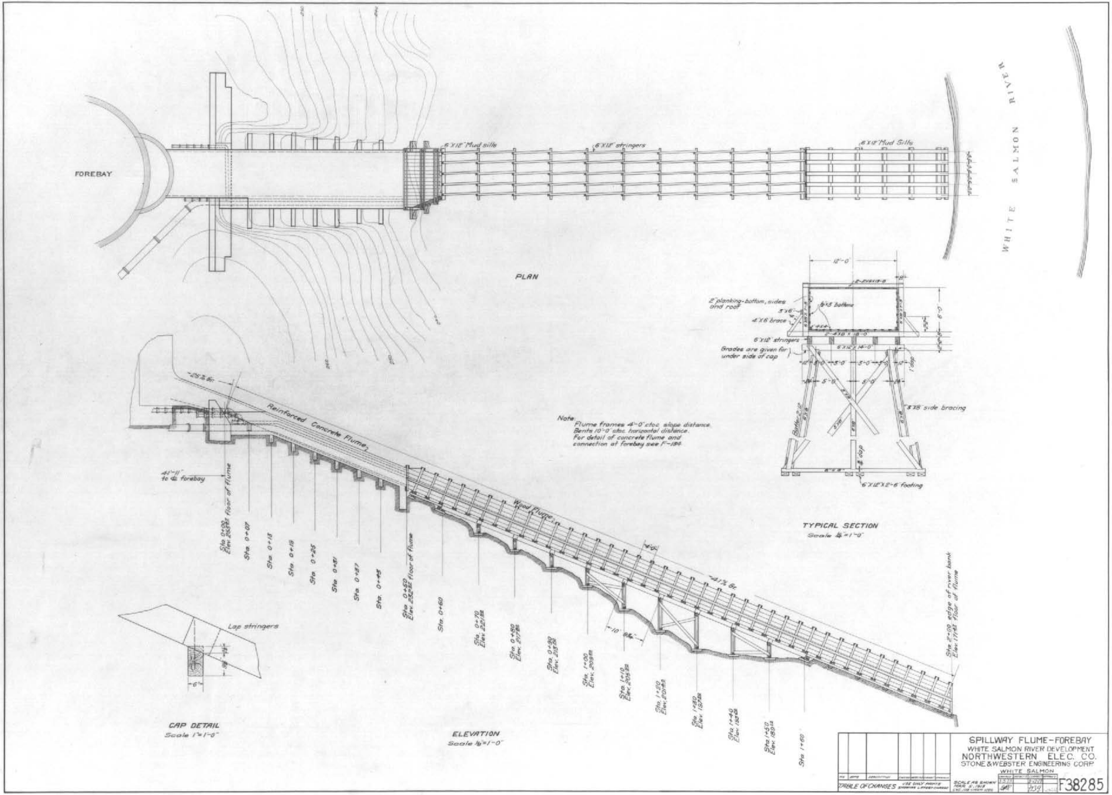
PLAN & ELEVATION-STAIRS-FOREBAY
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

F23627

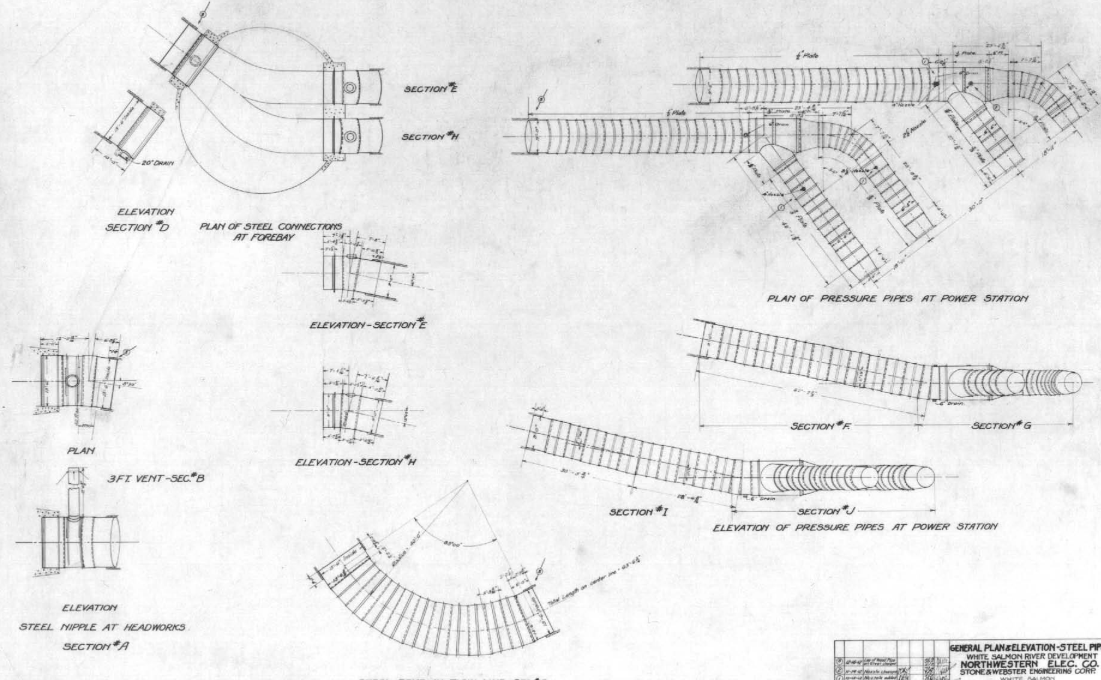
F-122
1239

CONDIT
F-38248-00
ELEVATION & FRAMING DETAILS - FORE





FOREBAY
6"X12" Mud sills
6"X12" stringers
6"X12" Mud Sills
WHITE SALMON RIVER
PLAN
2" planking-bottom, sides and roof
4"X6" brace
6"X12" stringers
Grades are given for under side of cap
12'-0"
6'-0"
6"X8" side bracing
6"X12"X2'-6" footing
TYPICAL SECTION
Scale 1/4"=1'-0"
Note:
Flume frames 4'-0" c to c slope distance.
Bents 10'-0" c to c horizontal distance.
For detail of concrete flume and connection at forebay see F-134
Reinforced Concrete Flume
Wood Flume
41'-11" to ℄ forebay
Sta. 0+00 Elev. 263 floor of flume
Sta. 0+07
Sta. 0+13
Sta. 0+19
Sta. 0+25
Sta. 0+31
Sta. 0+37
Sta. 0+43
Sta. 0+50 Elev. 232 floor of flume
Sta. 0+60
Sta. 0+70 Elev. 221
Sta. 0+80 Elev. 217
Sta. 0+90 Elev. 213
Sta. 1+00 Elev. 209
Sta. 1+10 Elev. 205
Sta. 1+20 Elev. 201
Sta. 1+30 Elev. 197
Sta. 1+40 Elev. 193
Sta. 1+50 Elev. 189
Sta. 1+60
Sta. 2+00 edge of river bank Elev. 171 floor of flume
Lap stringers
CAP DETAIL
Scale 1"=1'-0"
ELEVATION
Scale 1/8"=1'-0"
TABLE OF CHANGES
SPILLWAY FLUME-FOREBAY
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON
SCALE AS SHOWN
MAR. 5, 1913
F38285



No.	Date	Description				
3	12-16-12	Lay of Wood Pipe on Steel changed				
2	11-19-12	Nozzle changed				
1	10-18-12	Nozzle added				

TABLE OF CHANGES USE ONLY PRINTS SHOWING LATEST CHANGE

GENERAL PLAN & ELEVATION - STEEL PIPES
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

SCALE 3/8" = 1'-0"
SEPT. 6, 1912

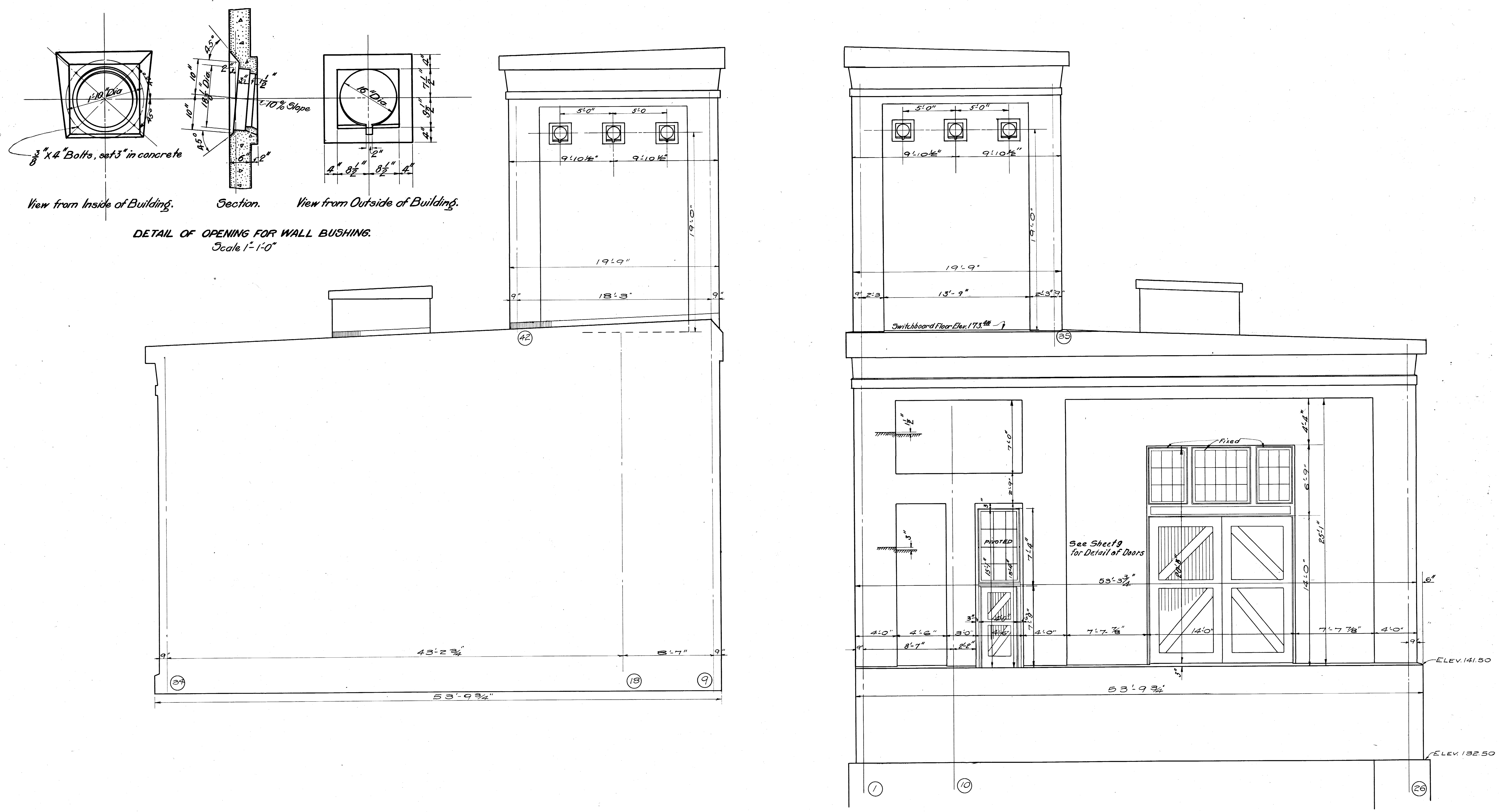
F28443

F-41
1239

F38411

					WHITE SALMON POWER STATION.	J.O. No. 1239
					NORTHWESTERN ELECTRIC CO.	
					FRONT ELEVATION	SHEET
					STONE & WEBSTER ENGINEERING CORP.	1.
2			A.J.R.		SCALE 1/4" SEATTLE DATE 9-5-16.	
1			A.J.R.			
No.	Date	Description	Chk'd	Appr.	Drawn: AN.K. Traced: A.J.R. Checked: L.H.P. Approved: Drawing No. F38411	
TABLE OF CHANGES						

1239-885



DETAIL OF OPENING FOR WALL BUSHING.
Scale 1"-1'-0"

Condit

F38412

No	Date	Description	Chkd	Appr.
4	1-16-13	Cornice	A.J.R	
3	1-10-13	Wall Bushings	A.J.R	
2	11-21-12	Small Door	A.J.R	
1	10-29-12	Cornices	A.J.R	

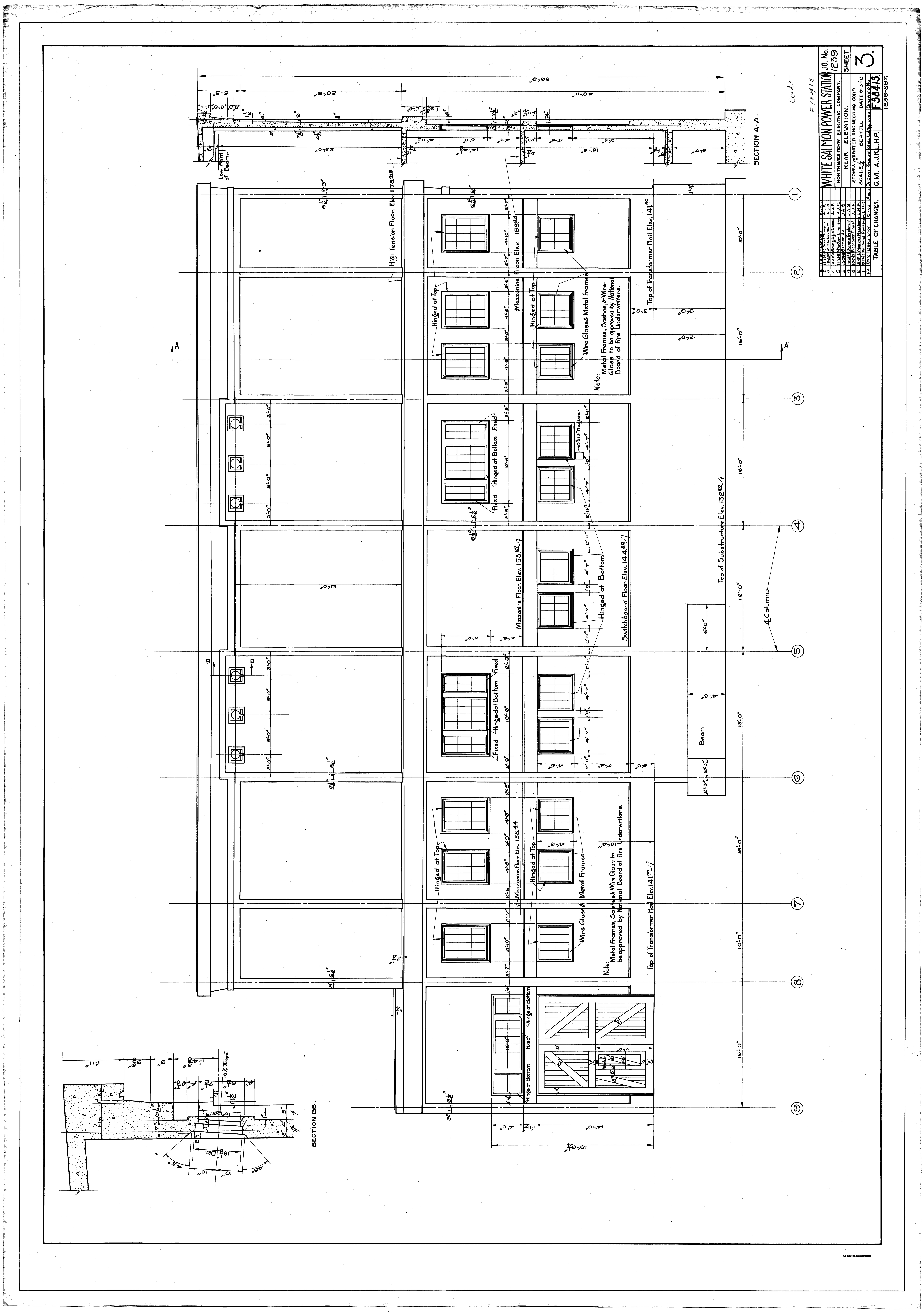
TABLE OF CHANGES

WHITE SALMON POWER STA — J.O. No 1239
NORTHWESTERN ELECTRIC CO.
END ELEVATIONS — SHEET 2
Stone + Webster Eng. Corp.
Scale 1/4"=1' SEATTLE 9-3-12

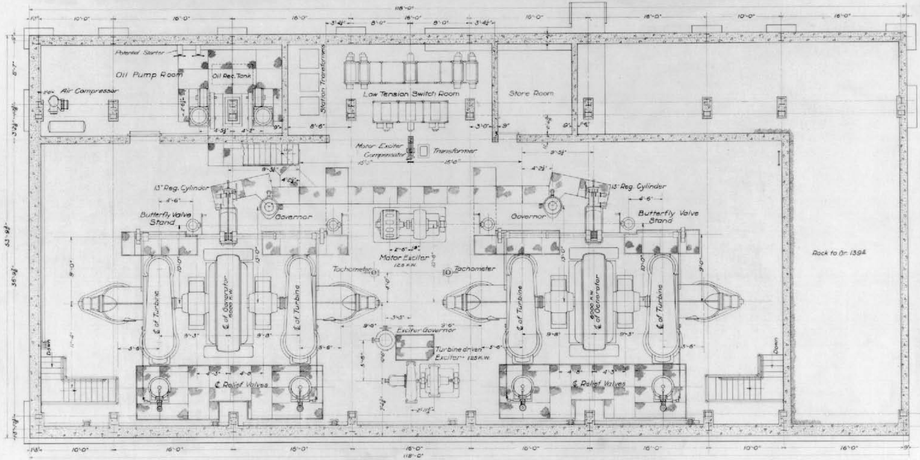
Drawn	Traced	Checked	Approved	Drawing No
C.M.	O.A.S.	L.H.P.		F38412.

1239-896

CONDIT
F-38413-00
REAR ELEVATION



CONDIT
F-38414-4
CROSS SECTION



GENERATOR FLOOR PLAN - PR. STATION
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

TABLE OF CHANGES

F38243

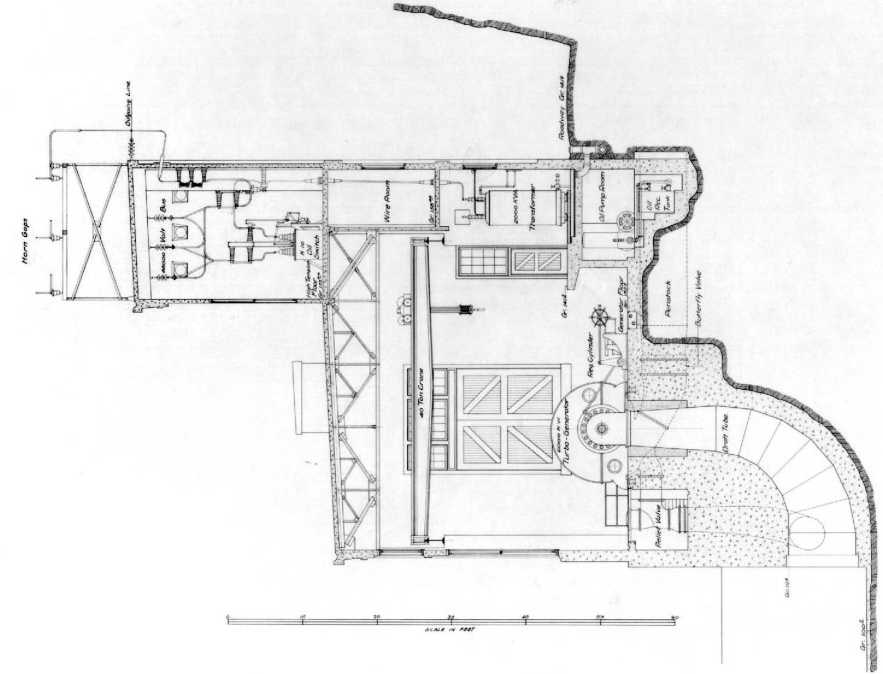


TABLE OF CHANGES

CROSS SECTION – POWER STATION
WHITE SALMON RIVER DEVELOPMENT
NORTHWESTERN ELEC. CO.
STONE & WEBSTER ENGINEERING CORP.
WHITE SALMON

F38246

F-140
1239