BAGNELL DAM AND OSAGE POWER PLANT
Spanning Osage River on Business Route 54
Lake Ozark
Miller County
Missouri

HAER No. MO-117

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Midwest Regional Office
601 Riverfront Drive
Omaha, Nebraska 68102-4226

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HAER No. MO-117

Location:	Spanning Osage River on Business Route 54 Lake Ozark Miller County Missouri
Quad:	Lake Ozark Quadrangle - Missouri 7.5 Minute Series, 1983 Bagnell Quadrangle - Missouri 7.5 Minute Series, 1983
Construction:	1929-31
Designer:	Stone and Webster Engineers
Present Owner:	AmerenUE, Lake Ozark, Missouri
Present Occupant:	AmerenUE, Lake Ozark, Missouri
Present Use:	Dam and Power Plant
Significance:	This property is listed on the National Register of Historic Places for significance related to social history and engineering. The construction of the dam and power plant in 1930-31 began the production of hydroelectric power in mid-Missouri and created the Lake of the Ozarks, a regional tourist attraction that dramatically changed social and economic aspects of central Missouri.
Project Information:	Bagnell Dam was recorded in 2009 by R. Gail White, White and Borgognoni Architects, Carbondale, Illinois, and by Benjamin Halpern, Halpern Photography, Champaign, Illinois. As a result of relicensing requirements, the historic structures will be altered for required technological upgrades and enhanced safety.

I. Physical Description of Bagnell Dam and Osage Power Plant:

Structurally, there are two general types of dams: massive, or gravity, and structural. The latter consists of two sub-types: arch and buttress. Arch dams are typically constructed between narrow canyons with hard, stable rock foundations and are thinner and less expensive than the massive gravity-type dam. This type of dam was in use by Roman times and was mathematically refined by the mid-nineteenth century. Buttress dams resemble gravity dams, although they are made of a series of buttresses designed to carry the water pressure downward to the foundation, and, like arch dams, require much less structural material to create them. There are likewise two types of buttress dams: flat slab and multiple arch. Most flat-slab dams are known as Ambursen dams, as the earliest of these were designed by the Ambursen Hydraulic Construction Company. Each of these individual dam varieties is capable of hosting a hydroelectric facility.[1]

Bagnell Dam, however, is a straight-crested concrete gravity structure. Gravity dams are by far the most common and rely on the principal of gravity, enabled by the bulk of the structure to resist the force of water weighing upon it. Early gravity dams, generally called earth-fill or embankment dams, were often built of locally available materials such as wood, rock, and earth. If built insufficiently, it was common to see them washed away in heavy rain and flooding. The most well-known of these washed-away structures was the South Fork Dam at Johnstown, Pennsylvania, an earth-fill dam which overtopped and washed out during a flood in 1889, killing 2,200 inhabitants of Johnstown.[2]

The gravity-type dam was built with a wide-based triangular cross section and vertically sloping sides. French engineer M. De Sazilly in the 1850s developed a calculation based on the density of stone in relation to that of water. The resultant was the amount of force acting upon the dam. If this force was kept within the middle third of the base of the dam, the dam would remain stable. De Sazilly's profile of equal resistance resulted in a basic height-to-width ratio of 3:2. Although his rational profile for gravity dams was often used as the blueprint for late nineteenth century masonry dams, the concrete structures that began replacing them in the twentieth century were constructed using the same basic principles.[3]

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[1]Donald C. Jackson, *Great American Bridges and Dams*, Great American Press Series (Washington, D.C: The Preservation Press, National Trust for Historic Preservation, 1988), 48–51.

[2]Jackson, 328-329.

[3]Jackson, 46-47.

Gravity dams built across a canyon or valley are known as straight-crested and those built along an upstream curve are known as curved gravity dams. These curved gravity designs, such as Hoover Dam, are some of the most spectacular. Although the assumption has been that the curved variety is generally stronger than the straight-crested dam, this theory is based on appearance. Some engineers, however, insist curved dams reduce the appearance of shrinkage cracks in concrete. These dams are often mistaken for arch dams, but they function as gravity structures, not arch structures.[4]

Most dams built today, whether massive or structural, are equipped to produce hydroelectric power. One of the main components of a hydroelectric dam is the turbine, which, in simple terms, powers a generator by utilizing the flow and pressure of water, creating energy. As water enters the intake from the reservoir through the penstock, its pressure turns the blades of the turbine, which in turn powers the generator. The amount of water entering the turbine, and thus the amount of power produced, can be regulated by opening or closing wicket gates, which are a series of louvers arranged in a ring around the turbine inlet. The number of turbines vary considerably from dam to dam, depending upon its size and power capacity. Bagnell Dam houses eight turbines, while Wilson Dam in Alabama contains eighteen. Smaller plants contain as few as one.[5]

Bagnell Dam spans the Osage River at mile 81.7. Bagnell Dam and Lake of the Ozarks, the reservoir created above the dam, are located in Central Missouri in the counties of Benton, Camden, Miller and Morgan. Bagnell Dam was constructed in 1930 and 1931 at a cost of $30 million. Bagnell Dam, built by the Union Electric Light and Power Company of St. Louis, was the largest and last major dam built in the United States to be financed solely by private capital. Bagnell Dam, Lake of the Ozarks, and the Osage Plant generating facility comprise the hydroelectric facility known as the Osage Project.[6]

When Bagnell Dam was originally constructed, it impounded a storage reservoir 129 miles long, having a surface area of 58,602 acres at elevation 660’ mean sea level (MSL) (normal pool). The subsequent conveyance of approximately 17,000 acres of land and land rights to the U.S. government for construction of the Harry S. Truman Dam, which abuts the Lake of the Ozarks, by the U.S. Army Corps of Engineers has reduced the surface area to approximately

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[4]Jackson, 47-48.

[5]Horace J. Sheely, “Wilson Dam,” National Register of Historic Places Nomination, U.S. Department of the Interior, National Park Service, Washington, D.C., listed November 14, 1966.

[6]W.R. Wood, “The Pomme de Terre Reservoir in Western Missouri Prehistory,” *The Missouri Archaeologist* 23 (1961): 6–7; and Cally Lence and Gail White, “Bagnell Dam and Osage Power Plant,” National Register of Historic Places Nomination, U.S. Department of the Interior, National Park Service, Washington, D.C., listed 2008.

58,342 acres at elevation 660' MSL. The dam impounds 650 billion gallons of water. At full capacity, it takes 30,000 gallons of water per second to drive each of the eight main generators.

Construction of the Osage Project was a massive undertaking. Approximately 26,000 acres of land were cleared for the reservoir. Some 546,500 square feet of steel sheet piles were driven for cofferdams, and 937,000 cubic yards of earth and 72,500 cubic yards of rock were excavated. Approximately 553,000 cubic yards of concrete, 2,100,000 square feet of form work, 2,300 tons of reinforcing steel, and 1,500 tons of structural steel were used. In all, 60,000 train carloads of material were used in its construction.

Bagnell Dam is a concrete gravity type structure with a total crest length of approximately 2,543', and a maximum height above bedrock of approximately 148'. From right to left (looking upstream), the dam consists of:

- a 331' long, non-overflow retaining section known as the East Retaining Section;
- a 511' long integral power station section known as the Osage Plant;
- a 520' long Gated Spillway section that discharges excess water in times of flooding; and
- a 1,181' long, non-overflow retaining section known as the West Retaining Section.

The UTM References for the structure are:

		East End:		West End:	
	Zone	Easting	Northing	Easting	Northing
East Retaining Section:	15	533099	4228509	533095	4228452
Power House:	15	533095	4228452	532947	4228318
Gated Spillway:	15	532947	4228318	532816	4228210
West Retaining Section:	15	532816	4228210	532591	4228048

The dam supports a concrete highway structure consisting of a 20' wide roadway (U.S. Highway 54, Business Route) and a 3' wide sidewalk that extend the entire length of the dam structure. The concrete guard walls along both sides of the bridge and pedestrian sidewalk are constructed of exposed concrete with a smooth finish. The guard walls are articulated by regularly spaced piers with spandrel panels. Each pier has a slightly projected center portion with flanking side sections that are stepped downward and inward. The spandrel panels have continuous, horizontal grooves in the upper half of each section. The guard rails along the operation decks are of two horizontal pipes spanning between vertical pipe stanchions.

Gated Spillway Section and Retaining Sections

The retaining sections of the dam have vertical upstream faces and slopes of 8 horizontal to 12 vertical on the downstream faces, except for the lower 30' of the maximum section where the slope is changed to 10-1/2 horizontal to 12 vertical. Under the spillway section, the exposed sandstone was all removed and the dam built on the Proctor dolomite with a 20' wide key trench cut into it at the heel. The retaining sections and the power station section were built on the Gasconade dolomite, which overlies the sandstone, for the greater part of their length, with a similar key trench at the heel except at the abutments where the rock was removed to permit keying the entire section into the hillsides.

A longitudinal drain installed just downstream from the key trench runs along the entire length of the dam. This drain is connected to the downstream face by lateral drains approximately 40' on center. Two rows of grout holes, 5' on center and staggered, extend about 30' into the rock under the key trench and about 2'-6" from the upstream face to the first row for the full length of the dam, forming a grout curtain at the upstream side and reducing seepage to a minimum. Between 1980 and 1982, post-tensioned anchors were installed along the entire length of the dam to increase stability of the structure under Probable Maximum Flood (PMF) conditions. These anchors are embedded down to as much as 126' below the bottom of the dam.

The gated spillway section of the dam is equipped with twelve radial tainter gates, each 34' x 22', which are used to control the reservoir water level during flood periods. Each tainter gate is supported by a trunnion bearing anchored in a concrete pier on each downstream side and normally rests on the seal at the upstream end. By use of the gantry crane and chains attached to the bottom of the gates, each one may be opened to the desired position and latched by chain dogs. The gates are provided with rubber side seals and a timber bottom seal. All bear on metal seal surfaces imbedded in the concrete. Two 70-ton capacity traveling electric gantry cranes mounted on rails on the operating level (elevation 669') above the spillway and power station are used to operate the tainter gates and head gates that open or shut the flow of water through the dam, and also to handle the stop logs and trash racks. One of these cranes has been equipped with an auxiliary gasoline electric drive for emergency service in the event of an electrical failure. The cranes were manufactured by the Whiting Corporation.

The upper portion of the spillway has a parabolic curve profile. This upper portion, in addition to a straight intermediate portion, is designed for streamline flow so as to minimize erosion of the concrete by the flowing water. The foot of the of the spillway is provided with a stepped apron made up of four ascending steps at the toe of the spillway section to dissipate energy from the discharged water and reduce erosion of the riverbed below the dam. Each step is 6' wide starting at the horizontal tangent of the bucket and rising 36", 15", 15", and 24" respectively. The apron dissipates to a large degree the energy in the lower portion of the overflowing jet within the limits of the apron and deflects the turbulent water to the surface of the tailwater, thus eliminating jet action on the riverbed and reducing scour due to turbulence and eddies. A concrete retaining wall extending 50’ downstream beyond the end of the stepped apron along the West side of the spillway protects the riverbank from erosion due to the flow of water over the spillway.

Power Station Section (Osage Power Plant)

The Osage Power Plant is located inside of and on the east side of Bagnell Dam. Its substructure is of mass and reinforced concrete founded on limestone rock. Its superstructure is concrete block, brick, and steel framing. The power house section is 511’ long and contains eight individual main generating units located side-by-side, and two service units in tandem. Along the east riverbank, adjoining the Power Plant, is a gravity wall provided to protect the east shore from erosion in the area near the generating units' discharges, and also to support the embankment under the walkway entering the power station.

The power station is immediately downstream from the headworks with the electrical bay built over the penstocks, between the generators and the headworks wall. The power plant uses the energy extracted from moving water, as the water passes from the reservoir through the penstocks to drive turbines and generate electricity. The eight main generators, each of which has a capacity of 21,500 kilowatts, produce electricity to meet the needs of approximately 45,000 households. At peak generation, however, the Osage Plant has been able to produce 220,000 kilowatts, enough power to meet the household needs of 225,000 people. The two smaller generators, one-tenth the size of the main units, produce power for the plant itself. These house power generators can be started without an outside source of electricity and provide start-up power in case of failure at Ameren’s electrical systems. This start-up capability is referred to as “Black-Start.”

The portion of the power station containing the scroll cases and draft tubes was originally constructed for an initial installation of six main units and two station service units, with provisions for two future additional main units. The two additional main units were installed in 1953.

The exterior walls of the power station are smooth-finish, exposed concrete. The portion of the power house where the administrative office and control room areas are located has a large-scaled, stylized denticulated cornice. The original steel sash windows have been replaced with aluminum windows and multiple lights.

Intake Structure and Equipment

The intake or headworks for the power station contains all the necessary head gates, appurtenances, stop logs, and trash racks for operation of this type of hydroelectric plant. A concrete skimmer wall extending about 30' below the maximum headwater level was also constructed as an integral part of the headworks. The head gates for each main unit are of structural steel and are of the fixed roller type. The gates allow a clear opening of 23' x 26'. Structural steel head gates of the fixed roller type, each with a clear opening of 7' x 12'-6", serve the station service units. The head gates were manufactured by the M. H. Treadwell Manufacturing Company.

Vertical trash racks are installed between the skimmer wall and the head gates. The guides for these vertical trash racks are arranged to allow the trash racks to be replaced by stop logs so that any unit may be unwatered as necessary. A motor-operated rake has also been provided for cleaning the trash racks. The trash racks were manufactured by the Stupp Brothers Bridge & Iron Company.

The four main divisions of the water passages to and from the turbines are:

- the intake
- the penstock
- the spiral casing (scroll case)
- the draft tube.

Lake water enters through the head gates, into the plate-steel-lined penstocks and then into the plate-steel-lined scroll case, the passage that encircles and narrows and admits water to all sides of the turbine. Both the penstock and scroll case are surrounded by reinforced concrete. The draft tubes are of the elbow type and have plate-steel liners for the upper end of the vertical section. The draft tubes discharge directly into the river with provision for stop logs at the draft exits for dewatering each unit.

Water from the lake enters the penstocks through rectangular openings of 26' x 23'. The intakes for the turbines are approximately 60' below the normal water surface. The openings may be closed by lowering the head gates with the gantry crane after the turbine gates have been closed. The head gate consists of two steel bulkheads which, when permanently bolted together, make the dimensions of one unit about 27' x 27'. The head gate slot is provided with rails which serve as guides. Wheels mounted on the head gate roll upon a downstream pair of guide rails to limit the amount of compression given to the rubber seals that are mounted around the edges of the gate. The rubber seals bear against brass sealing plates that are installed around the penstock entrance. A bottom rubber seal, with its compression stops, bears upon a steel channel imbedded in concrete at the bottom of the head gate slot. The head gate is normally lowered at any time there is required maintenance within the penstock, spiral casing, or draft tube, or on the turbine or governor.

A bypass, or filler gate, is opened to fill the penstock after the turbine gates are pressure-closed and the unwavering valve is closed and locked. The filler gate is a 3' x 3' sliding steel gate that is positioned by a stem or shaft that extends to a motor-driven valve stand in the filler-gate tunnel at elevation 660' MSL. A venting channel from the penstock to above full lake level allows air to escape as the penstock is filled with water.

The water intake is provided with a strainer made up of two parts. The first is a skimmer wall that prevents floating debris from entering the intake for all lake levels within the design range of elevation 630' MSL to elevation 660' MSL, plus 9' of excess. The second is a set of seven trash racks, which, when used with one stop log in the storage position, provide a screened entrance to the penstock to prevent the entry of submerged debris. Each of the five lowest racks is a steel framing about 11' x 30', covered with vertical steel bars spaced 6" apart. The two upper racks have wood timbers with 4" openings between timbers, rather than steel, to reduce the problem of corrosion as the racks are alternately exposed to water and atmosphere as the lake elevation varies. A trash rake, a device with steel fingers that enter the rack slots, is used to clean the upstream side of the racks as debris accumulates.

The penstocks, or passages that convey water from the intake structure to the scroll cases, are concrete for a few feet adjacent to the entrance, but change to a riveted plate-steel liner embedded in concrete for the remainder of the distance to the entrance of the spiral casing. The upper end of the steel liner makes a gradual transition from a rectangular to circular cross-section, reducing in size gradually, until at the entrance to the spiral casing, the inside diameter is 18'-6". Each of the openings to the penstocks can be closed by lowering a head gate consisting of two bolted-steel bulkheads.

Spiral casings encircle the speed rings of the turbines for the purpose of admitting the water pressure to all sides of the turbines. The spiral casings become progressively smaller over their length in order to keep the average water velocity below maximum design values. Two manholes are provided for access to the casing interior, one on the top downstream side, the other on a side at the elevation of the centerline of the turbine setting.

Draft tubes discharge water from the bottom of each turbine to the downstream side of the dam. The draft tubes are flared from the entrance to the elevation of the minimum tailwater in order to recover some of the energy remaining in the water discharging from the runner. This upper portion of the draft tubes is lined with a smooth steel liner to reduce turbulence to a minimum and to prevent erosion of the draft tube entrance due to turbulence in the water leaving the runner. The gradual enlargement of the tube is continued, as it turns to a horizontal direction and issues to the river through the discharge openings.

Each of the eight main units is a vertical shaft water wheel of the Francis Type, rated at 33,500 horsepower (HP) with a 4,000 cfs discharge, under a design head of 90’ and a rotating speed of 112.5 revolutions per minute (RPM). Both of the station service units are vertical-shaft water wheels of the Francis Type also, with a rating of 3,025 HP with a 350 cfs discharge, under a design head of 90’ and a rotating speed of 327.3 RPM. The main water-wheel units were furnished by the Allis-Chalmers Manufacturing Company. In 2002, the original water wheels #3 and #5 were removed and replaced with new turbines manufactured by American Hydro. One of these original turbines is now displayed in the visitor overlook above Bagnell Dam. The other turbine is on display on the west end of the dam in an area provided by the City of Lake Ozark. As of 2010, a total of six of the original water wheels have been replaced. The replacement wheels have three different designs with numbers for flow and horsepower.

The amount of water that passes through the turbine is controlled by positioning the guide vanes (wicket gates). The guide vanes act as the machine throttle. The positioning of the guide vanes is achieved by links connecting to a shifting ring located concentric to the machine shaft. The opening and closing of the turbine gates is controlled by a governor, varying the gates automatically to regulate machine speeds.

The water wheels are located inside plate-steel scroll cases encased in concrete, and they discharge into reinforced-concrete draft tubes with short plate-steel liners directly below the runners. An inspection and drainage tunnel is located upstream from the draft tubes and directly below the scroll cases.

Steel covers for the eight main turbine-generators are located above the generators and turbines on the lower operating deck (elevation 600’ MSL) on the downstream side of the dam. A 150-ton capacity traveling electric gantry crane is located above the lower operating deck. It is used to lift the steel covers over the generators and water wheels and to remove components for maintenance or replacement.

Each water wheel is direct-connected to an umbrella-type, 13,800-volt, 3-phase, 60 cycle, vertical shaft generator. Each generator has a continuous capacity of 23,888 KVA, at 90 percent power factor, 112.5 RPM, 60 degrees Centigrade temperature rise, or 27,500 kW, at 100 percent power factor, at 80 degrees Centigrade temperature rise. The two station service units are vertical-shaft generators rated at 3000 KVA, 70 percent power factor, 2400 volt, 3 phase, 60 hertz, 327.3 RPM. The generators were furnished by Westinghouse Electric and Manufacturing Company.

Each main generator has a closed, water-cooled, air-circulating system. The air discharging out through the windings is carried through metal housings around the generators and passed through air coolers located at each side of the generator along the longitudinal center line of the generator room, thence up to the closed chamber over the top of the generator and back down and out through the windings. The bottom of the intake opening for each main unit is at elevation 584’ MSL. The bottom of the intake opening for each station service unit is at elevation 590’ MSL.

The step-up transformers and getaway structure for the transmission lines are located over the electrical bay, with the transformers under the highway bridge and a transformer transfer track between the getaway structure columns and the transformers. Mounted on the getaway structure are the line disconnecting switches, carrier-current coupling condensers, and lightning-arrester equipment.

Electrical current produced at the Osage Power Plant is generated by three-phase alternators. Three-phase current is a better source of power for motors and is more economical to transmit, making its use an advantage to both the customer and the producer. Transmission of power from the Osage Plant is over a three-phase system. The main transformers convert the 13,800 volt current produced by the generators to 138,000 volts for transmission to customers. The main transformers were manufactured by the General Electric Company.

In addition to energy and capacity, the Osage Power Plant provides ancillary services to the AmerenUE system. The Osage Plant provides load-following capabilities, quick-start capacity, Black-Start capability in the event the electrical system is down, and voltage support.

II. Historical Development of Bagnell Dam and Osage Power Plant

The Lake of the Ozarks and lower Osage River project area are located in the northwest and northeast portions of the Osage Study Unit, encompassing portions of Osage, Cole, Miller, Morgan, Camden, and Benton counties. This region has gently rolling hills with maximum elevations in excess of 900’ above mean sea level. Many of the ridge tops are open prairie with oak-hickory forests on the slopes and in bottomland areas.[7] In the nineteenth century, the region around Miller County was described as having moderately-rolling hills with rich soils suitable for cultivation. At the time, the wooded areas consisted of hickory, pin oak, hackberry, ash, and elm.[8] More recent descriptions list several varieties of oak, as well as hickory on ridge slopes,

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[7]Wood, 1-131.

[8]C.L. Jenkins, *Judge Jenkins’ History of Miller County, Missouri, Through the Civil War* (Tuscumbia, Missouri: Clyde Lee Jenkins, 1971), 348.

and some cedar.[9] Bagnell Dam is located approximately two miles southwest of Bagnell, Missouri. The dam was constructed where the Osage River cut deeply into the bedrock bluffs on both sides of the Osage River. The bluffs rose approximately 200' above the valley floor, providing a stable anchorage for the dam.

In 1912, Kansas City lawyer, Ralph W. Street conducted a study to develop a privately funded dam across the Osage River. This proposal would erect a 130' dam on the Niangua River a few miles above its confluence with the Osage. However, the plan did not materialize. In 1924, Walter Cravens of Kansas City joined with Street to provide financing and was granted a permit to begin construction on a dam on the Osage River that would be operated by the Missouri Hydro-Electric Power Company, incorporated in 1920. Although construction had begun on buildings, roads, and a railroad from Bagnell, the project was abandoned in 1926 due to financial difficulties. A year later, however, Cravens and Street teamed with Union Electric Light and Power Company of St. Louis (now AmerenUE) and hired one of the largest engineering companies in the country, Stone and Webster, Inc., of Boston, to redesign the project. The firm was given the task of completing the project and delivering power to the St. Louis area within twenty-eight months.[10]

Stone and Webster, Inc. was founded in Boston, Massachusetts, in 1889 by two graduates from the Massachusetts Institute of Technology (MIT), Charles A. Stone and Edwin S. Webster. They became responsible for a significant portion of power production infrastructure in the United States, including coal, oil, natural gas, nuclear, and hydroelectric plants, which yielded approximately 20 percent of the nation's generating capacity. Stone and Webster quickly earned the confidence of New York and Boston investors who helped develop regional power systems. Their first significant contract was with the S.D. Warren Company in Maine, for a project involving the design and installation of a generating plant associated with a dam.[11]

Prior to contracting with Union Electric to build Bagnell Dam, Stone and Webster had completed several large-scale massive hydroelectric dam projects for power companies in the south and northwest. The Big Creek Dams consisted of four masonry dams in central California, completed in 1912–13. In 1912, Stone and Webster built the concrete gravity White Salmon Dam on the White Salmon River near Portland, Oregon. In 1925, Bartlett's Dam was constructed

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[9]Historic Preservation Associates (HPA), *Phase I Cultural Resource Survey Route 5 Corridor Study, Camden, Morgan and Laclede Counties, Missouri,* MHTD Project No. J5P0694 (Fayetteville, Arkansas: Historic Preservation Associates, 1994), 10.

[10]Carole Tellman Pilkington, "The Story of Bagnell Dam," *Lake Area Chamber of Commerce*, 1989, 5.

[11]Funding Universe, "Stone and Webster, Inc.," http://www.fundinguniverse.com/company-histories/Stone-amp;-Webster-Inc-Company-History.html (accessed May 21, 2010).

on the Chattahoochee River in Georgia. The Baker River Dam northeast of Seattle, an impressive concrete arch overflow type, was built between 1924 and 1926. In 1928, Conowingo Dam was built across the Susquehanna River in Maryland and is a straight-crested concrete gravity structure like Bagnell Dam. However, it is nearly twice as long as Bagnell. Their experience and areas of expertise made Stone and Webster an ideal selection for the Bagnell Dam and Osage Power Plant project.[12]

Ten days after Union Electric purchased the failed Missouri Hydro-Electric properties on July 27, 1929, Stone and Webster began construction on Bagnell Dam. This was two months prior to the stock market crash which heralded the onset of the Great Depression. At that time, the dam project was the largest construction project in the country, furnishing thousands of jobs. By the time it was completed, an estimated 20,500 workers had been involved in the construction of the dam. It was also the largest and last major dam built in the country financed entirely by private capital and, at the time it was built, it was the largest man-made lake in the country.[13] Power generated at the plant would furnish southeastern Missouri's St. Joseph Lead Company, one of the world's largest lead producers, with the 150,000,000 kilowatt hours it purchased from Union Electric Light and Power Company. Union Electric was to provide power to supplement a recently-purchased steam-power plant in Rivermines, Missouri, in the heart of the State's lead district.[14]

Prior to construction, several facilities were constructed to supply the Osage Project with locally manufactured materials. A sand and gravel plant, located at Bagnell, supplied much-needed gravel and sand for concrete production. All sand and gravel was taken from the Osage River. The plant used sand rollers to crush small rock into sand because the Osage River does not produce enough sand for use in making concrete. This plant provided over 75 percent of the gravel and 40 percent of the sand used by the concrete plant. The remainder of the sand and gravel was purchased from the privately-owned Bagnell Sand and Gravel Company, also located in Bagnell. The concrete plant supplied all of the concrete mixed for the project with the exception of a very small portion of the west abutment. The plant was located on the west side of the river, downstream from the construction bridge. Located further downstream, storage tanks for cement, sand, and gravel were connected to the concrete plant by belt conveyors.[15]

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[12]Funding Universe, "Stone and Webster, Inc."

[13]Pilkington, 8-9, 25, 28.

[14]Pilkington, 5.

[15]American Society of Civil Engineers, "Inspection of Osage Hydro-Electric Development of Union Electric Light and Power Company by Stone and Webster Engineering Corporation Engineers and Builders," Fall Meeting, St. Louis, Missouri, October 4, 1930, 1–2, 6.

Construction on the Osage Project was officially initiated on August 6, 1929, and the clearing for the reservoir began on September 5, 1929. Less than a month later, on September 30, 1929, the cofferdam was laid out for the spillway and west abutment. On October 3, 1929, the excavation for the east abutment began, and excavation for the west abutment began on October 11, 1929.[16] The first steel setting was made on Osage bridge on November 21, 1929, and the temporary power house was tested exactly one month later, on December 21. The first concrete was poured on April 9, 1930. On July 22 of the same year, a diversion channel opened and the upstream side of the cofferdam was closed shortly thereafter, on August 5, 1930.[17]

A storage yard was cleared for use halfway between Bagnell and the dam site. It was used to store large equipment, and as of October 4, 1930, it held the scroll case and penstock plates, speed ring castings, gate guides, and other ready-for-installation hardware. In the bottom land, adjacent to the storage yard, was a two-runway airport that eased travel during scheduled company trips between St. Louis and the dam. A temporary steam power plant was constructed to power fixed equipment at the dam site and plant sites.[18]

Ralph W. Street, Walter Cravens, and Stone and Webster contracted various companies from all over the country to supply integral parts of the dam. For example, the two gantry cranes were ordered from Whiting Corporation of New York City on June 13, 1930, for a total price of $84,270. The six original generators were purchased from Westinghouse Electric and Manufacturing Company of Boston on July 7, 1930, for a total of $1,012,000. The intake stop logs and trash racks were purchased from Stupp Brothers Bridge and Iron Company of St. Louis for a price of $58,700 under a contract dated September 2, 1930. Twelve tainter gates, complete with anchorages, guides, and accessories, and three stop log sections, complete with guides and accessories, were purchased from Mississippi Valley Structure Steel of St. Louis at a price of $88,000. The six main turbines, including penstocks and governors, were purchased from the Allis-Chalmers Manufacturing Company on October 30, 1930, for $890,000. These turbines were manufactured at their West Allis Works in West Allis, Wisconsin, a suburb of Milwaukee. In addition, a total of 34,746 bolts, nuts, and washers were furnished by the Bayonne Bolt Corporation of Bayonne, New Jersey, at a cost of $4,240.[19]

The above hardware was to be shipped by rail to Bagnell Dam.[20] To accommodate such shipments, 3.75 miles of permanent railroad and 10.9 miles of temporary railroad were built

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[16]Pilkington, 15.

[17]Pilkington, 15.

[18]American Society of Civil Engineers, 2.

[19]Stone and Webster Engineering Corporation, various purchase orders on file at Bagnell Dam, 1930.

[20]Stone and Webster.

prior to construction of the dam. The railroad was completed on August 22, 1929, and until February 1, 1931, 55,580 cars of material plus all sand and gravel shipped to the concrete plant were transported on the new tracks. The two hydraulic turbines and accessories installed in 1953 were also purchased from Allis-Chalmers, and the generators were again obtained from the Westinghouse Electric Corporation.[21]

On December 10, 1930, the power house steel structure erection began. Immediately after the completion of the highway slab on January 31, 1931, the lake began to fill, and it finally reached the spillway crest elevation on May 20, 1931. The lake was finally usable, and it began to see traffic only ten days later. On August 6, 1931, generator tests started taking place, followed by the operation of water wheels beginning on September 3, 1931. The official date of the first commercial use of Osage Plant was October 16, 1931. Lake area electric service became available on December 24, 1931.[22]

During the early years of operation, Bagnell Dam produced from one-third to one-fourth of Union Electric's power needs. By 1980, this figure had dropped to only 2 percent, and the plant was used primarily as backup for peak periods. Output of power at 138,000 volts still runs to two stations, as it did in 1931. One double-circuit line runs 120 miles to Rivermines and another to the Page Avenue substation in St. Louis, a distance of 136 miles.[23]

With its completion occurring in 1931, the Bagnell Dam and Osage Power Plant project falls within a remarkable point in American history. October 27, 1929, the date of the most notorious stock market crash in the history of the United States, marked the beginning of the Great Depression. During its initial stages, economists did not predict the financial catastrophe that would soon sweep across the nation, forcing individuals and families into unemployment. By 1933, 15 million Americans were without jobs. The results of this staggering unemployment rate were extreme; impoverished families lived on the bare minimum at best. In an attempt to alleviate the financial strain, President Hoover encouraged private charities and local governments to provide relief to the unemployed and homeless.[24]

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[21]AmerenUE and Duke Engineering and Services, Inc. Osage Project (FERC No. 459), Initial Consultation Document, January 2001.

[22]Pilkington, 15.

[23]Pilkington, 26-27.

[24]Eleanor Roosevelt National Historic Site, "The Great Depression," http://www.nps.gov/archive/elro/glossary/great-depression.htm (accessed May 28, 2010).

Upon his inauguration in 1933, Franklin D. Roosevelt instituted a new relief effort dubbed the "New Deal," which began a series of direct work relief programs. The New Deal focused on three primary goals: relief for the unemployed and poor, recovery of the economy to normal levels, and reform of the financial system to prevent a repeat depression. In order to achieve these goals, part of the plan involved the implementation of work projects that would employ great numbers of otherwise-jobless Americans. Several of the nation's large gravity dams were constructed during this time. Not only did these projects have the potential to create jobs and boost the economy, but completed dams could also supply electricity to households across the nation. Interestingly, the Bagnell Dam and Osage Power Plant project's construction provided more than 20,000 jobs, generated electricity, and boosted the economy before the New Deal had even taken off. Given the financial restrictions of the time, it is remarkable that the Bagnell project was even able to take place.

Many of the earliest dams constructed in the United States were crude, created out of a need for freshwater supply and irrigation. In the western United States, most dams of the late nineteenth century and early twentieth century were of the massive design. There was great need in the Midwest, particularly in isolated areas, for water storage, as well as for water-generated power. The concept of multi-purpose river development and basic federal responsibility for the development of public-owned water resources first obtained statutory recognition with the Federal Water Act of 1920. Many gravity dams were constructed in the early twentieth century in the western states, and in the mid-1930s, partly due to Franklin Roosevelt's New Deal.[25]

Many of the early twentieth-century water storage dams were built with federal dollars. Agencies such as the Reclamation Service (now the Bureau of Reclamation) funded water storage projects in an attempt to open the west to increased settlement. Hoover Dam (1935) was among the first Bureau of Reclamation gravity dams and became part of Roosevelt's work relief program. This massive structure provided both water storage and irrigation, as well as electricity, to the States of Arizona, Nevada, and California. The Grand Coulee Dam, completed in 1942, was built at a height of 550', creating a 150 mile-long reservoir, providing irrigation to central Washington, supplying electricity to much of the Pacific Northwest (as the largest producer of hydroelectric power in the United States), and allowing navigation on the Columbia River for some 350 miles.[26]

A growing need for rural electricity brought about the creation of such agencies as the Rural Electrification Administration (REA) in 1935 and the Tennessee Valley Authority (TVA) in 1933. The TVA was created by the Roosevelt administration as the first government-owned

[25]Jackson, 51-52.

[26]Norman Smith, *A History of Dams* (London: Peter Davies, 1971), 227-228.

and operated entity of its kind, promoting the means of creating energy, as well as improving navigation, flood control, and agricultural and industrial development. The TVA's first dam, Norris Dam, was completed in 1936. In some instances, the TVA has gained control of dams built by privately-financed utility companies, such as the Ocoee Dam No. 1, built by the Eastern Tennessee Power Company in 1911. The TVA also took over ownership of Wilson Dam, a straight-crested overflow gravity dam built by the U.S. Army Corps of Engineers (USACE) in Muscle Shoals, Alabama. In fact, one of the first duties of the TVA after its formation was to utilize Wilson Dam, which, although not completed until 1925, had been intended for use as a power supply for the production of nitrate during World War I.[27]

While federally funded dam construction prevailed in the western United States during and after the Depression, particularly in an effort to spur the economy while providing hydroelectric power and much-needed water storage and irrigation, private investors were often driven by the potential for profit.[28] Once construction costs are recouped the free, renewable resource of water power is often very profitable. Nevertheless, by mid-century, the USACE and other federally sponsored dam projects were more popular in part due to the Flood Control Act of 1954, which authorized the building of dams in flood-prone areas such as the Osage River basin. Between 1941 and 1974, at least fifteen dams were built by the USACE in the Missouri Ozarks.[29]

In Missouri, several hydroelectric dams have been built during the twentieth century, perhaps none more relevant to Bagnell Dam than Powersite Dam and Harry S. Truman Dam, both located in the Missouri Ozark region. Powersite, an Ambursen-type dam, was built in 1911-13 on the White River in Taney County by the privately funded Ozark Power and Water Company. Powersite Dam was the first of its kind in the Ozarks, and with it was born the idea that power could be brought to even the most rugged, remote areas. From an engineering standpoint, Powersite Dam pioneered the effort to construct a large-scale hydroelectric facility in the Ozarks. Not only was the large-scale generation of power a new innovation, but the transmission of this power into remote areas signaled a transition into a modern, electrified society.[30] In addition, Lake Taneycomo, the reservoir created by Powersite Dam, hosted what is generally considered the first Ozark-area lake resort, Rockaway Beach, which eventually led to a change in the character of the Midwestern vacation in that it promoted the availability and

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[27]Sheely.

[28]Jackson, 51-52.

[29]Milton D. Rafferty, *The Ozarks: Land and Life* (Norman: University of Oklahoma Press, 1980), 205-210.

[30]Cliff Edom and Vi Edom, *Twice Told Tales and an Ozark Photo Album* (Republic, Missouri: Western Printing Company, Inc., 1983), 94-95.

affordability of local and regional recreational destinations.[31] The success of Powersite Dam and Lake Taneycomo directly supported the viability of Bagnell Dam and paved the way for its construction.

Like Bagnell, many hydroelectric dams were built by local or regional power companies in the early twentieth century. Another local structure, Tunnel Dam Hydroelectric Facility, was built during the same period as Bagnell Dam. It is also a gravity dam built for hydroelectric power by a private power company. While much smaller than Bagnell, Tunnel Dam created Lake Niangua in Camden County, and was completed just six months prior to Bagnell.[32] To date, more than fifteen other dams in the Ozarks provide similar services.[33] The Missouri Ozarks' powerful rivers fueled the selection of this area for hydroelectric facilities. In fact, one of Powersite Dam's consultants, after traveling the country, claimed the Ozarks could provide water power not found elsewhere.[34]

III. Ancillary Facilities

Although Bagnell Dam and Osage Power Plant is the only property considered under this documentation, many ancillary facilities were constructed to serve the thousands of workers who descended upon the site in 1929–31 and supply the project with locally manufactured materials. Auxiliary buildings were built in preparation for the 20,500 workers who would, through the course of two years, help build Bagnell Dam. First aid stations, a hospital, commissary, a mess hall, school, and cottages were constructed before the arrival of the first 800 men in August of 1929. The camp hospital was equipped with fifteen beds in 1930. The kitchen and mess hall were equipped with cold-storage rooms, an ice plant, dry-storage rooms, and a bakery. The kitchen could produce up to 3,000 meals at once. Adjacent to the mess hall were a jail, police and fire stations, and commissary store. Bunkhouses were constructed, including ten foremen’s houses and thirty-two laborers’ houses with a capacity of 1,083 bunks. The largest number of workers at the site at one time was 4,600 in the summer of 1930. The town of Eldon housed many as well and even extended its store hours to accommodate dam workers.

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[31]Rafferty, 205-207.

[32]C. Sturdevant, *Cultural Resource Investigations, Phase I Survey, Lake Niangua—Tunnel Dam Hydroelectric Facility, Camden County, Missouri* (Jefferson City, Missouri: Environmental Research Center of Missouri, Inc., 1994), 14-34.

[33]Rafferty, 205.

[34]Edom and Edom, 90.

The temporary town of Damsite existed downstream from the dam during construction and was the largest of several small ephemeral communities surrounding the dam. Others were Spring Camp and Conner's Camp. Space was rented for from $3 to $10 per month, and buildings and tents were hastily erected. Damsite hosted a theater, taverns, restaurants, gambling houses, and other small businesses. After completion of the dam, many of the businesses of Damsite moved to the area west of the dam. This area would soon become Lake Ozark.

Willmore Lodge and Oak Lodge were constructed at the lakeshore adjacent to the dam as part of the Osage Project. Willmore Lodge, known originally as the Administration Building, was built by Union Electric Company and functioned as an administrative center for executives to oversee the Osage Project. The building, which is listed on the National Register of Historic Places, was designed by Louis La Beaume, a noted St. Louis architect and partner in the firm of La Beaume and Klein. La Beaume's design took its cue from the rustic Adirondack style that flourished first in upstate New York and then made its way across the country as a model for lodges in the west. Stone and Webster Engineering Corporation, the firm in charge of the dam, also carried out the lodge project. The guest rooms in the lodge were named after the five towns destroyed by the lake: Linn Creek, Zebra, Passover, Arnolds Mill, and Nonsuch.[35]

Throughout the 1930s, the lodge became host to Union Electric officials and friends as a recreation center. The Administrative Building was put up for sale in 1941. It was purchased, along with thousands of acres of lakefront property, by Cyrus Crane Willmore, a St. Louis real estate developer. As a result, Willmore Lodge became a private residence. By 1996, Union Electric had repurchased the lodge, which is now under lease to the Lake Area Chamber of Commerce and is used as a visitor center and museum for the lake area.[36] Oak Lodge was built to house female employees during the construction of Bagnell Dam. It is currently used as a retreat for AmerenUE employees. Another building, the original camp hospital, is now used as a recreational center for AmerenUE employees and various community groups.

Lake of the Ozarks is also home to Duncan's Point, an African-American resort—one of the first of its kind. Daniel Duncan purchased 239 acres of shoreline property in 1952–1953 from the Willmore Lake Company in hopes of developing a resort community. The historic Duncan's Point Road, built during the 1950s, was the first road built to make a way into the resort area. Without help from outside investors, Duncan completed three additions by 1955. That year, he formed a partnership with Henry Vester, and in 1957, a fourth addition was added. The Duncan's

[35]Lorraine Burke, *50th Anniversary Bagnell Dam 1931-1981*, Lake of the Ozarks Area Council of the Arts, 1981, 36.

[36]Laura Johnson and Benjamin Cawthra, "Union Electric Administration Building – Lakeside," National Register of Historic Places Nomination, U.S. Department of the Interior, National Park Service, Washington, D.C., listed 1998, 14.

Point Lot Owners Association of the Lake of the Ozarks was organized in 1958. Several Negro League baseball players, most notably Wilber "Bullet" Rogan, once a Kansas City Monarchs standout, spent time at Duncan's Point.[37]

IV. Future of Bagnell Dam and Osage Power Plant

AmerenUE owns and operates the Osage hydroelectric project under a license issued on March 30, 2007, by the Federal Energy Regulatory Commission (Commission or FERC). Relicensing is required on a routine basis. The Commission must comply with a number of federal laws, regulations, executive orders, policies, and guidelines prior to issuance of a new hydroelectric project license. Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 USC 470 *et seq*., as amended) and the regulations implementing Section 106 issued by the Secretary of the Interior (36 Code of Federal Regulations [CFR] Part 800) requires the Commission to take into account the effects of its undertaking (in this case the relicensing of a hydroelectric project) on historic properties. Because the Bagnell Dam and Osage Power Plant is an historic property, the facility was recorded for the HAER collection per stipulations developed through Section 106 consultation.

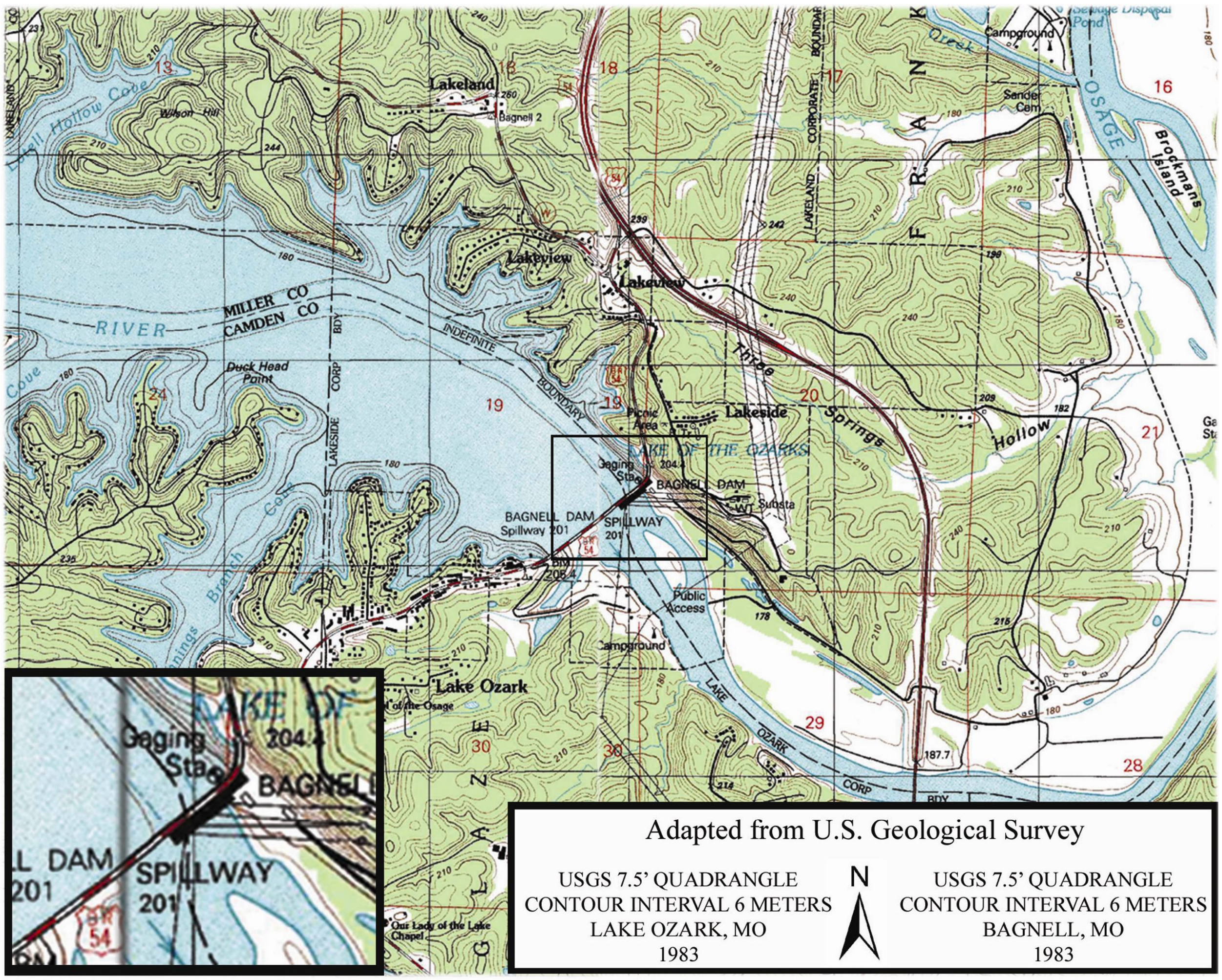
The relicensing process involves a thorough evaluation of the facility, its operation, and needed improvements. Most changes to hydroelectric developments are mandated by the Commission for safety reasons or are day-to-day operational upgrades required for the efficient functioning of the facilities. Continued operation plans for Bagnell Dam include the following measures:

- upgrade two additional main units and the two house units, and eliminate the flow limitation associated with the November 13, 2000 Order Amending License;
- pilot test installation of a draft tube door vent on Unit 6 and implement re-aeration flows and a vent optimization control system to enhance dissolved oxygen (DO) levels and undertake assessments of alternative DO enhancement technologies;
- modify off-normal operational procedures to spread high flows in excess of turbine capacity across 11 of the spill gates to reduce the effects on fish habitat downstream from the dam;
- continue operation and maintenance of Bagnell Dam Overlook and fish and wildlife observation area; and,
- install a barrier net in front of the intakes at Bagnell Dam and develop a fish protection plan, including biological monitoring.

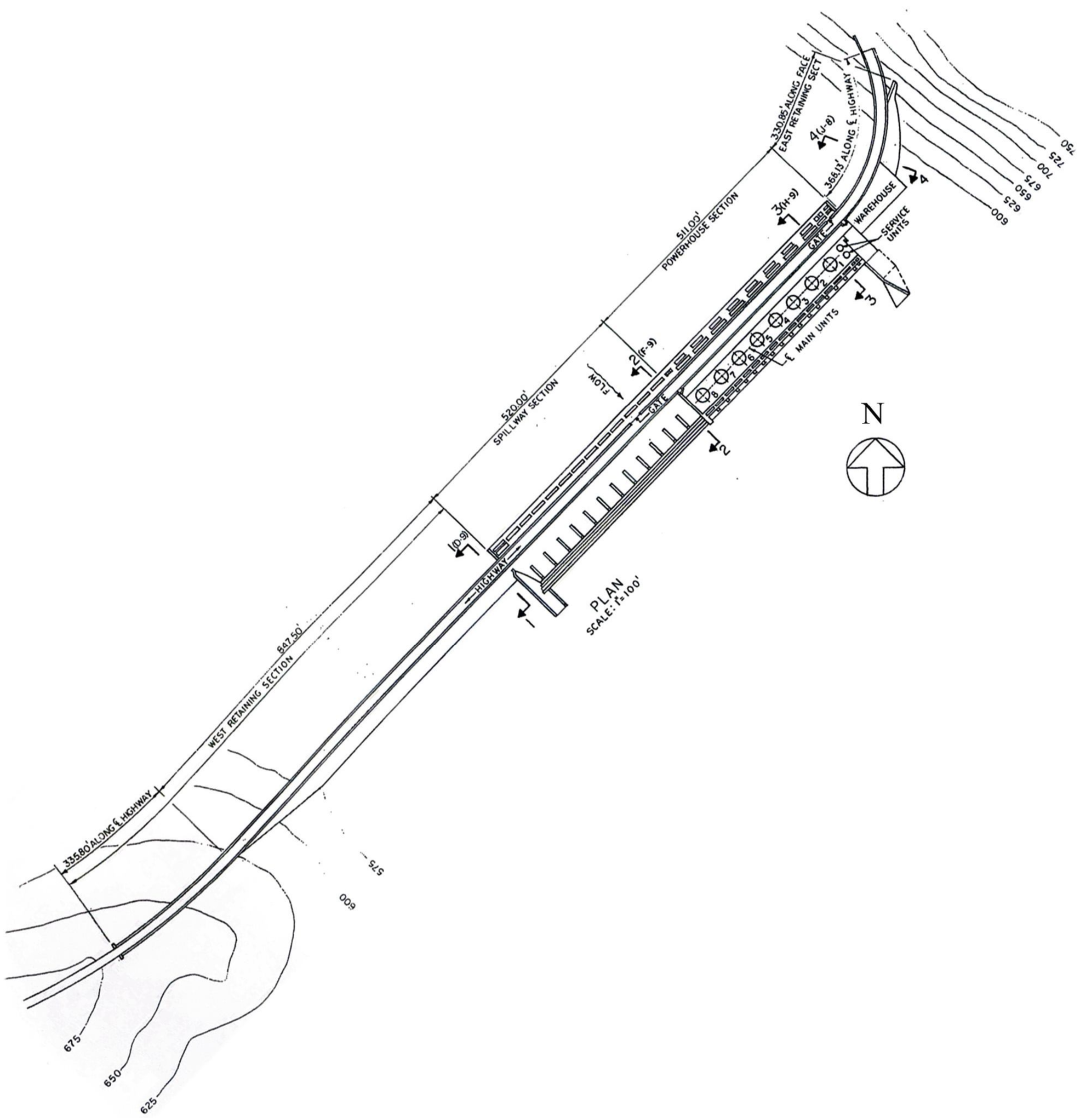
[37] N.A. Brunson, "Duncan's Point: An African American Resort," n.d., n.p.

AmerenUE plans to continue operating the project as a peaking and load regulation facility with the goal of ensuring that the hydropower facilities retain their historically significant features while maintaining safe and cost-effective generation of electricity for the people of Missouri and the larger Midwest.

Map of Location within the State of Missouri
Bagnell Dam and Osage Power Plant
Adapted from http://www.lib.utexas.edu/maps/united_states/missouri_90.jpg



Map of Vicinity of Lake Ozark
Bagnell Dam and Osage Power Plant
Adapted from U.S. Geological Survey, Lake Ozark and Bagnell Quads,
http://store.usgs.gov/b2c_usgs/usgs/maplocator



Sketch Map
Bagnell Dam and Osage Power Plant
Adapted from Construction Drawing 7649-X-501752
Original on file at AmerenUE, St. Louis, Missouri

Materials and Equipment Used in Construction of the Bagnell Dam and Osage Power Plant

Earth excavation	937,000 cubic yards
Rock	72,500 cubic yards
Concrete	553,000 cubic yards
Reinforcing steel	2,000 tons
Structural steel	1,500 tons
Gates, trash racks, and guides	2,100 tons
Hydro-electric machinery	1,500 tons
Form work	2,100,000 square feet
Reservoir clearing	26,000 acres

Stream Flow

Drainage area	14,000 square miles
Maximum recorded flow (recorded 1943)	216,000 cubic feet/second
Minimum recorded flow	324 cubic feet/second
Average flow	10,500 cubic feet/second

Reservoir

Area	95 square miles
Length	93 miles
Shoreline	1150 miles
Water impounded	650 billion gallons

Dam

Length including headworks	2,543’
Length of spillway section	520’
Length of abutment section	1,512’
Length of headworks	511’
Max height bedrock to highway	148’
Max width base of spillway	132’
Max width base of abutment	93’
Cost of project	$30 million

Primary Engineering Features of the Bagnell Dam and Osage Power Plant

Civil/Structural Features	
Length of West Non-Overflow Section	1181’
Permanent Crest Elevation of West Non-Overflow Section	669’*
Length of Gated Spillway Section	520’
Permanent Crest Elevation of Gated Spillway Section	638’*
Type and Number of Gates Within Gated Spillway Section	12 Tainter gates (34’ x 22’) (sill - 638*)
Length of Powerhouse (Integral with Dam)	511’
Width of Powerhouse (at the base)	150.5’
Height of Powerhouse	148’
Length of East Non-Overflow Section	331’
Permanent Crest Elevation of East Non-Overflow Section	669’ (original); 674’ (revised)*
Gross Flow Area Upstream of Trash Racks (per unit)	1,058 square feet
Clear Trash Rack Spacing	6”
Max Velocity at Trash Racks	3.8’ per second

*UED=Union Electric Datum which is equal to USGS datum.

Primary Engineering Features of the Bagnell Dam and Osage Power Plant (continued)

Impoundment Features	
Total Drainage Area of Osage River	15,300 square miles
Total Length of Drainage Area	250 miles
Drainage Area Upstream of Bagnell Dam (located at river mile 81.7)	13,944 square miles
Normal Maximum Water Surface Elevation	660’*
Surface Area at Normal Maximum Water Surface Elevation	54,000 acres
Impoundment Length (Lake of the Ozarks)	93 miles (river mile 81.7 to 174.5)
Shoreline Length	1,150 miles
Gross Storage at Normal Maximum Water Surface Elevation	2,000,000 acre-feet
Normal Operating Range Normal Operation Range (elevation)	10’ 660’ - 650’*
Useable Storage (elevation 650) (elevation 645)	468,000 acre-feet 668,000 acre-feet
Minimum Reservoir Elevation (Emergency)	645’*

*UED=Union Electric Datum which is equal to USGS datum.

Primary Engineering Features of the Bagnell Dam and Osage Power Plant (continued)

Main Turbine Features (Original 1930 and 1953, Eight Main Turbines, Two House Turbines)	*Main Turbine*	*House Turbines*
Runner Manufacturer Orientation and Type	Allis-Chalmers Vertical Francis	Allis-Chalmers Vertical Francis
Design Head	90’	90’
Rated Capacity	33,500 HP	3,025 HP
Rated Turbine Discharge	4,000 cfs	350 cfs
Runner Diameter	133”	40”
Runner Operation Speed	112.5 rpm	327 rpm
Runner Tip Speed	65.3 fps	57.1 fps

Primary Engineering Features of the Bagnell Dam and Osage Power Plant (continued)

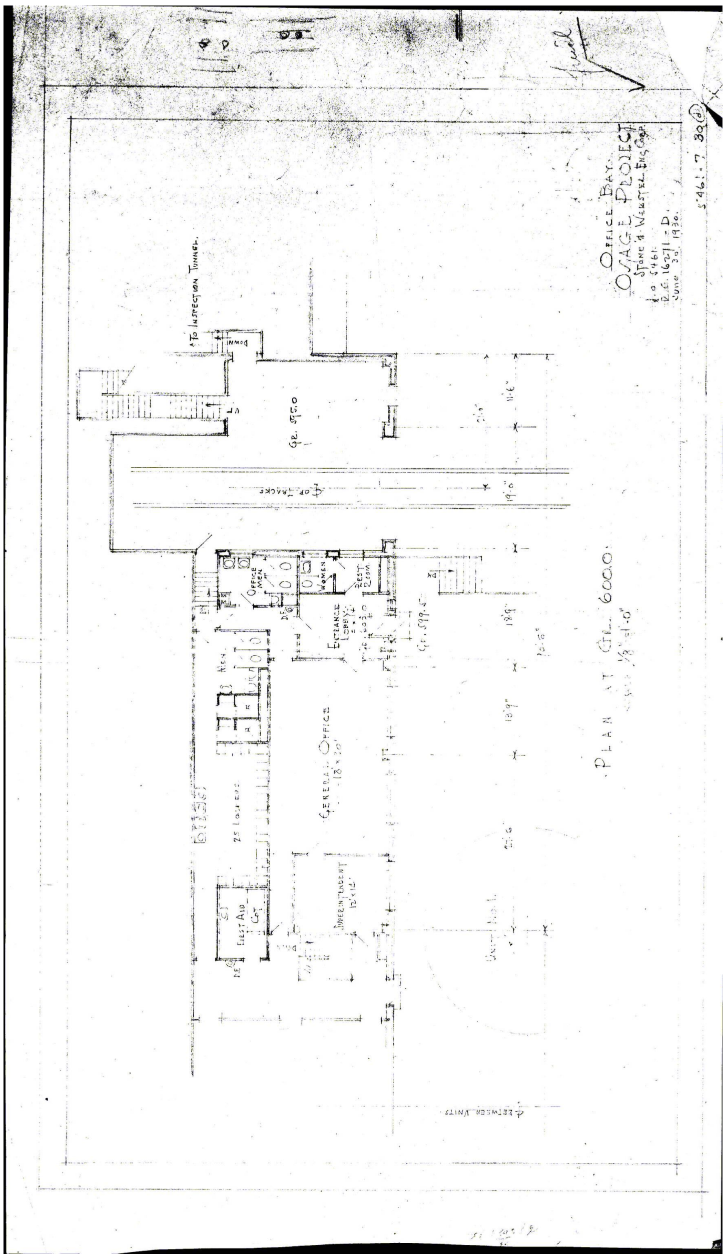
Generator Features *(Eight Main Generators, Two House Generators)*	*Main Generators*	*House Generators*
Generator Manufacturer Nameplate Rating	Westinghouse Electric & Mfg. Company 21.5 MW	Westinghouse Electric & Mfg. Company 2.1 MW
MVA Rating	23.8 MVA	3.0 MVA
Power Factor	90	70
Voltage	13,800 volts	2,400 volts
Current	1,150 amps	722 amps
Cycles/Phases	60/3	60/3
Exciter Manufacturer Capacity Voltage Current	ABB solid sate 250 volts 1,000 amp	Westinghouse 35 kW 250 volts 118 amp
Station Output at Maximum Discharge	200 MW	4.2 MW

Primary Engineering Features of the Bagnell Dam and Osage Power Plant (continued)

Appurtenant Equipment Features	
Step-Up Transformers Number Low Side Voltage High Side Voltage MVA Rating	Four 3-phase transformers service the eight main generators (one set of 3 single phase transformers per 2 generators) 13.8kV 138.0 kV 60 MVA
Station Service Transformers Number Low Side Voltage High Side Voltage MVA Rating	One 3-phase transformer services the two house generators 2.4 kV 13.8 kV 3.75 MVA
Governor Type and Pressure	Voith 160 psi
Powerhouse Crane	150 ton - Whiting Corporation
Gantry Cranes on Dam	70 ton - Whiting Corporation
Crest Gates	Mississippi Valley Structural Steel Co.
Head Gates	M. H. Treadwell Mfg. Company
Trash Racks	Stupp Bros. Bridge & Iron Company

Information taken from Initial Consultation Document, Osage Project (FERC No. 459), AmerenUE and Duke Engineering and Services, Inc. January 2001.

Reduced copy of historic aerial photographs, dated February 20, 1973
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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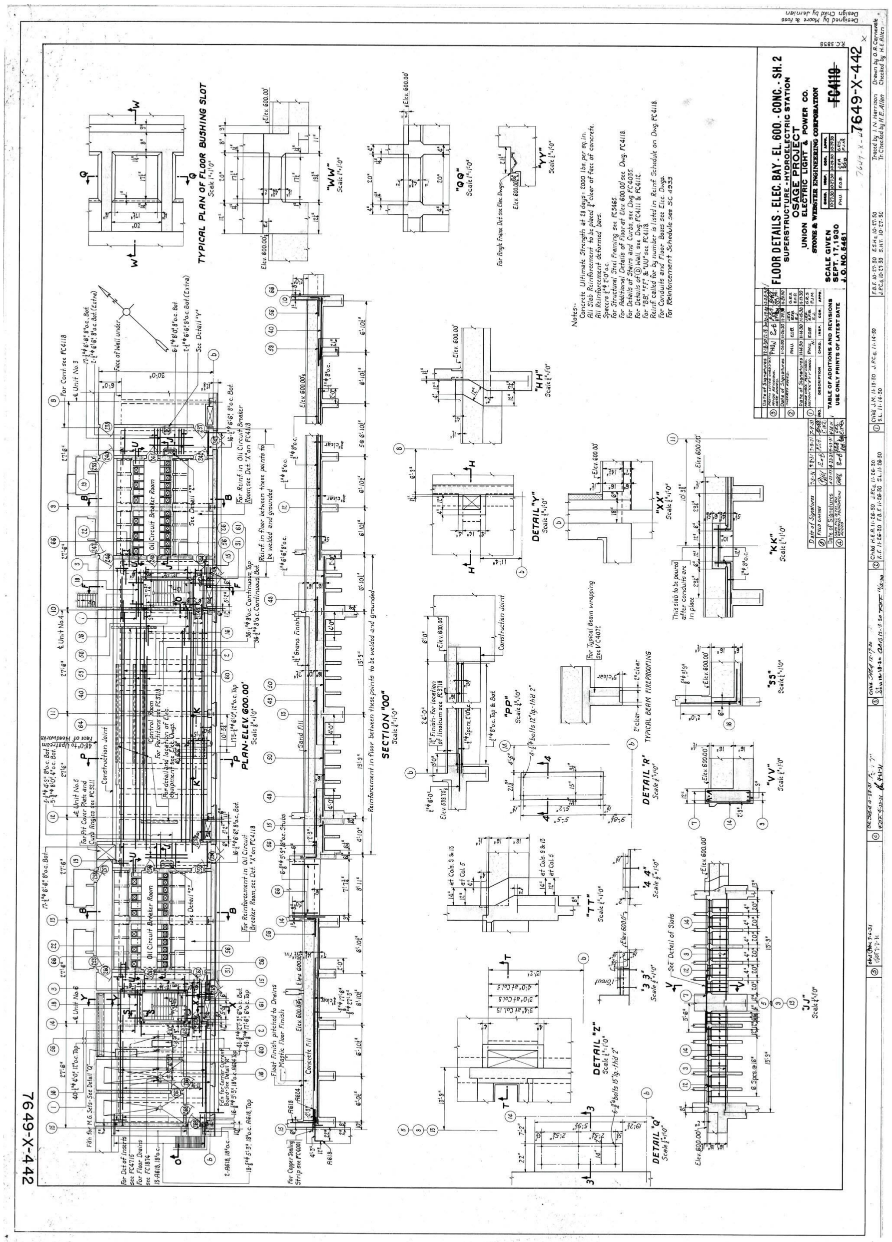

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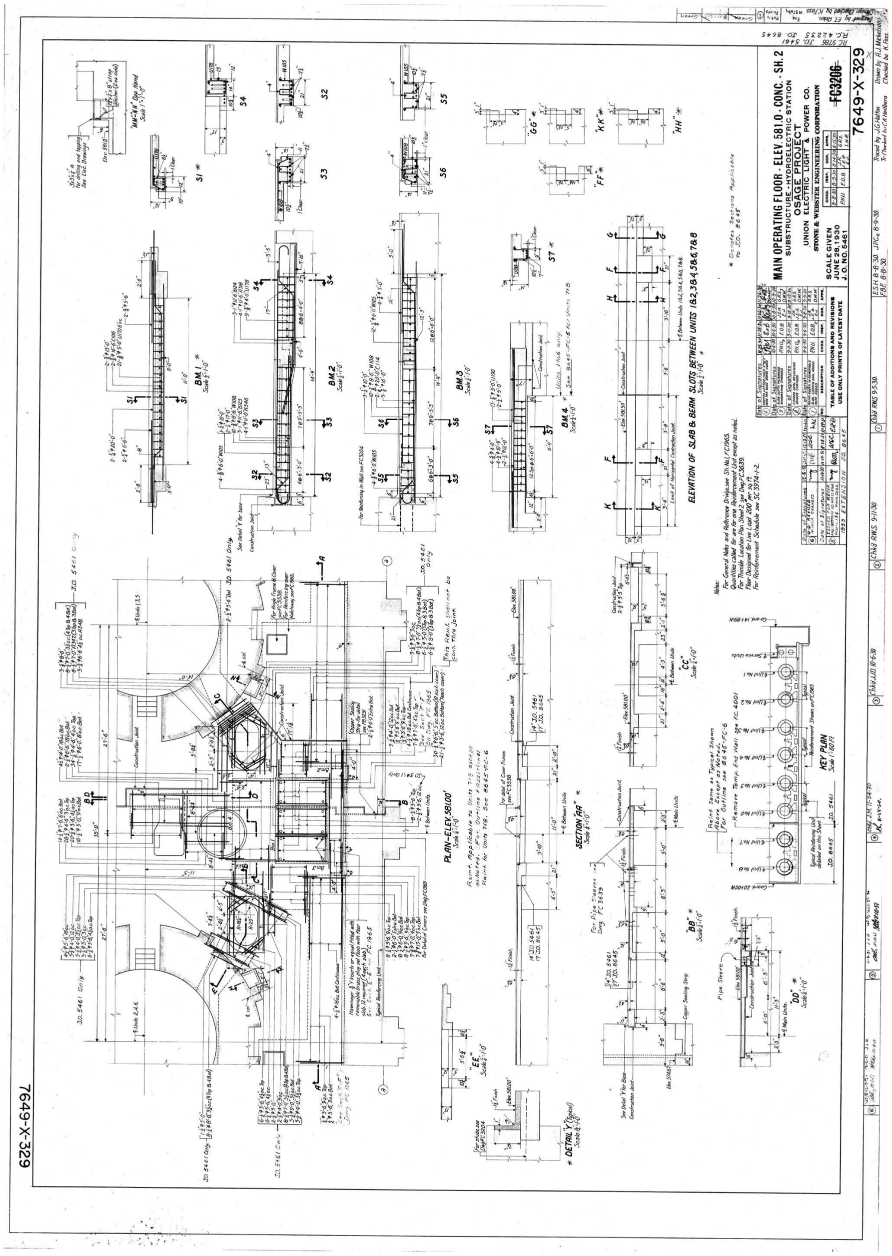
BAGNELL DAM AND OSAGE POWER PLANT
HAER No. MO-117
(page 33)



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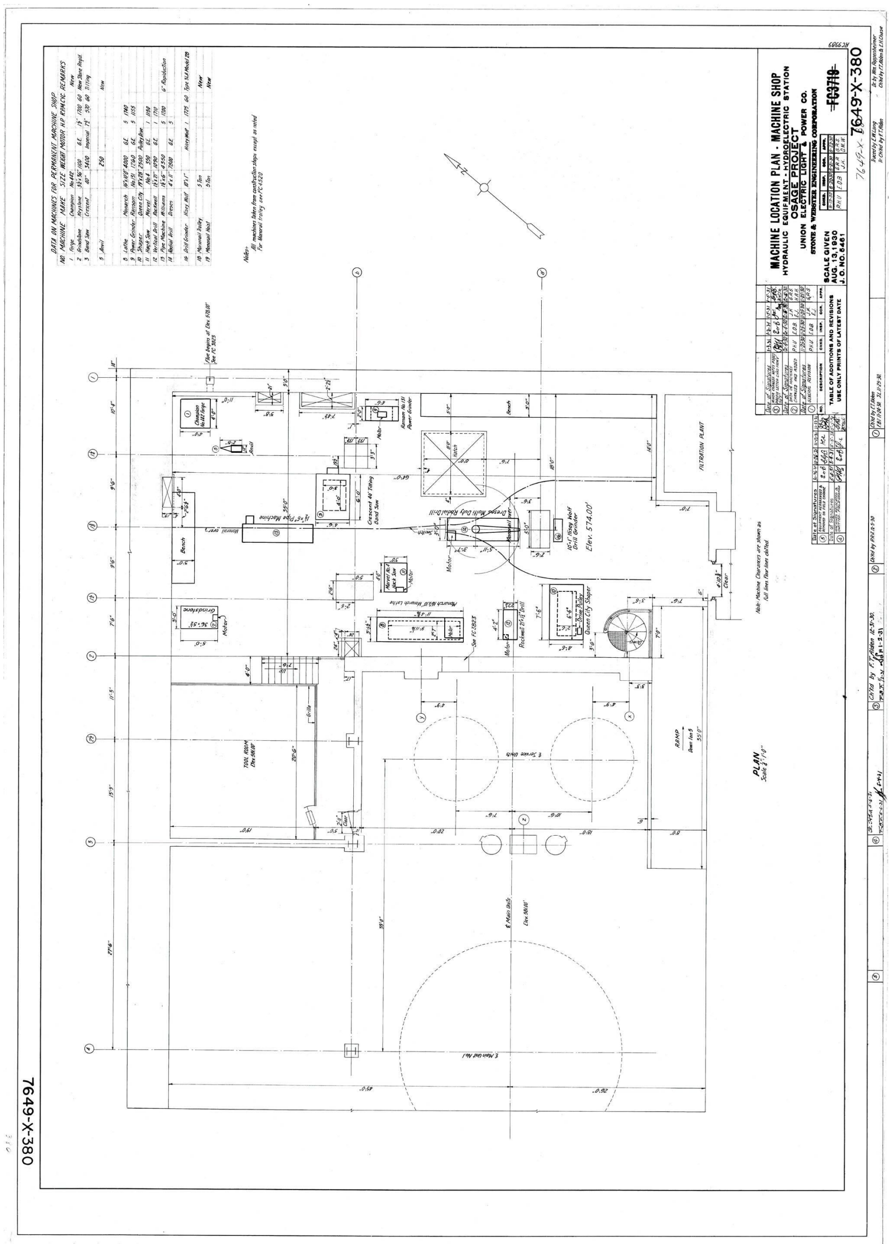

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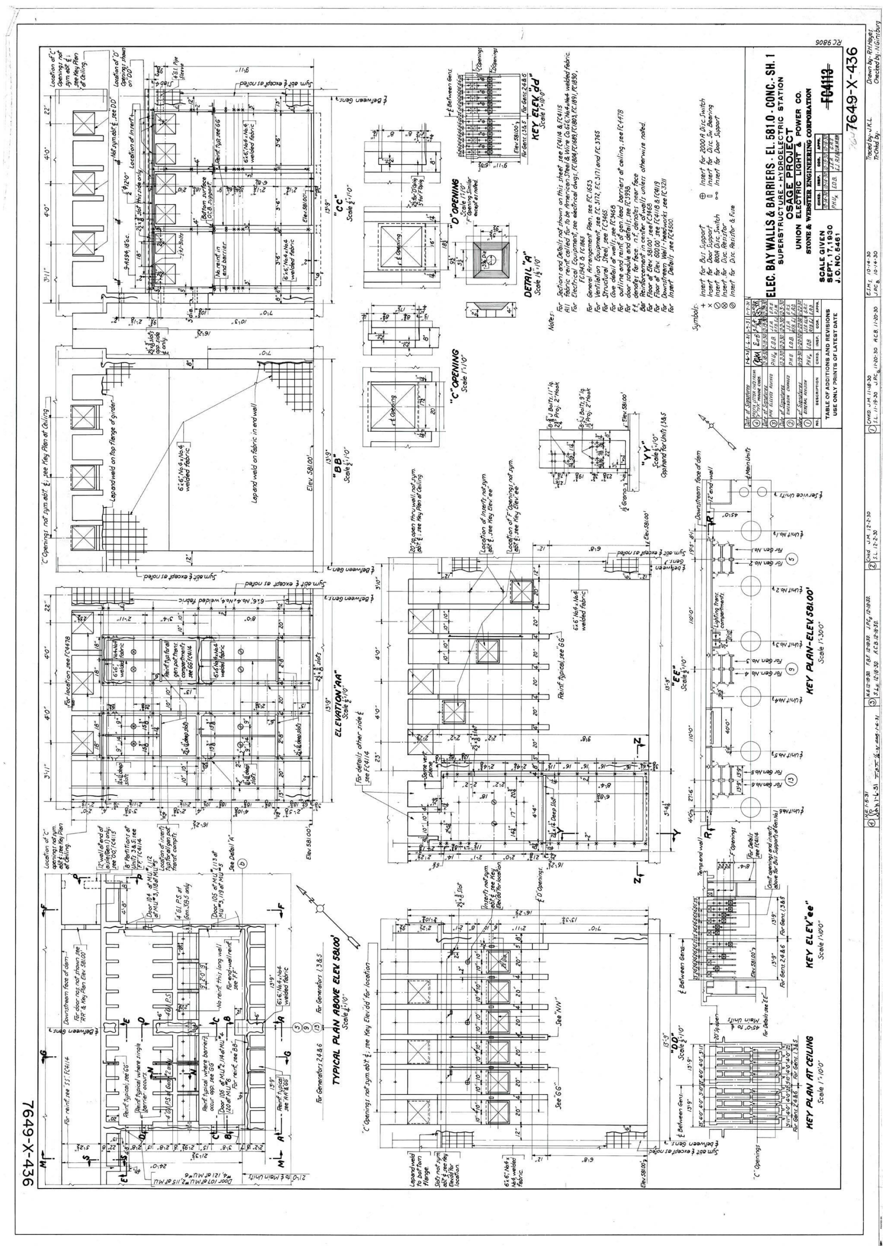

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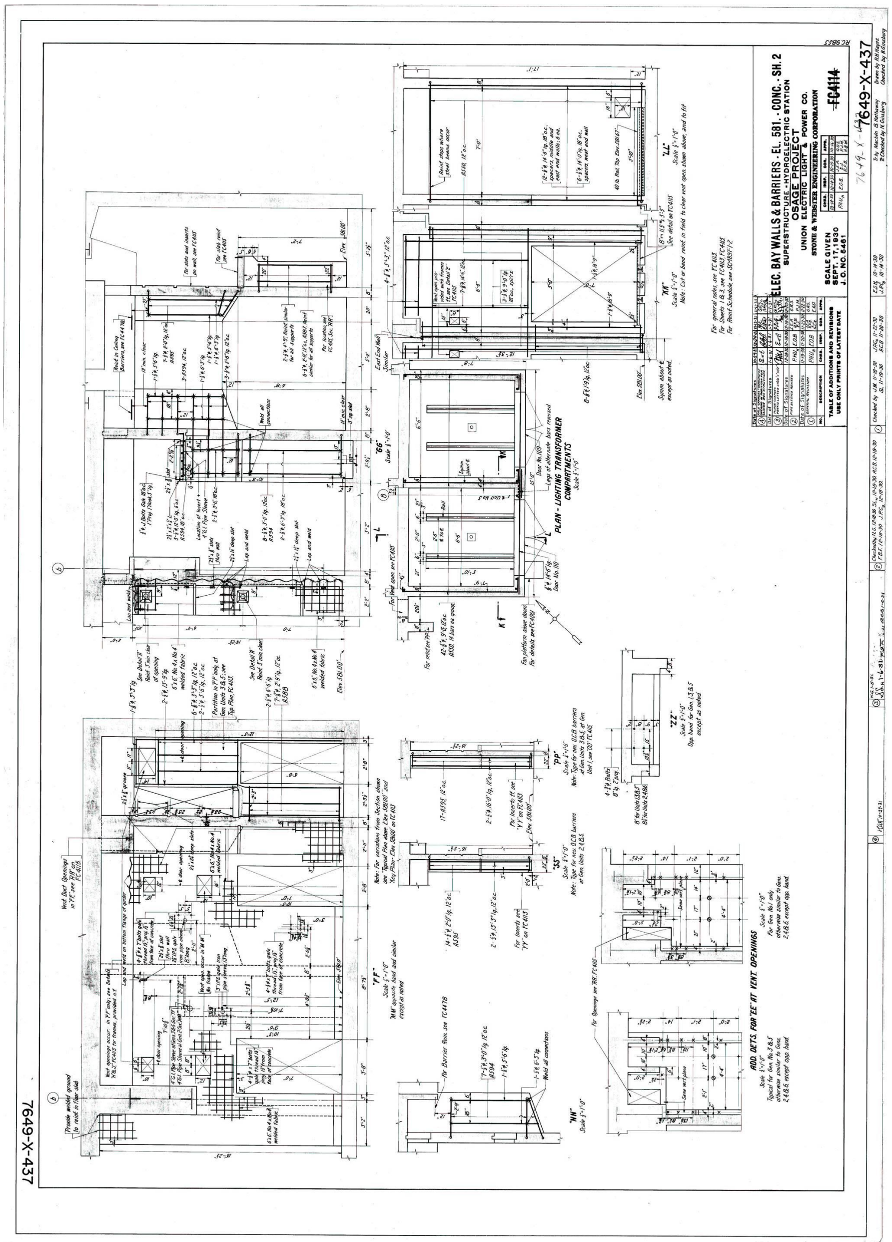

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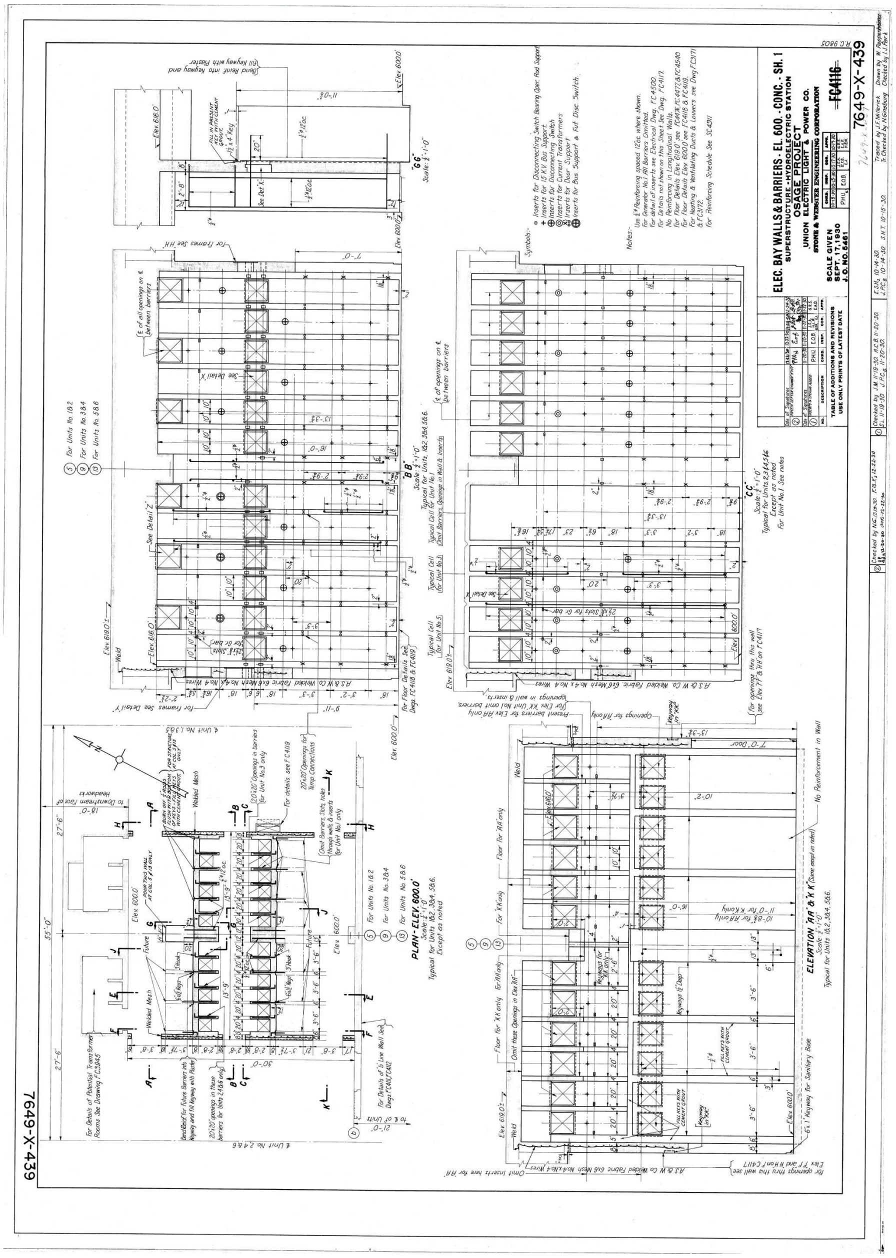

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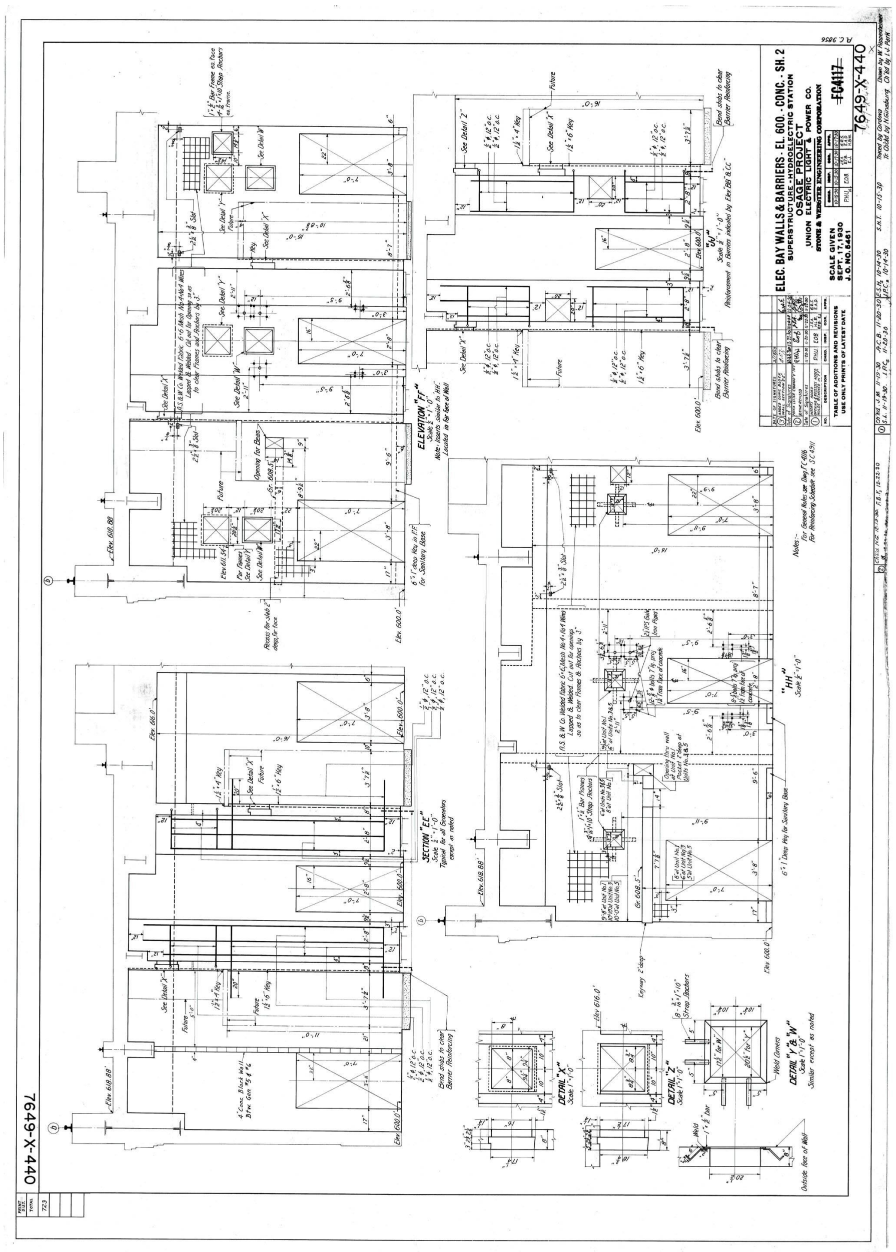

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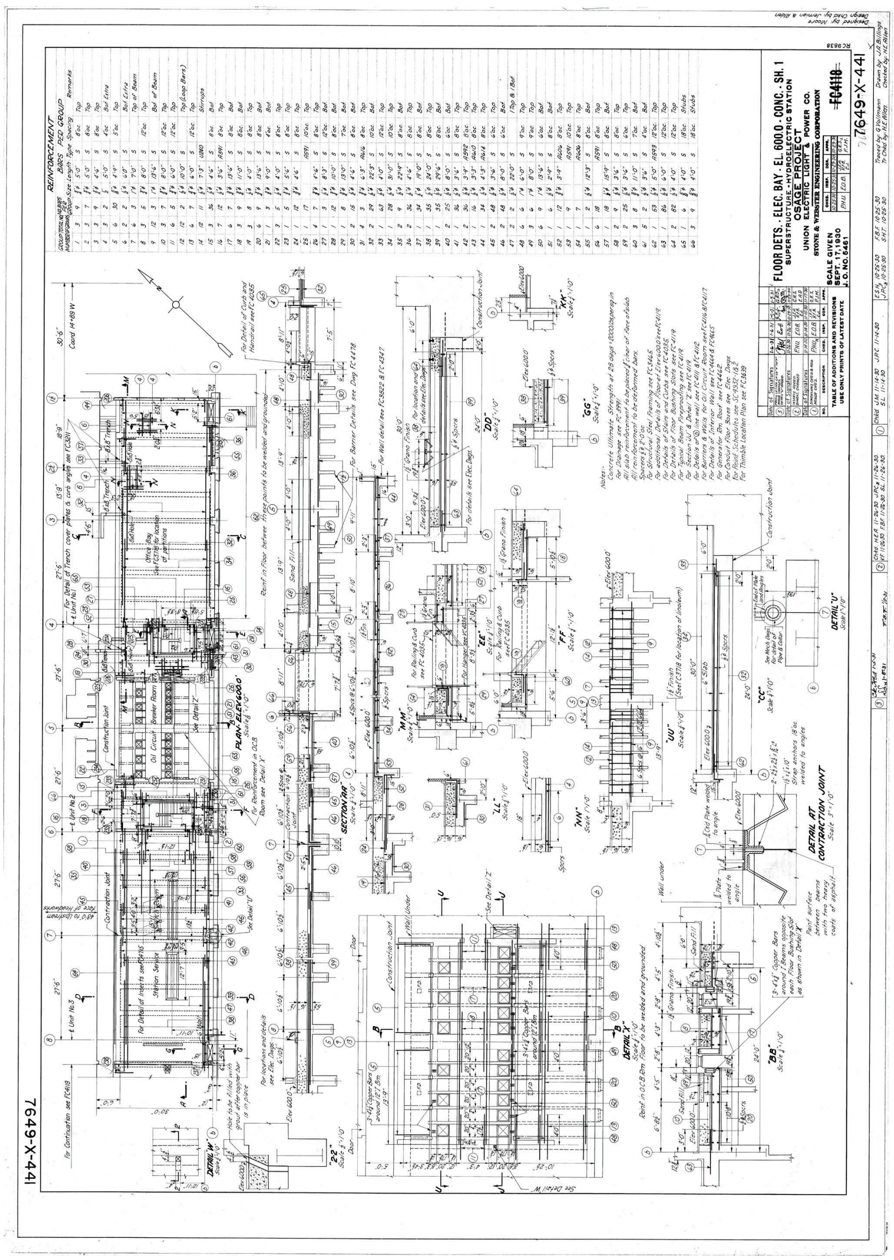

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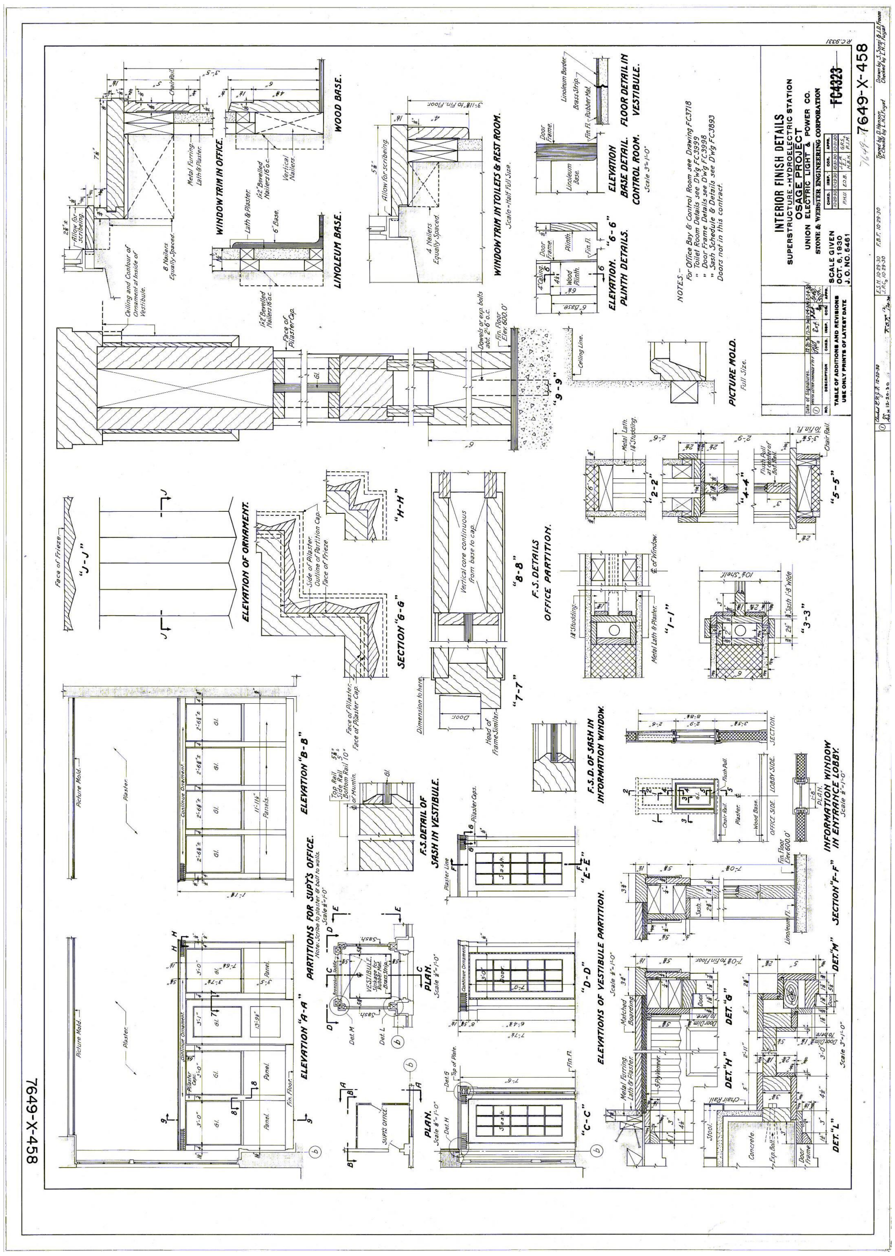

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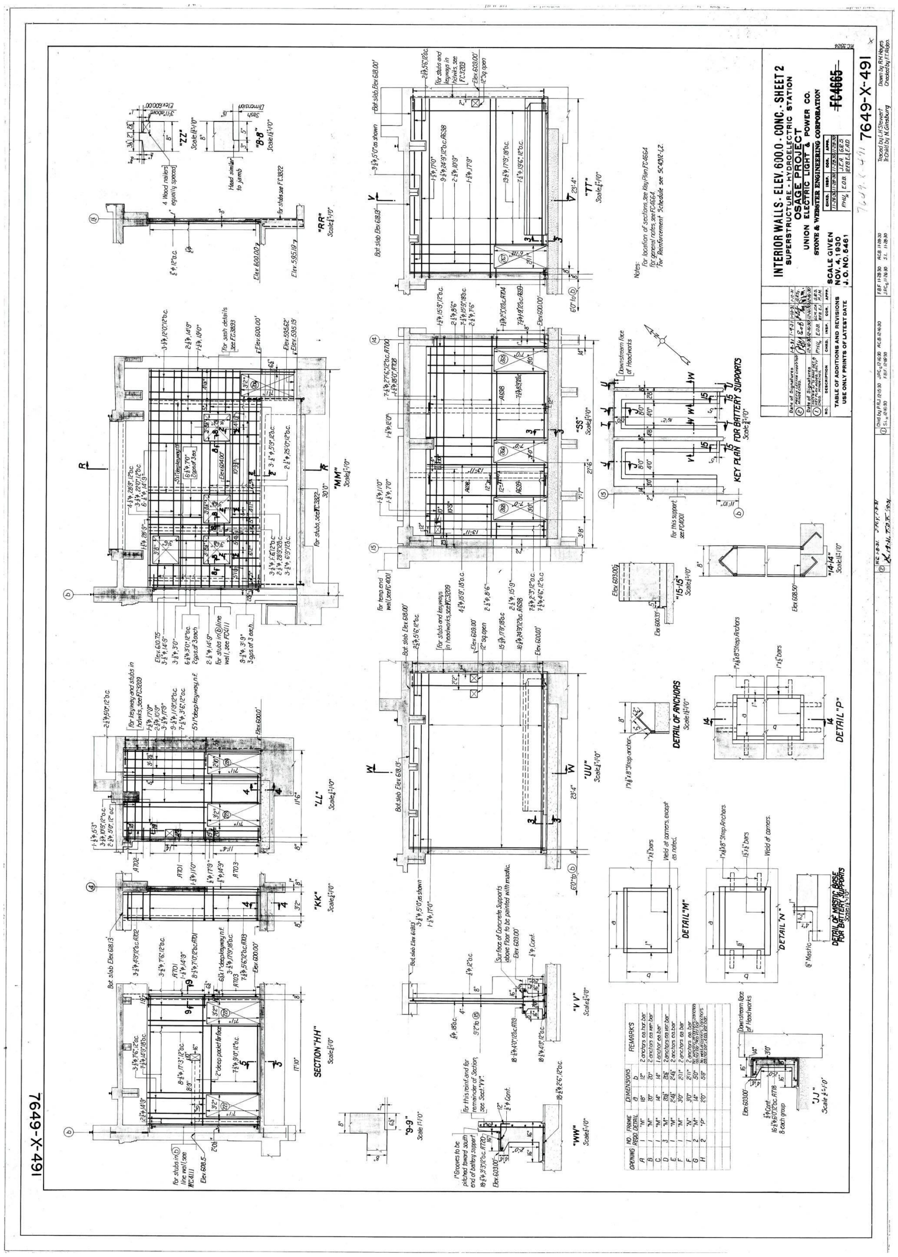

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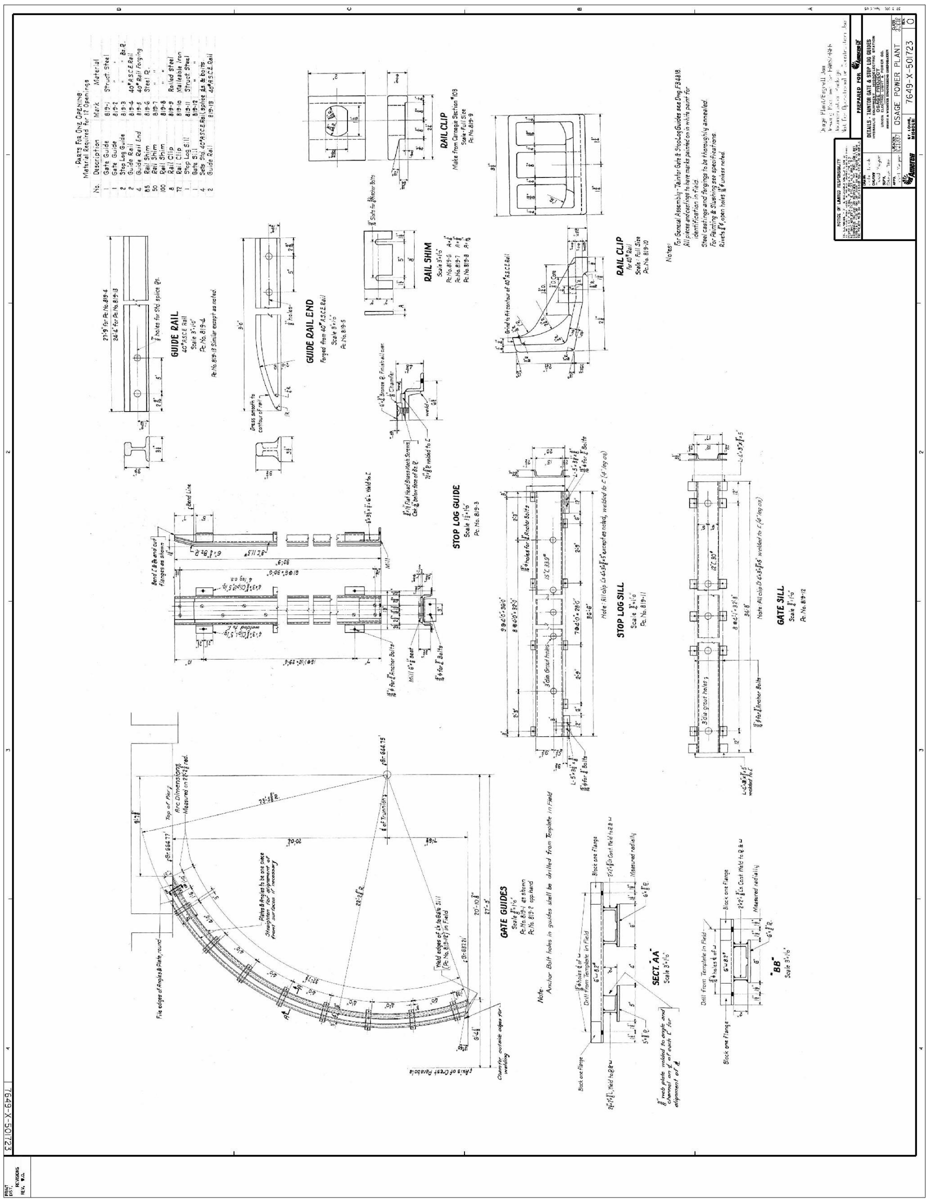

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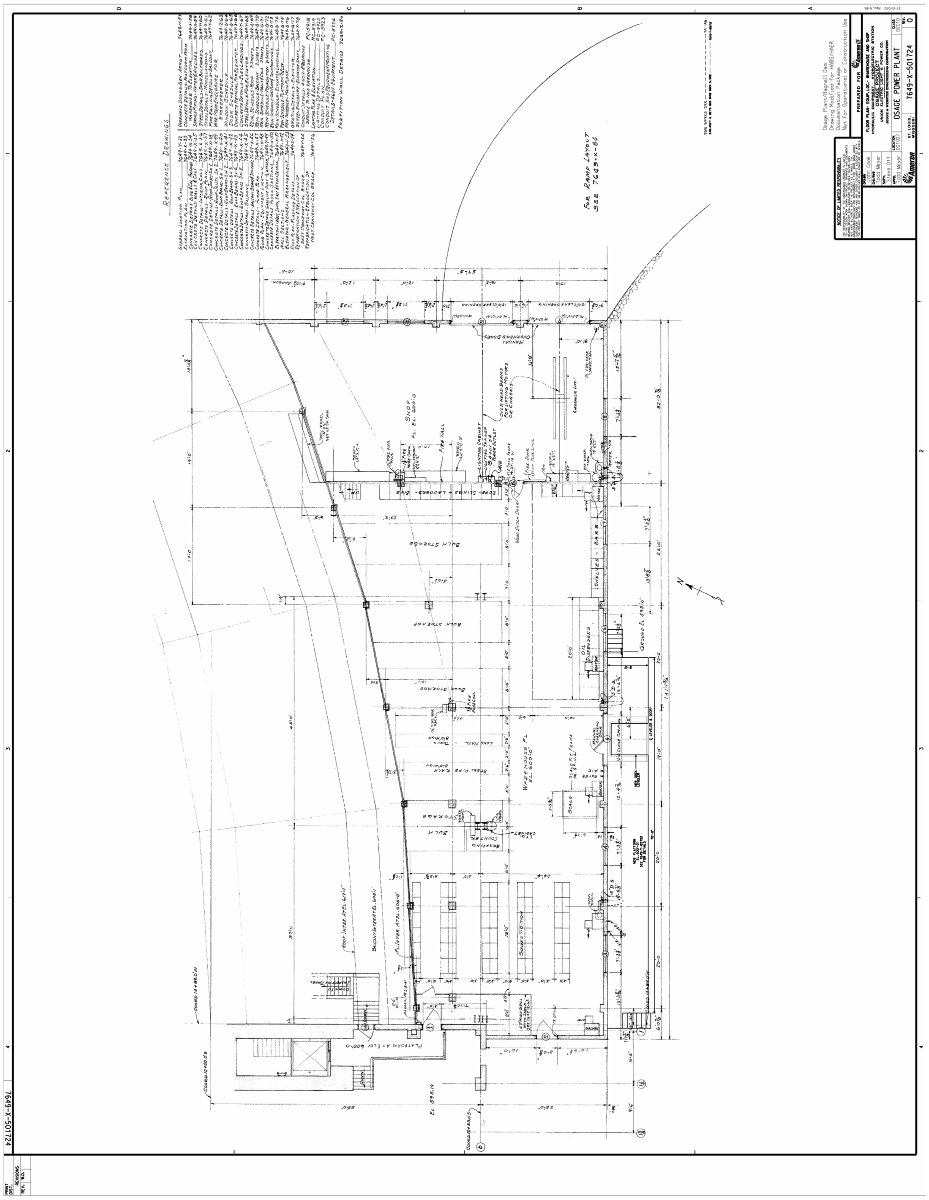

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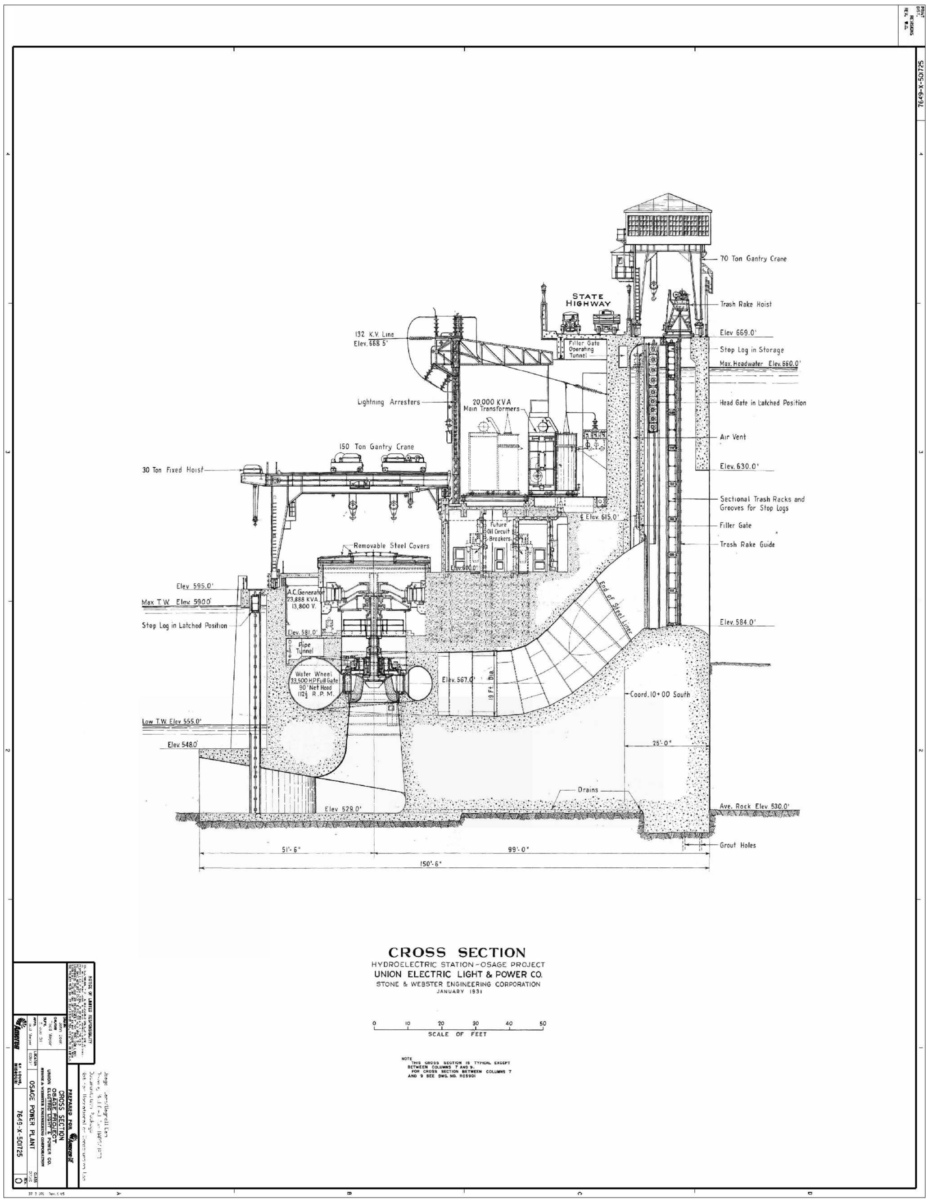

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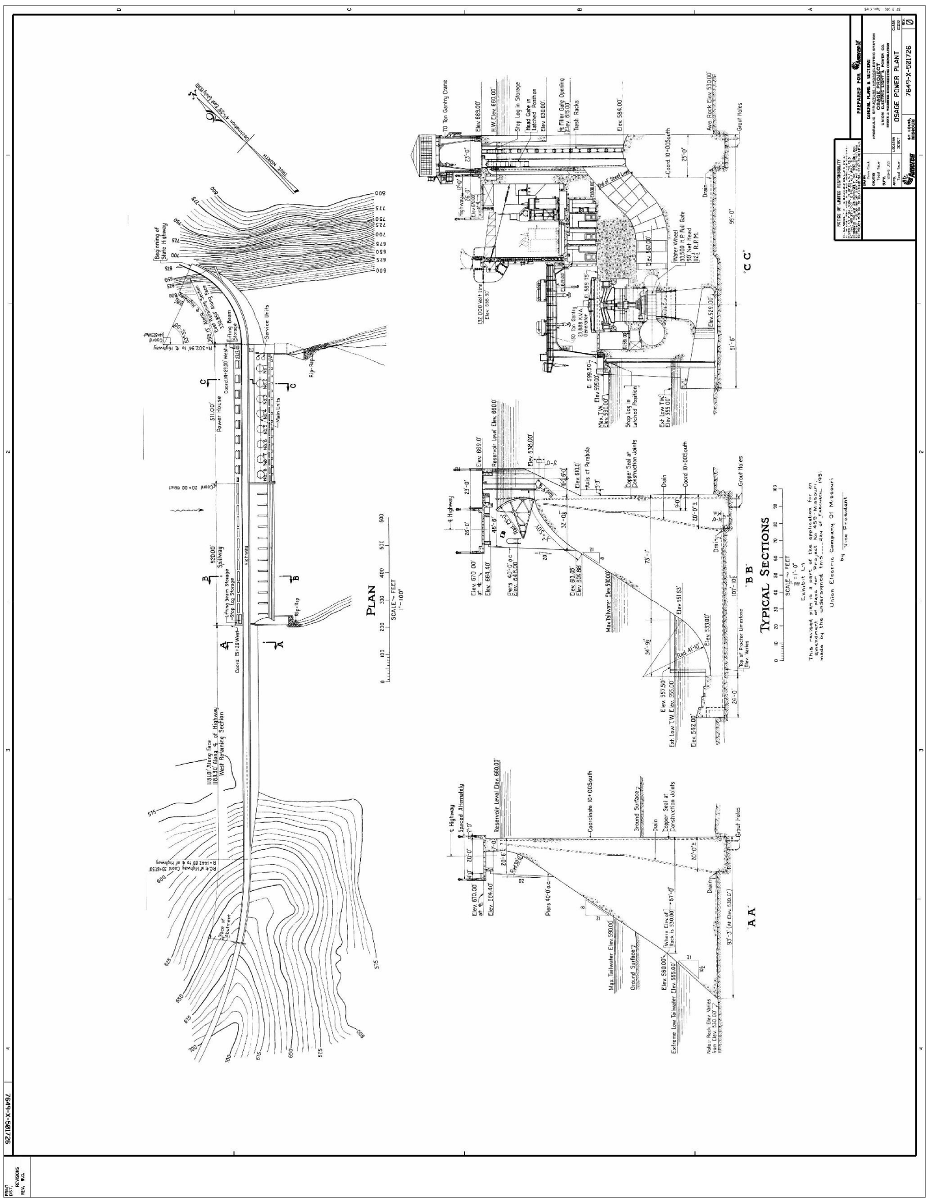

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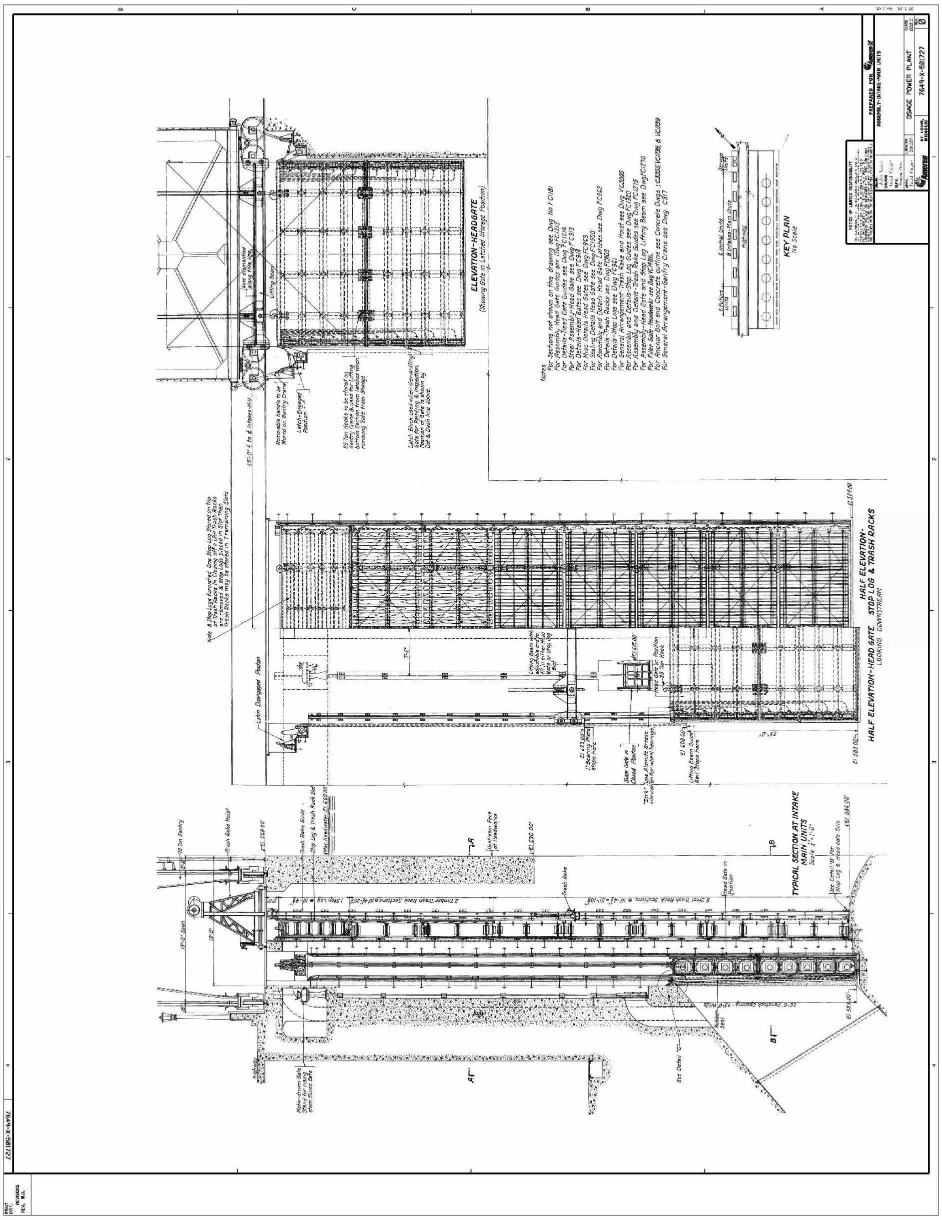

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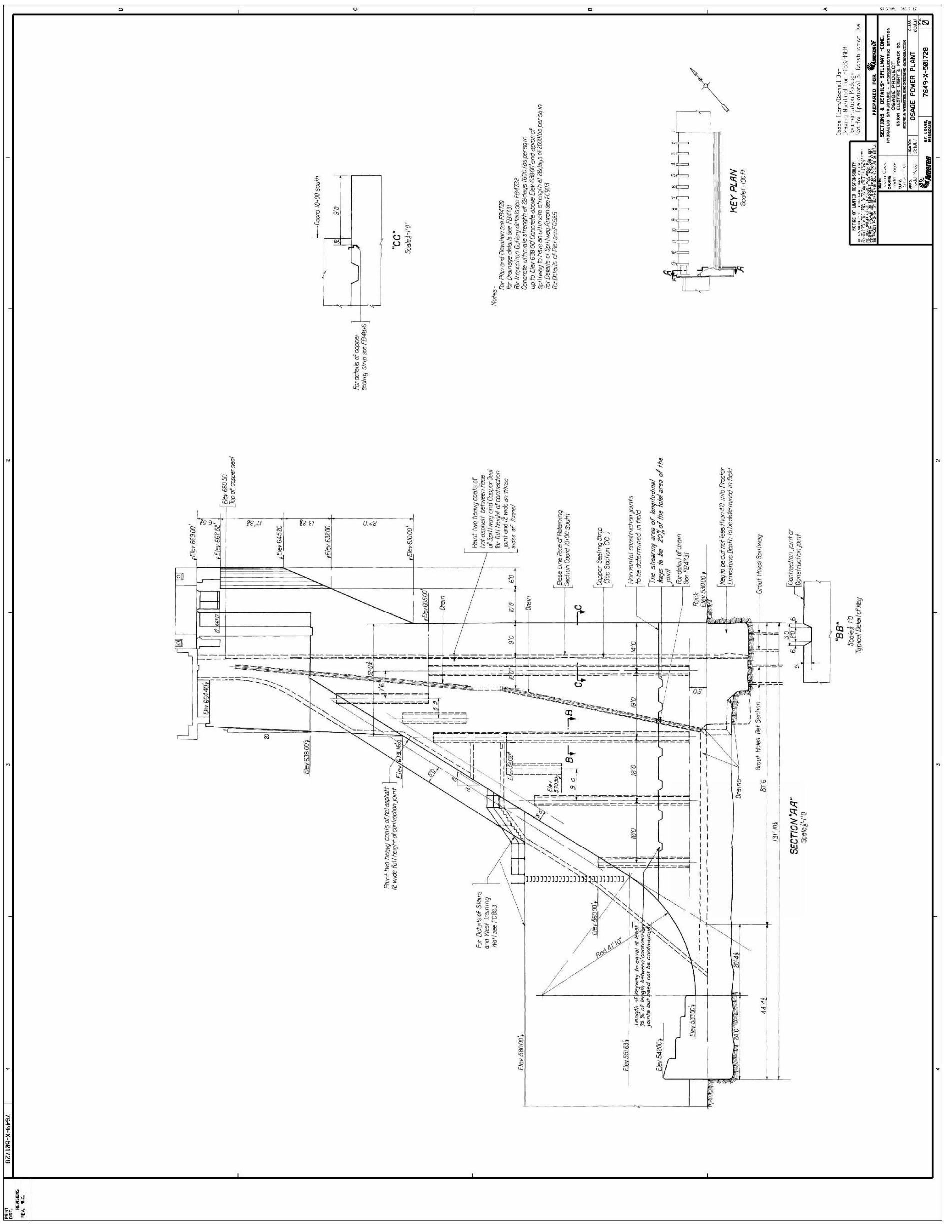
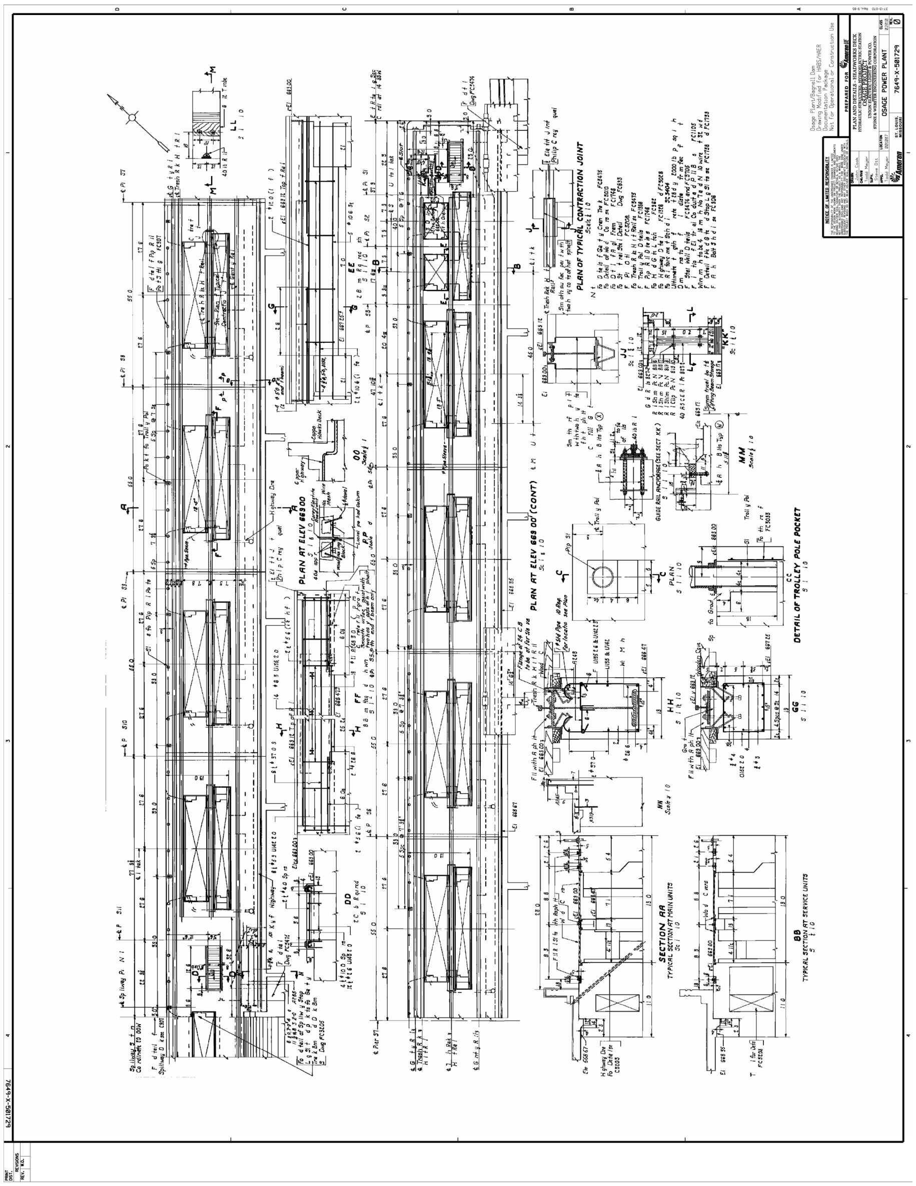
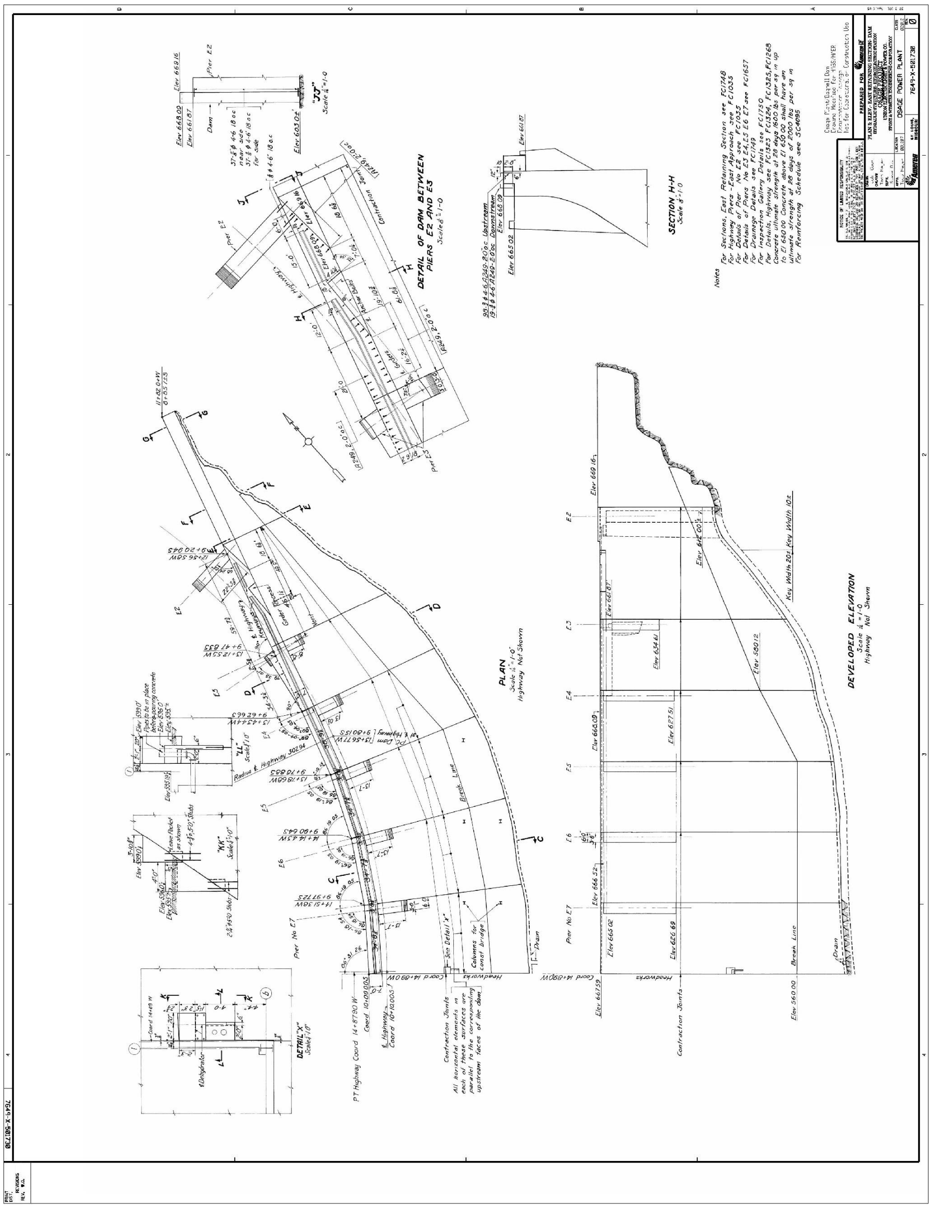


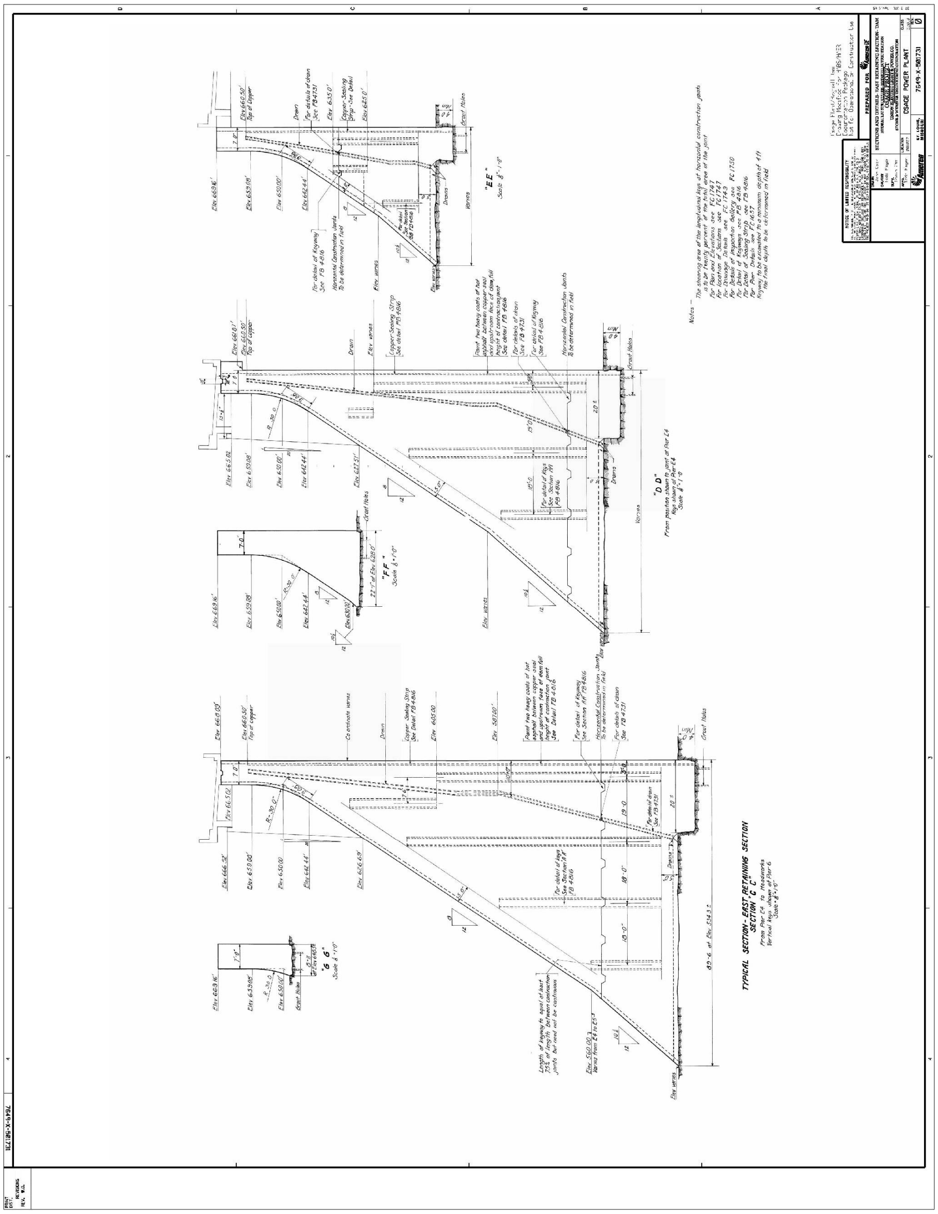
Reduced copy of historic sections and details, dated May 5, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



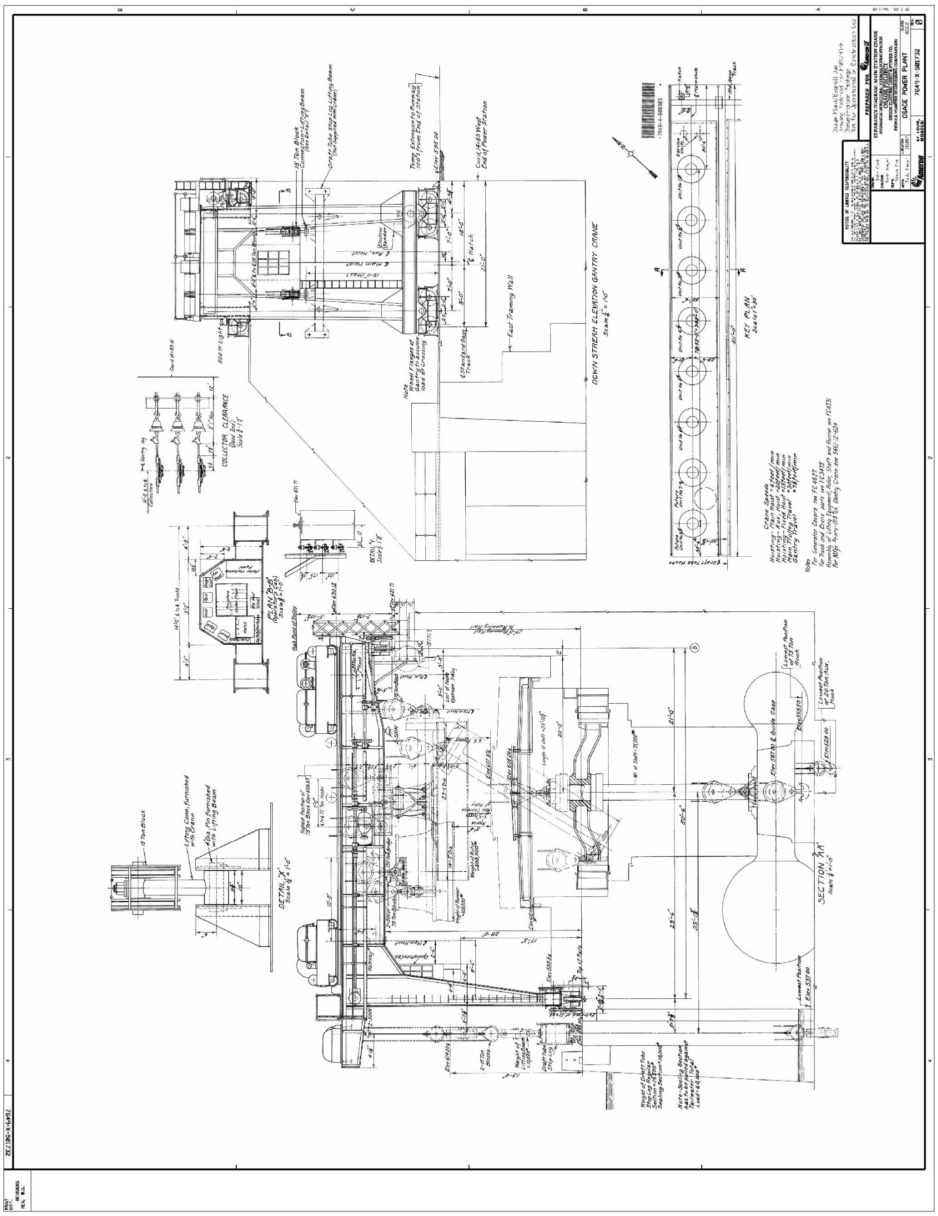
Reduced copy of historic plan and details, dated June 26, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



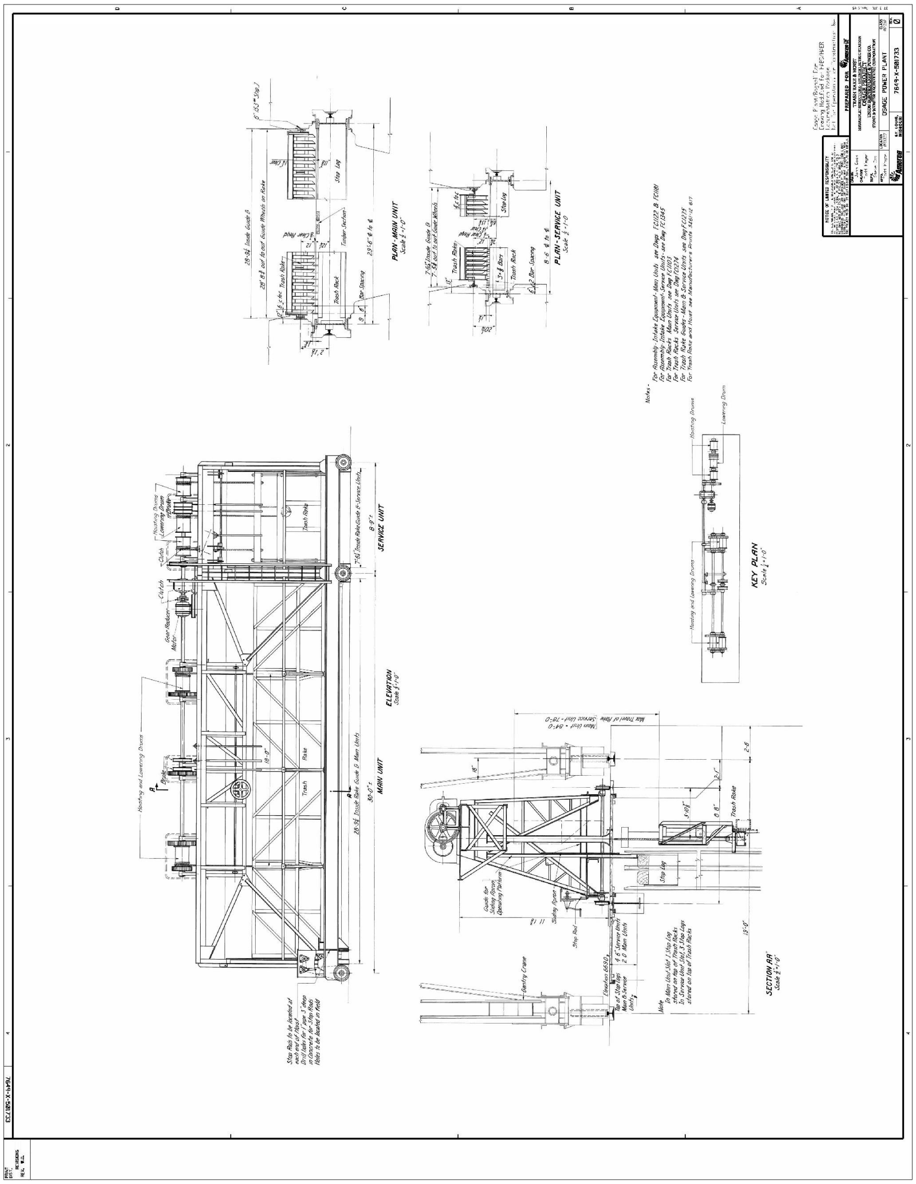
Reduced copy of historic plan and elevations, dated June 13, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



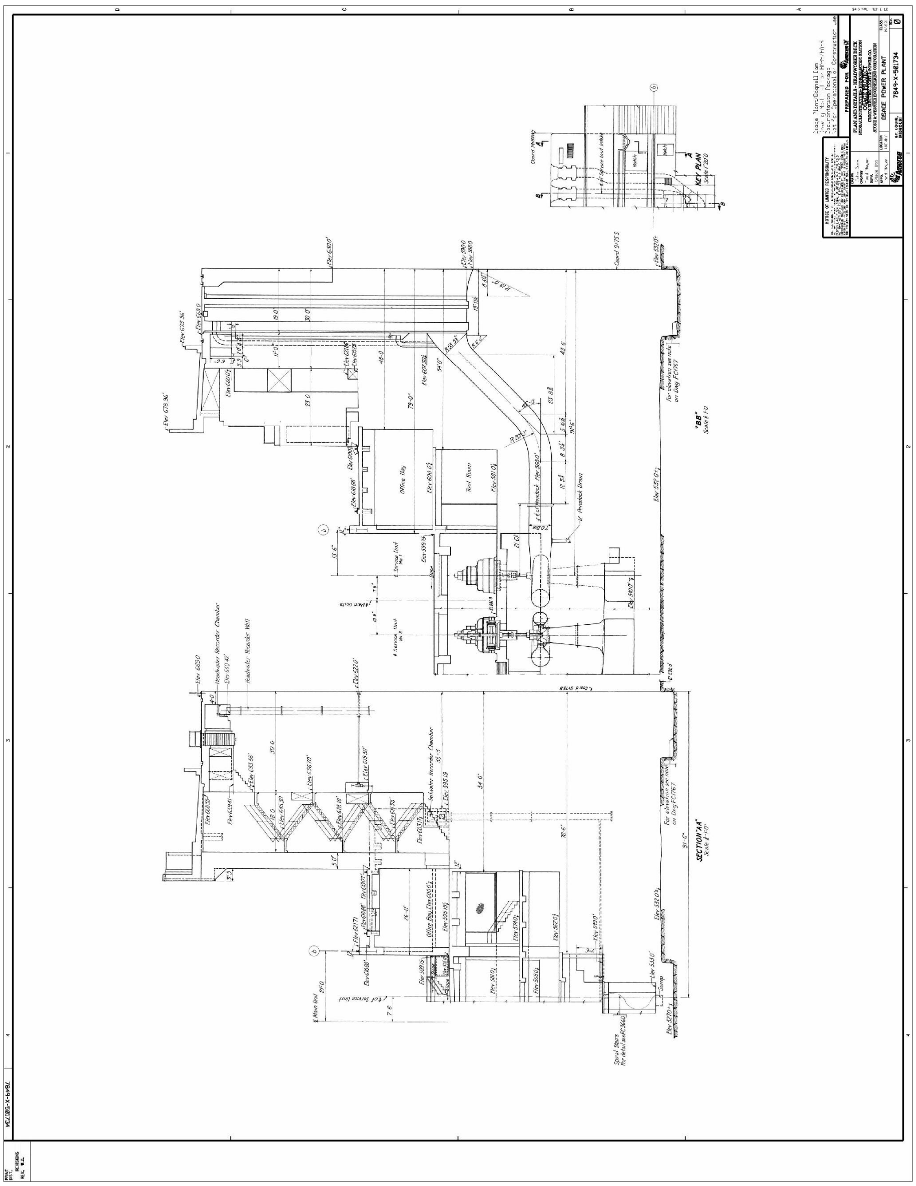
Reduced copy of historic sections and details, dated June 13, 2010
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



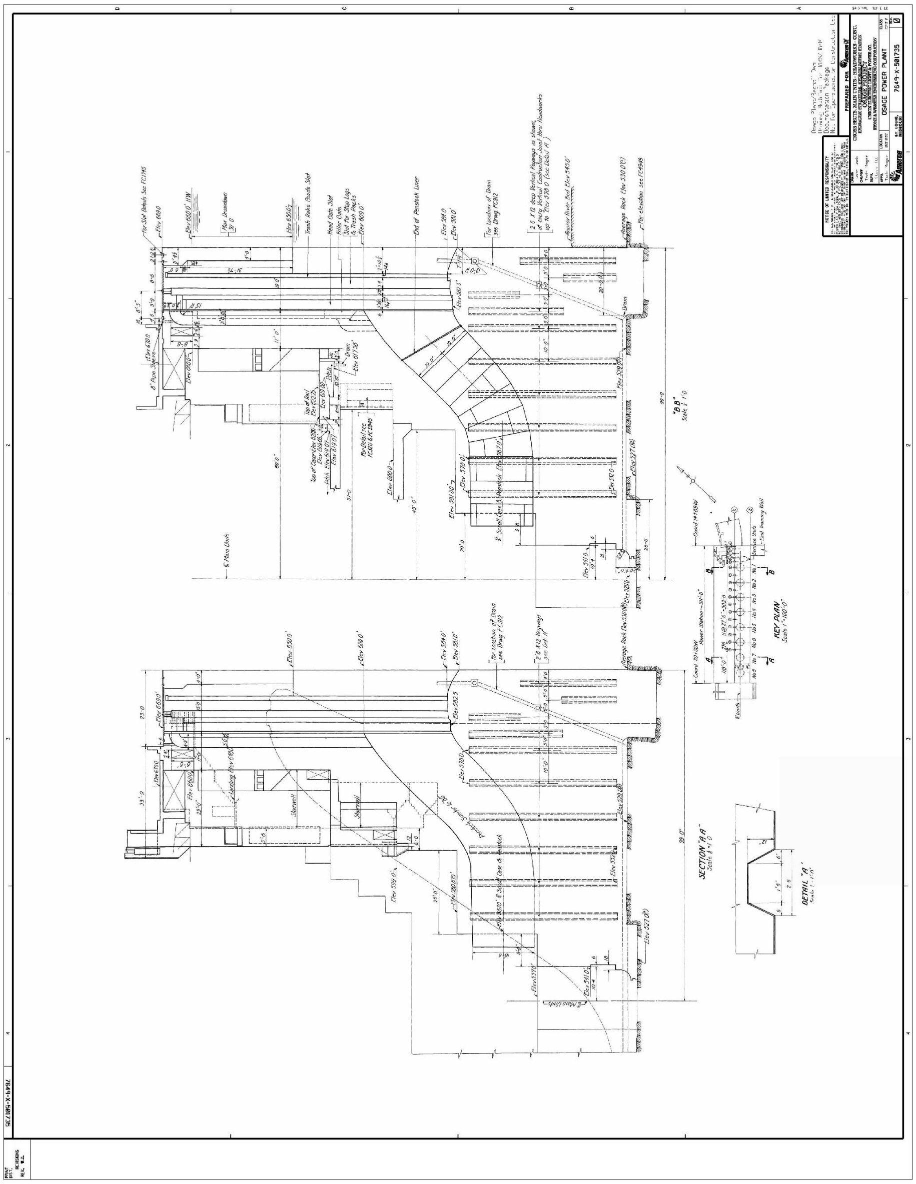
Reduced copy of historic diagram, dated June 14, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



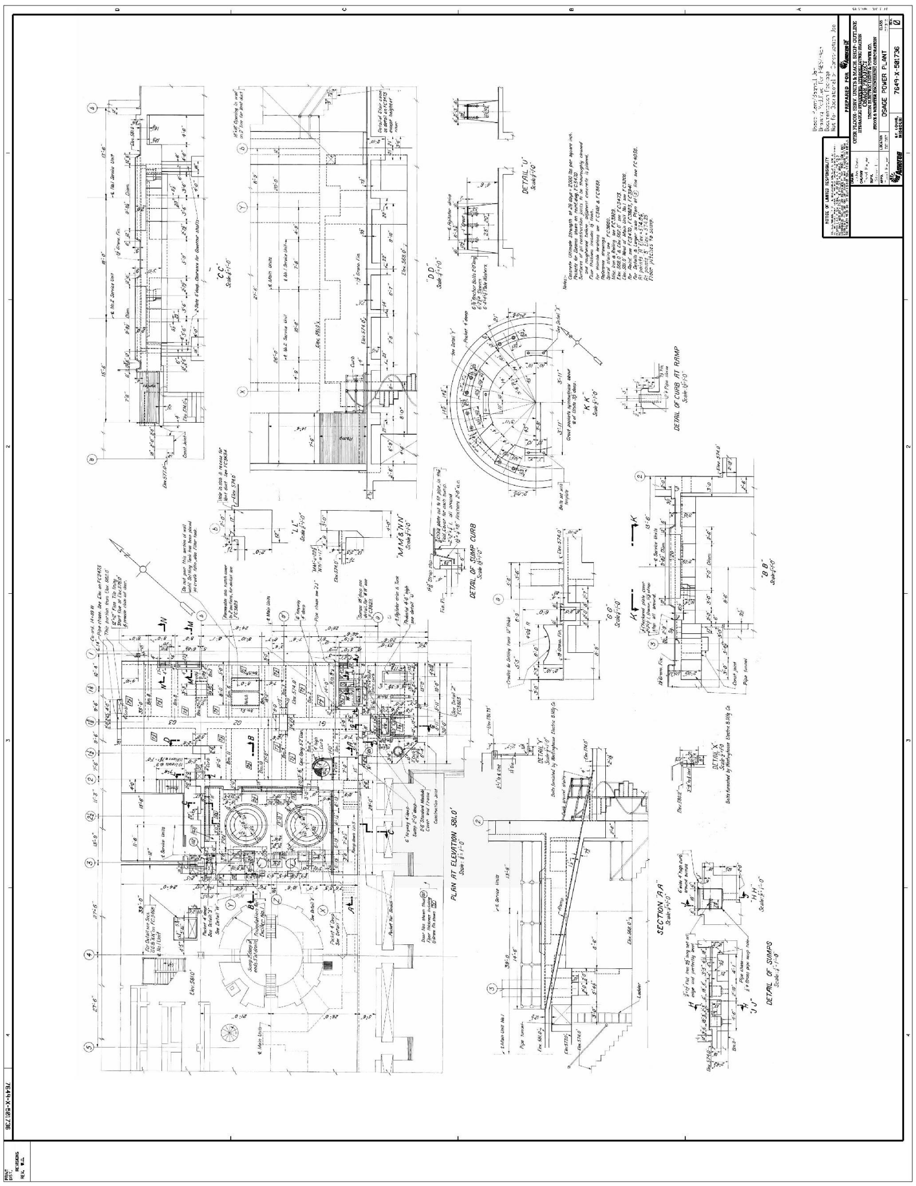
Reduced copy of historic plans, dated July 7, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



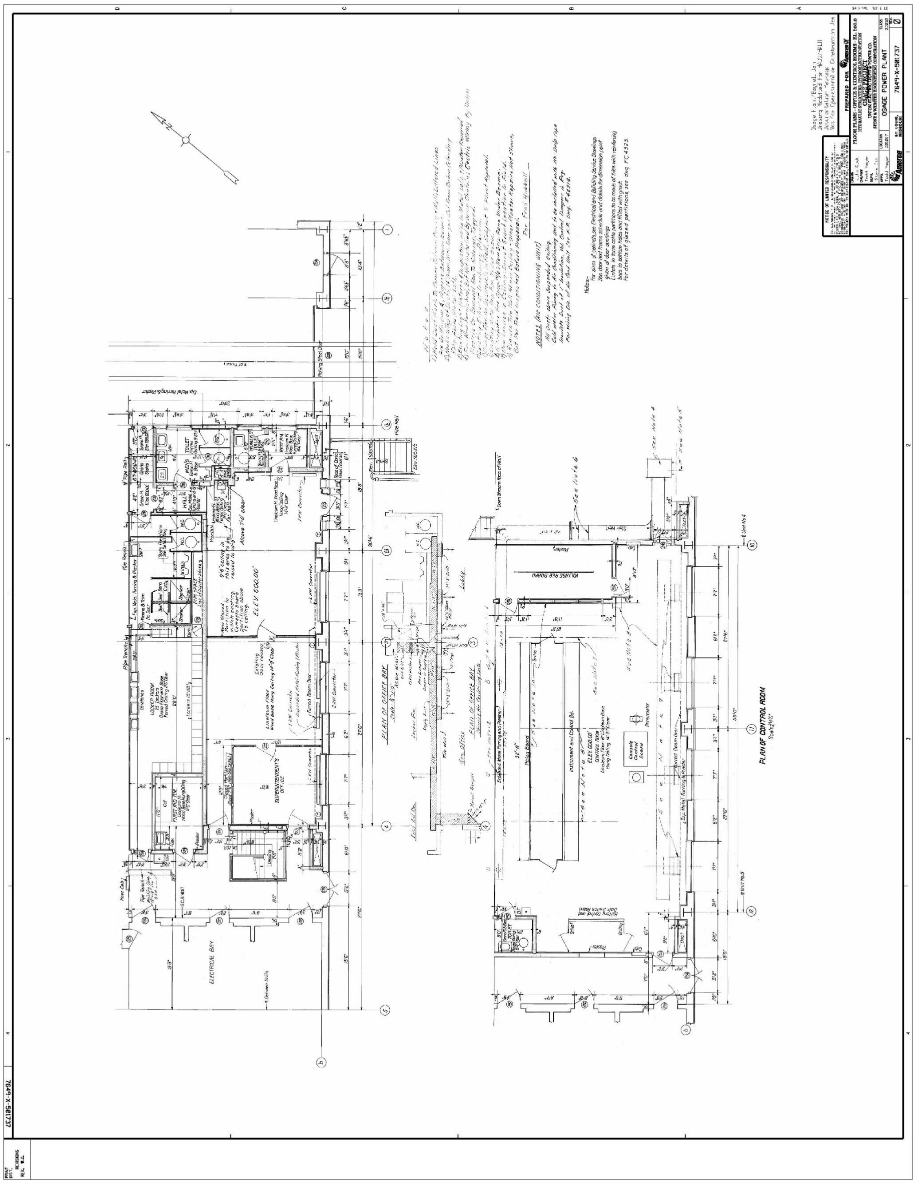
Reduced copy of historic plan and details, dated July 18, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



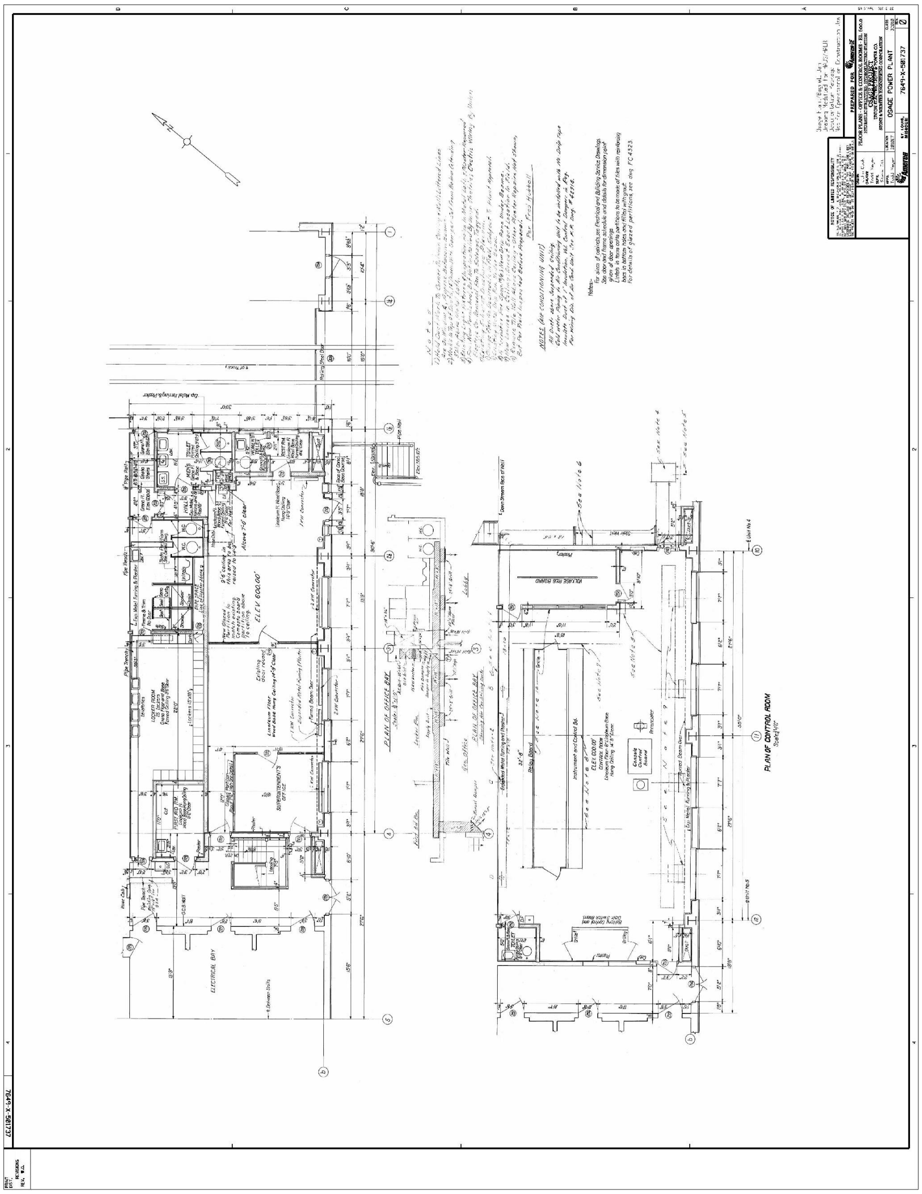
Reduced copy of historic sections, dated July 18, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



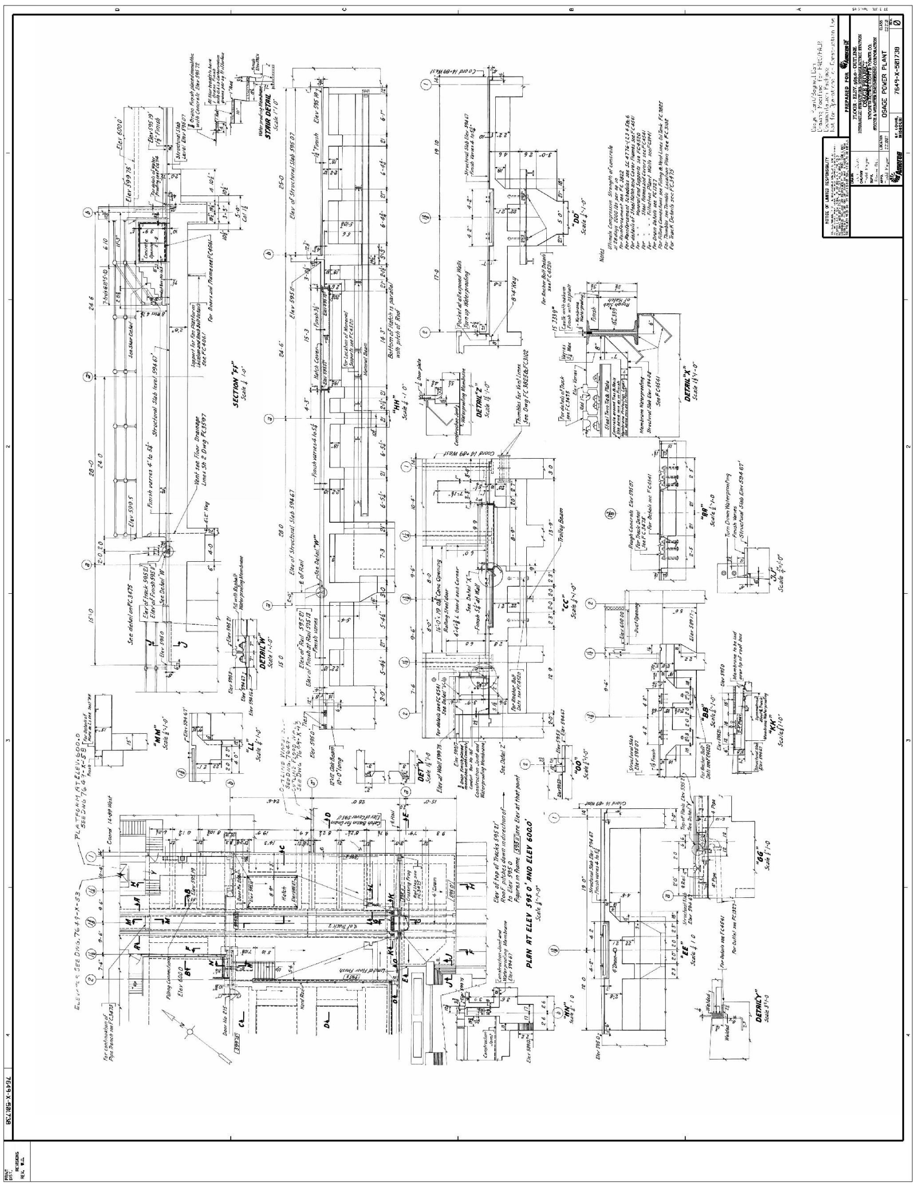
Reduced copy of historic details, dated August 13, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans, dated September 13, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans, dated September 13, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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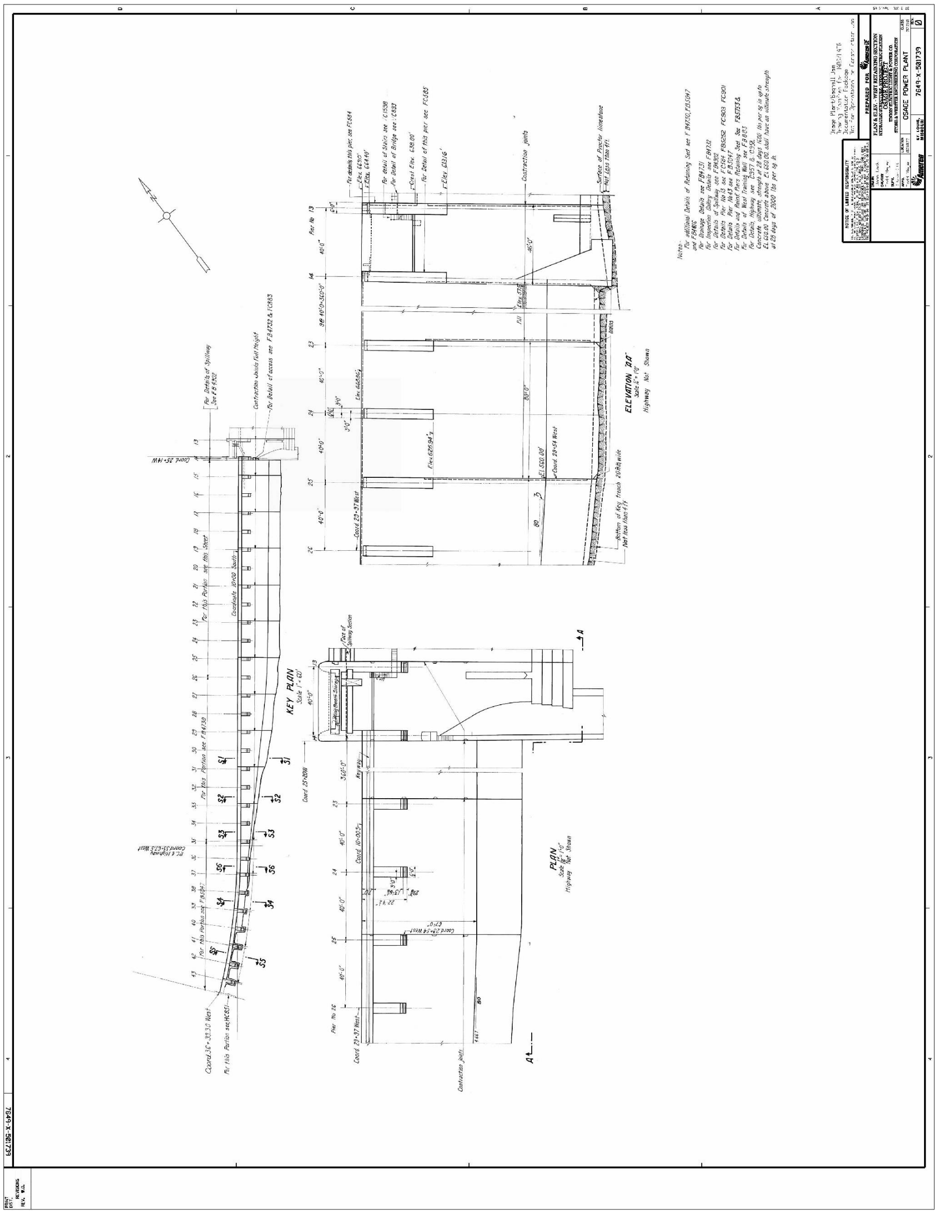
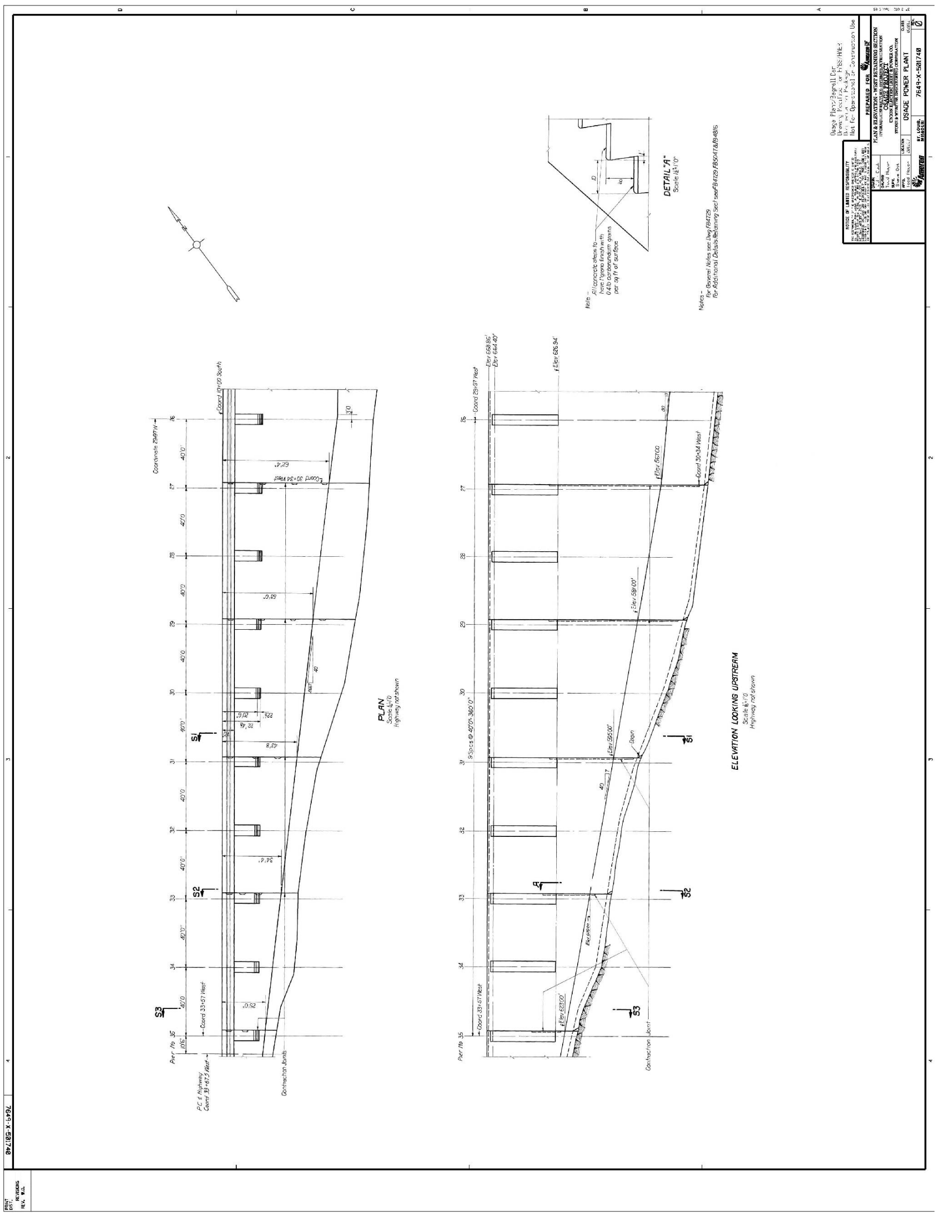
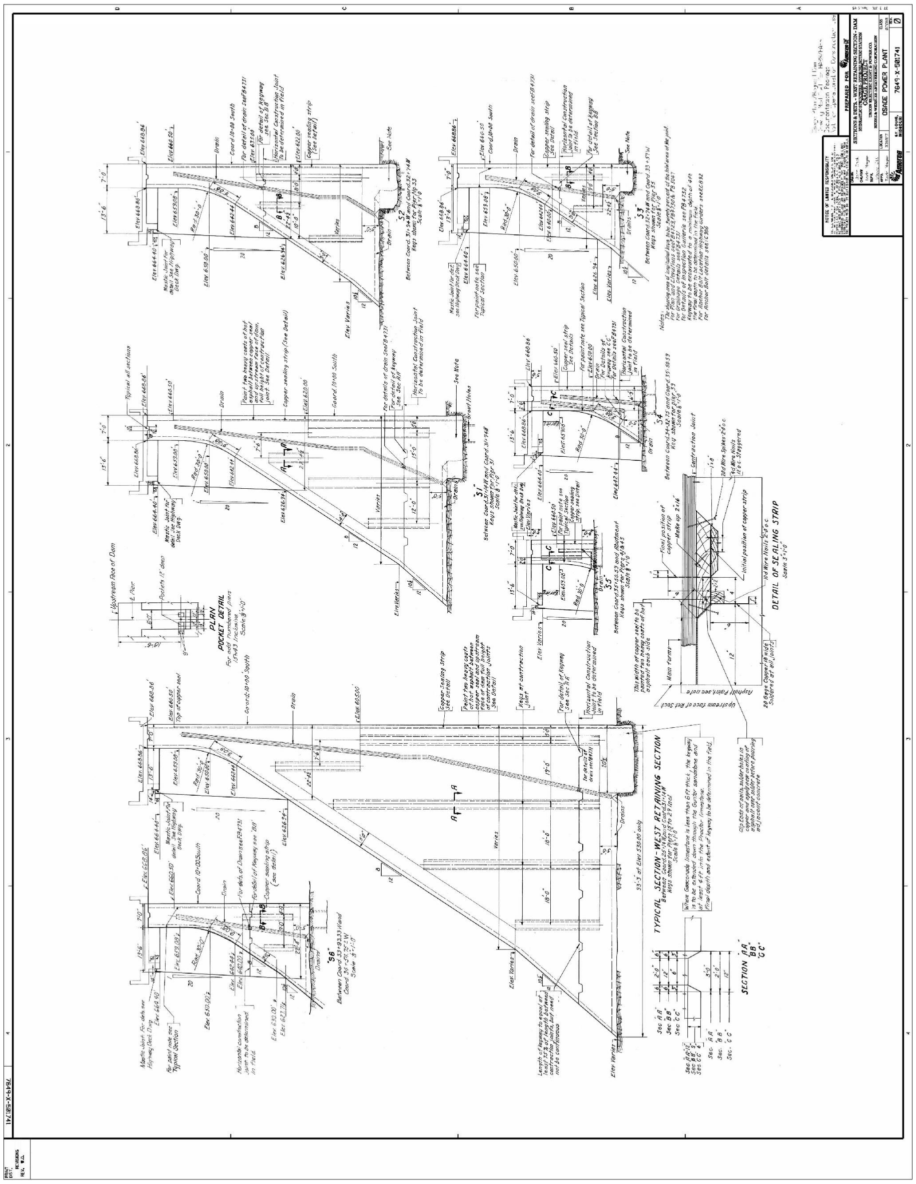
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



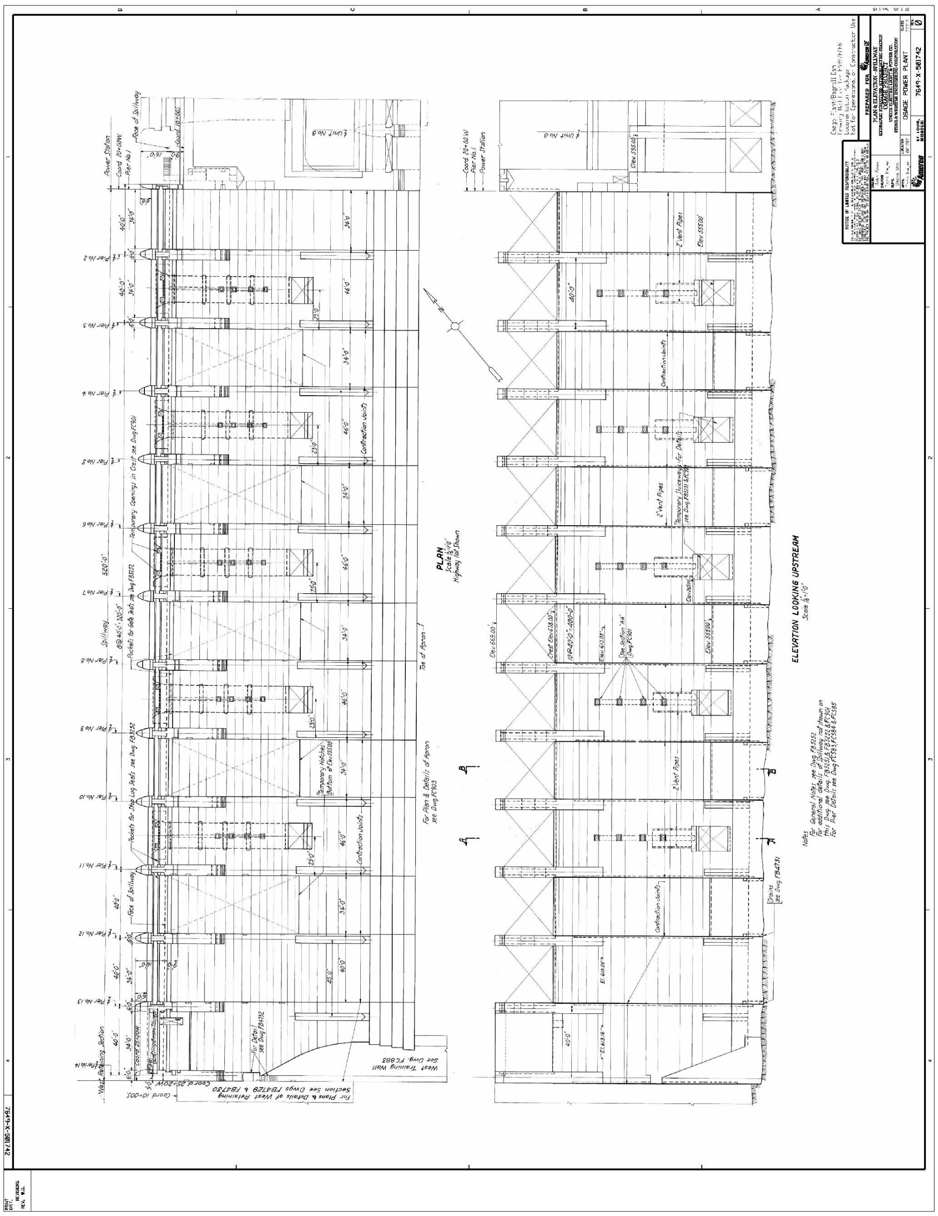
Reduced copy of historic plan and elevation, dated March 22, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



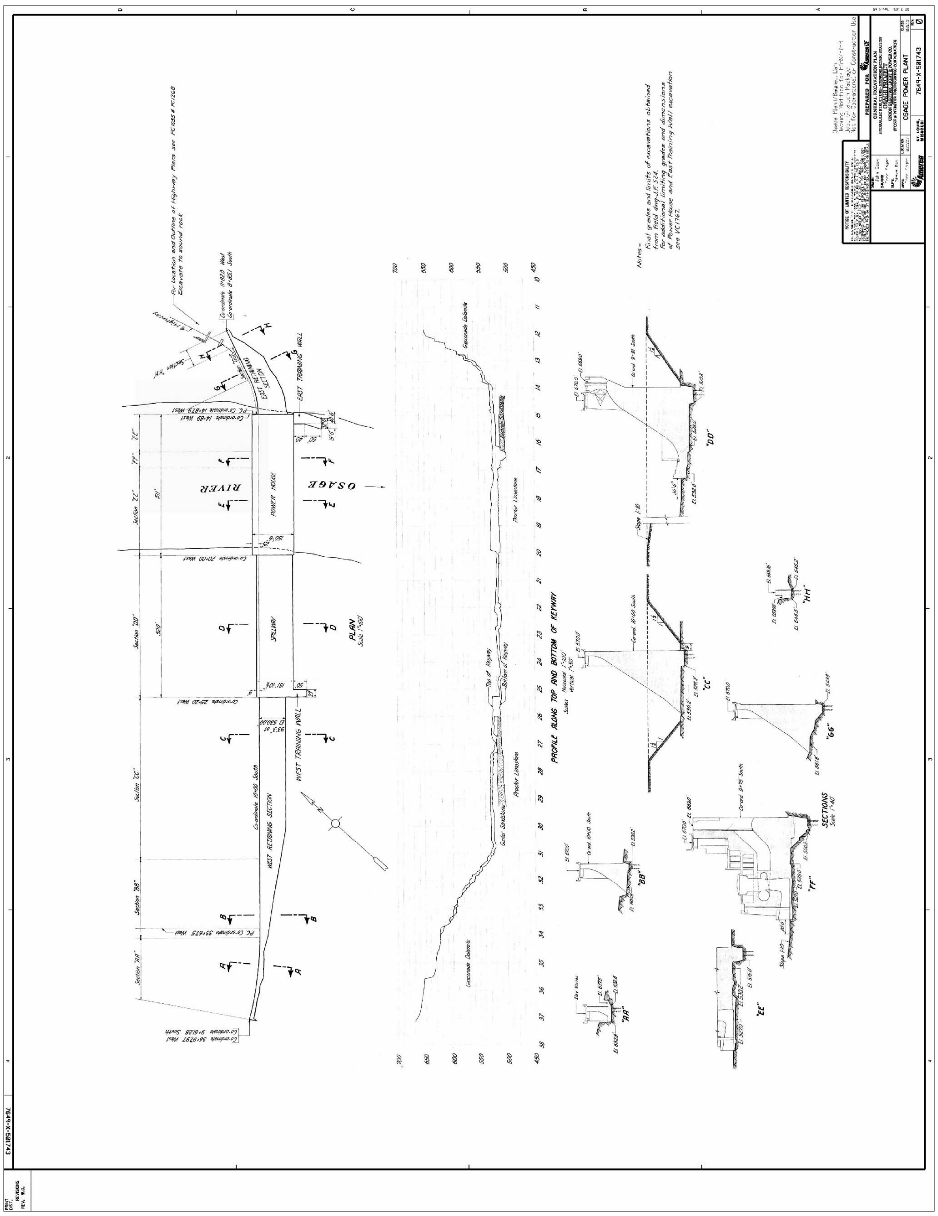
Reduced copy of historic plan and elevation, dated January 17, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic sections and details, dated June 13, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plan and elevation, dated March 22, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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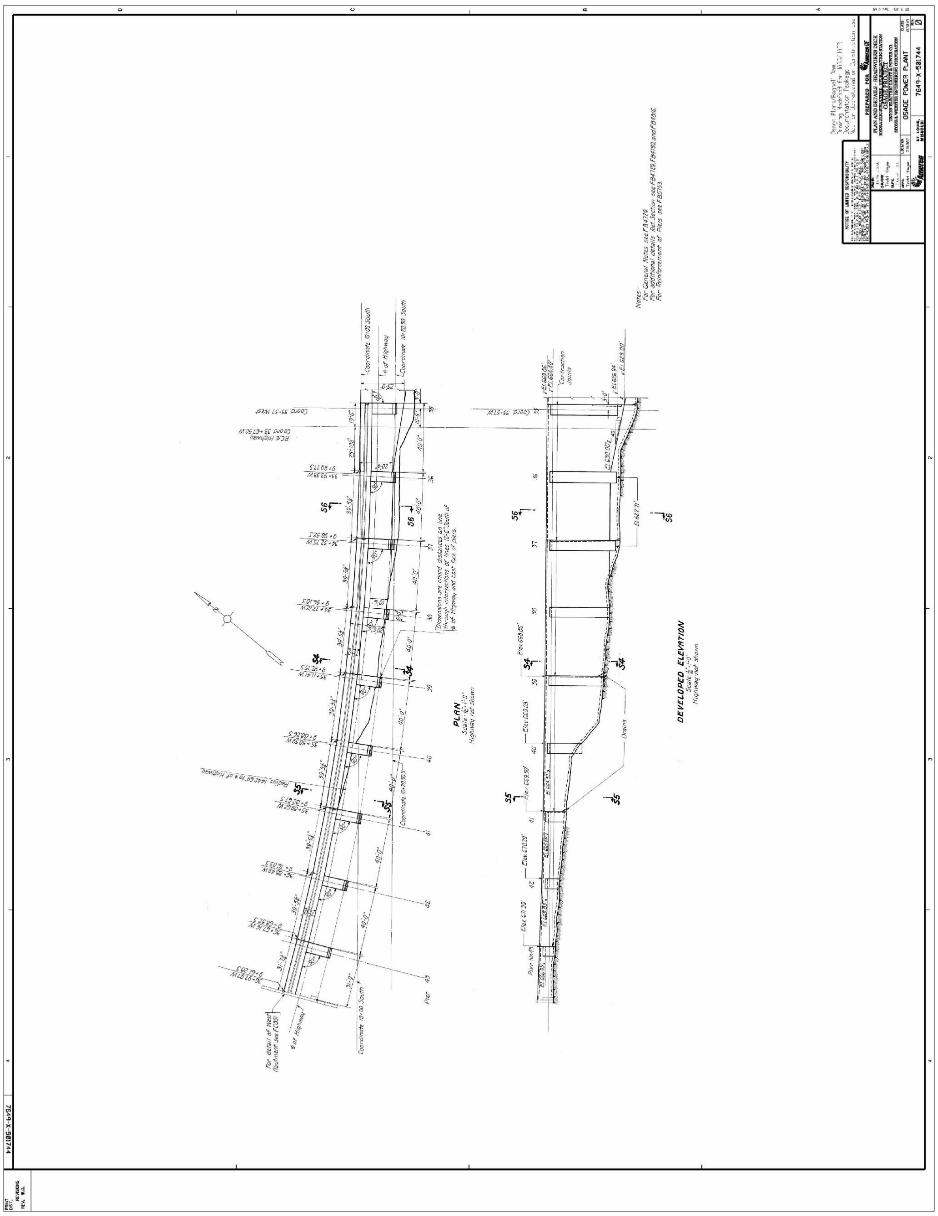
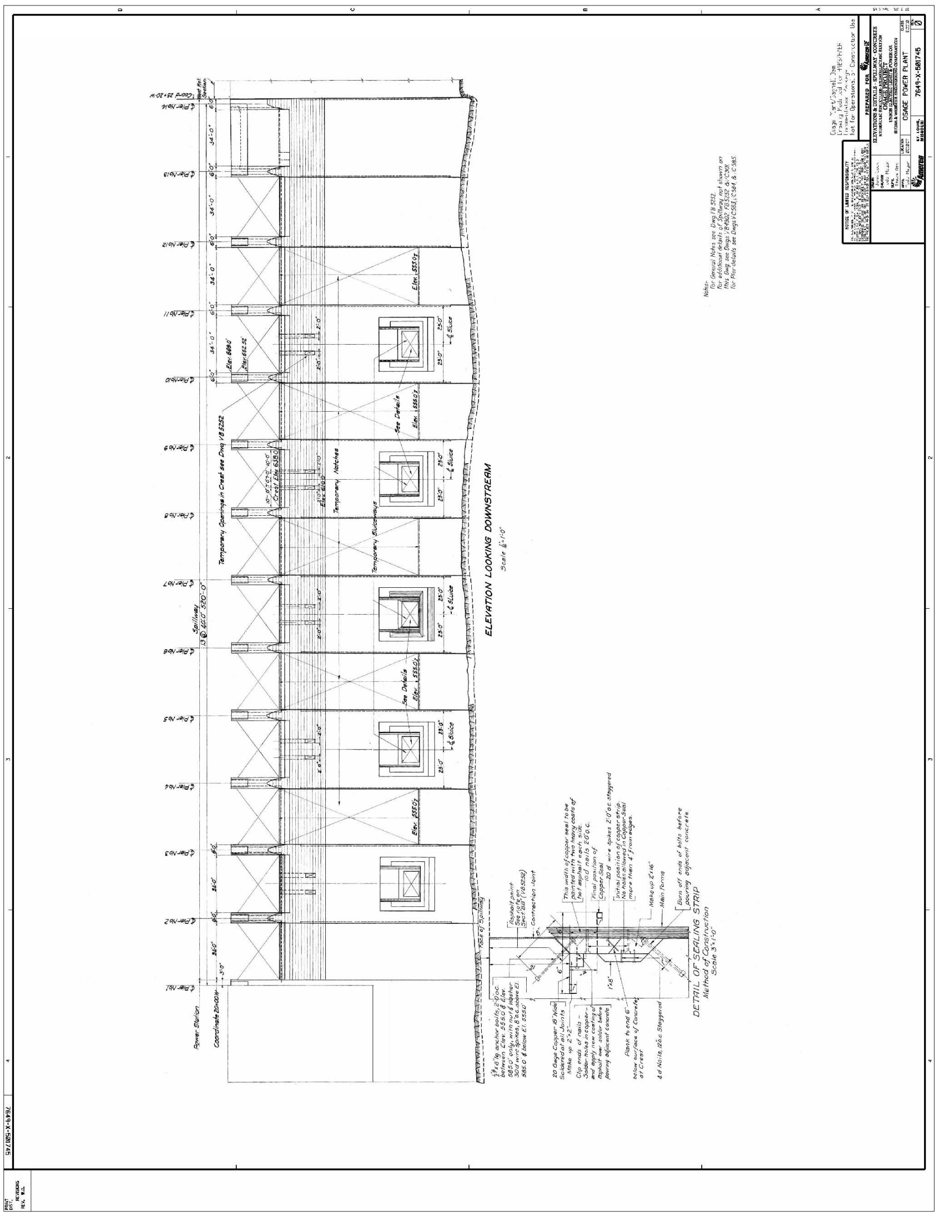
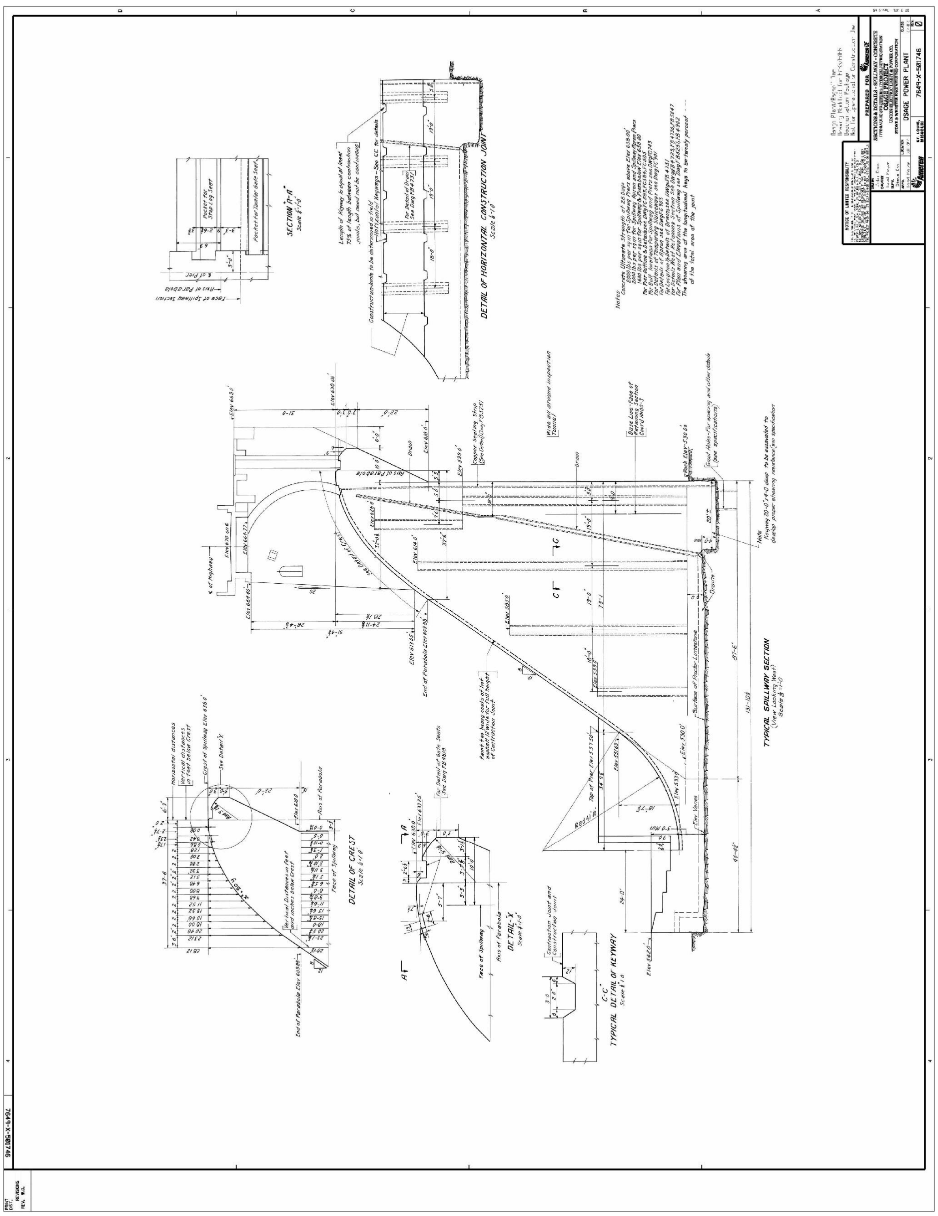
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plan and details, dated January 17, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic elevations and details, dated March 22, 1930
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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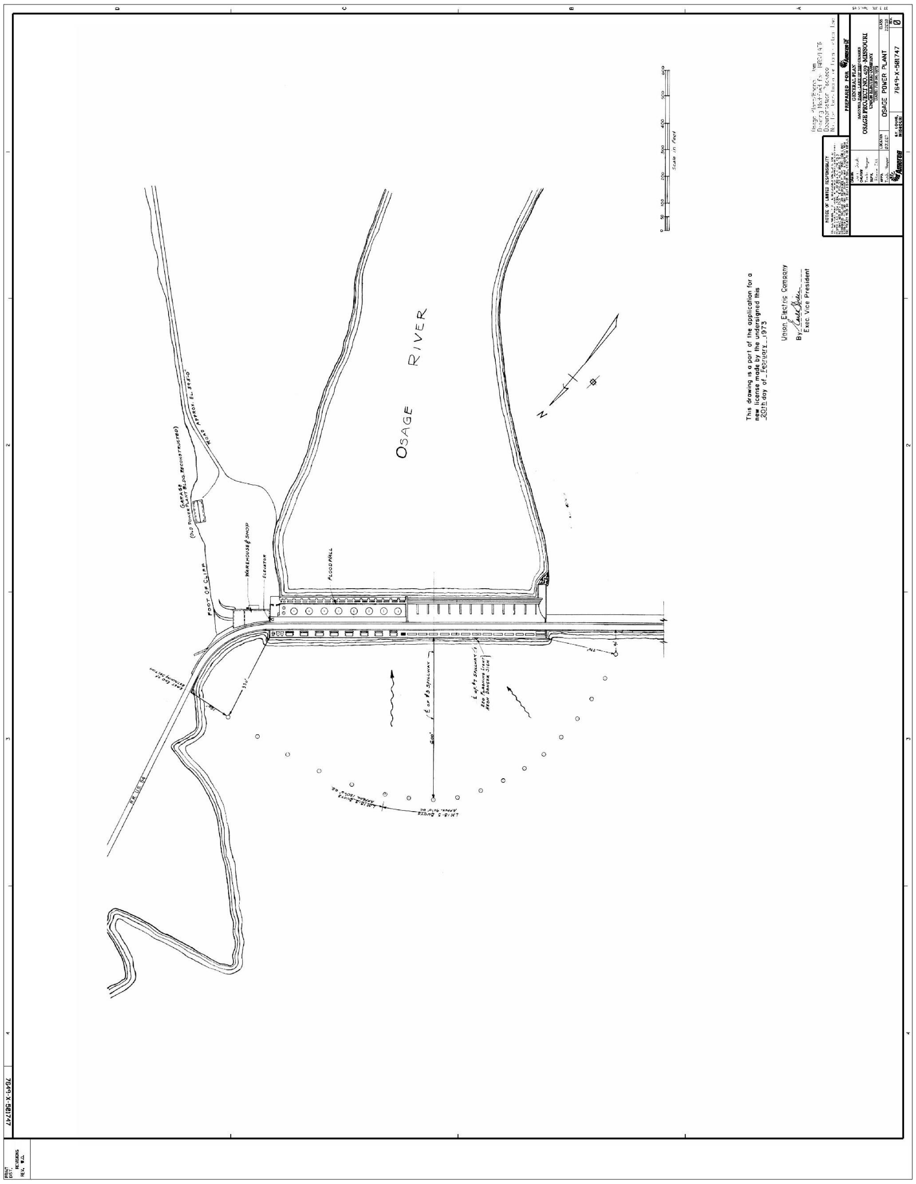
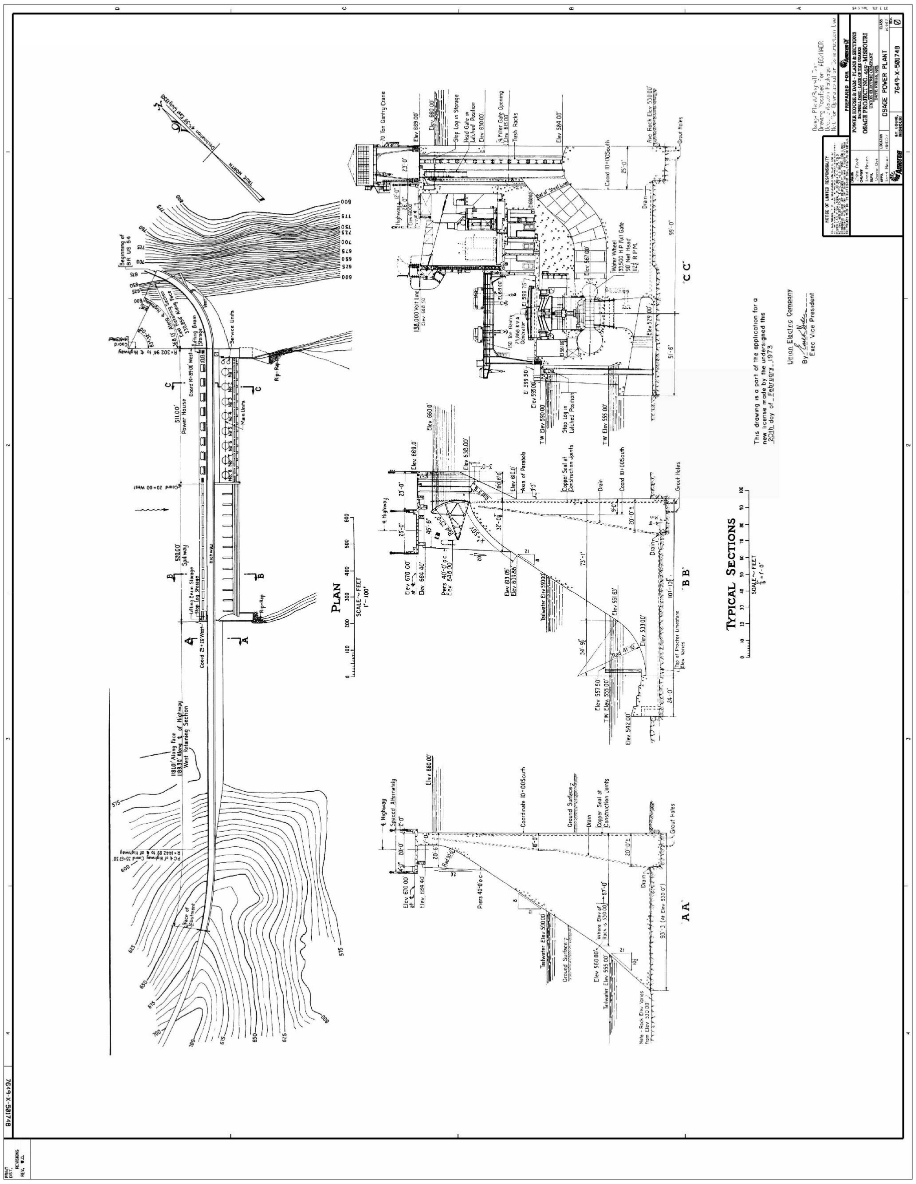
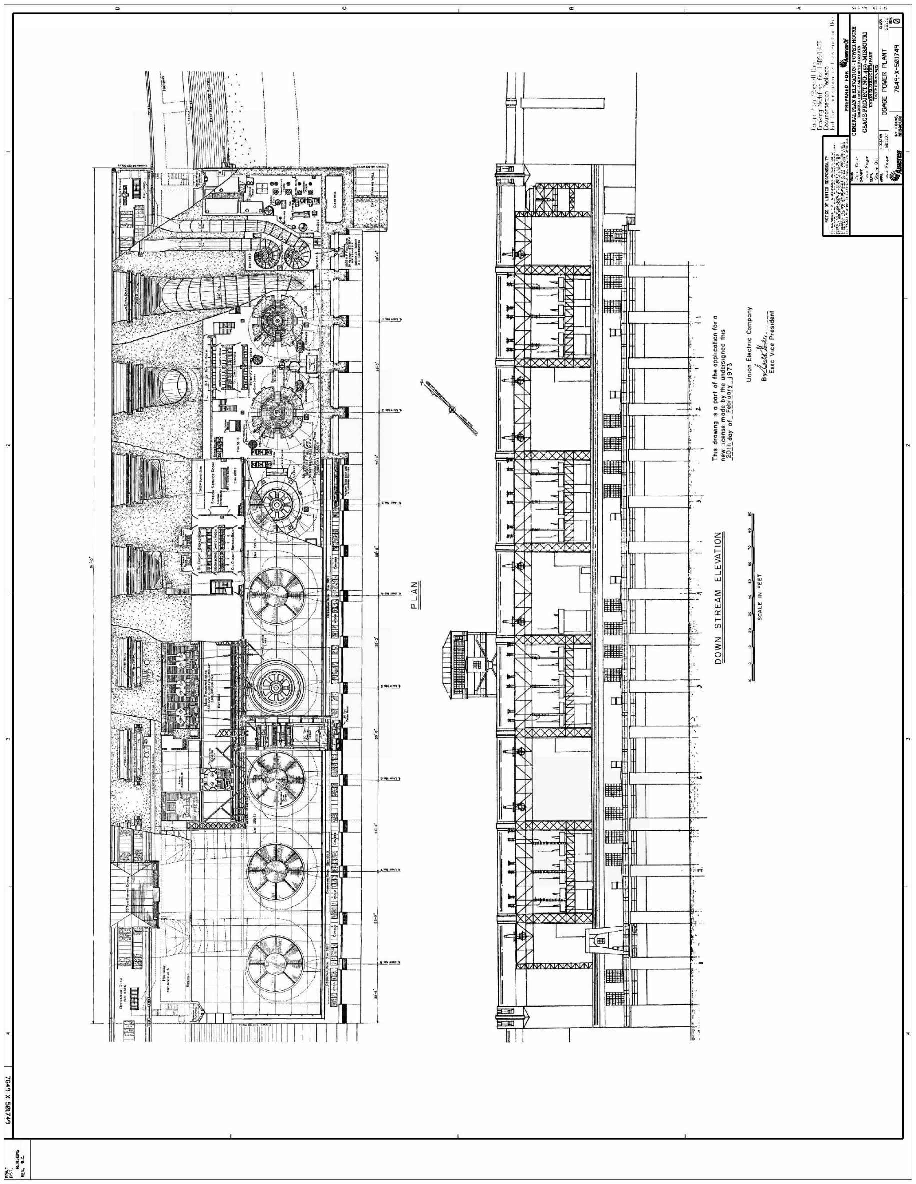
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



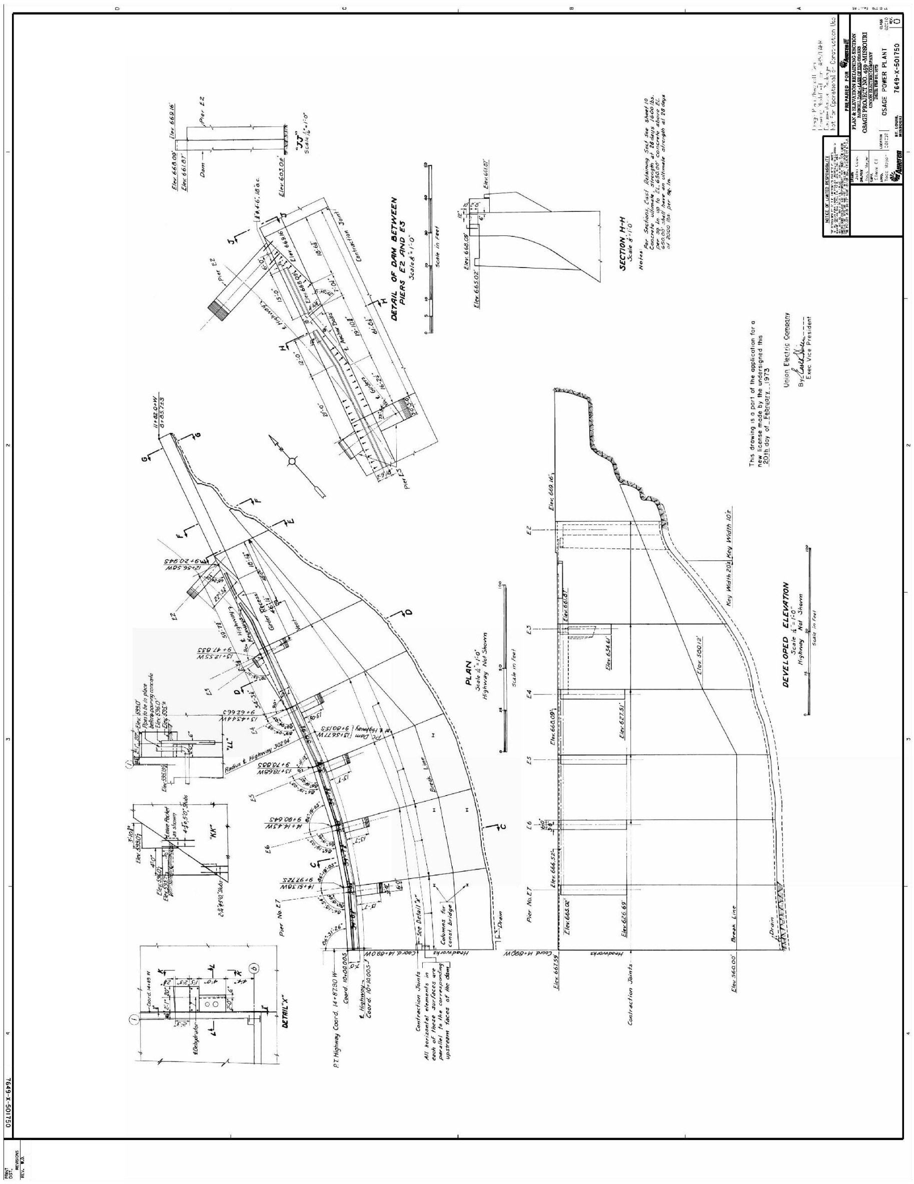
Reduced copy of historic plan, dated February 20, 1973
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans and sections, dated February 20, 1973
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plan and elevation, dated February 20, 1973
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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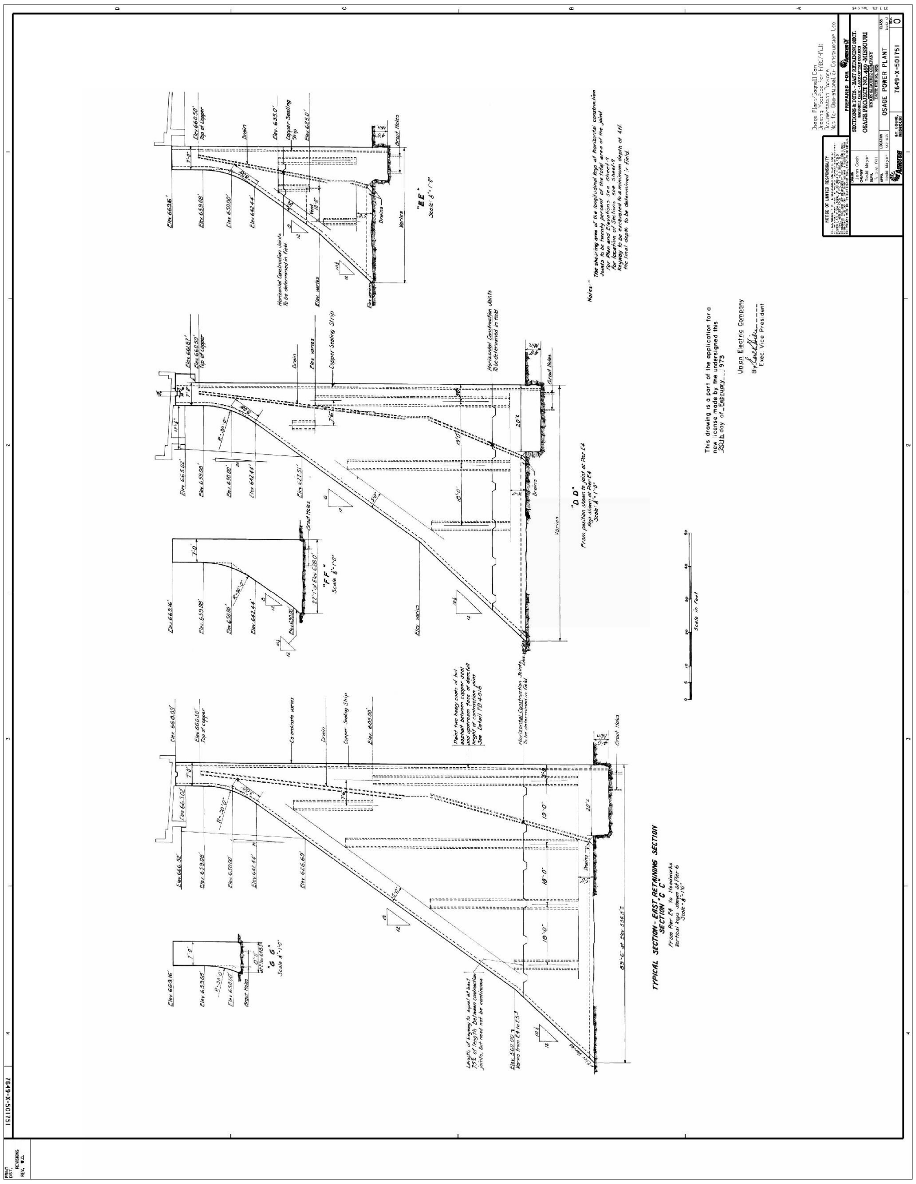
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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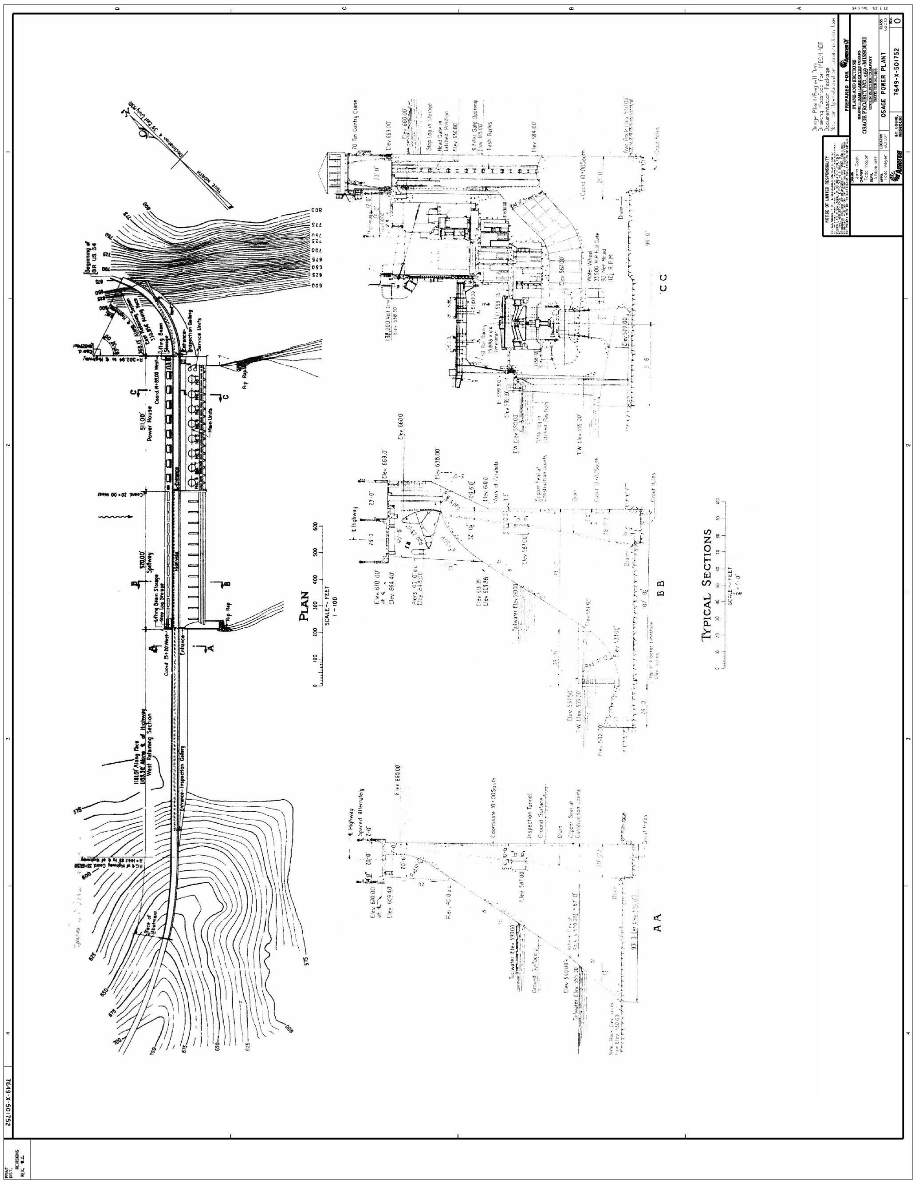
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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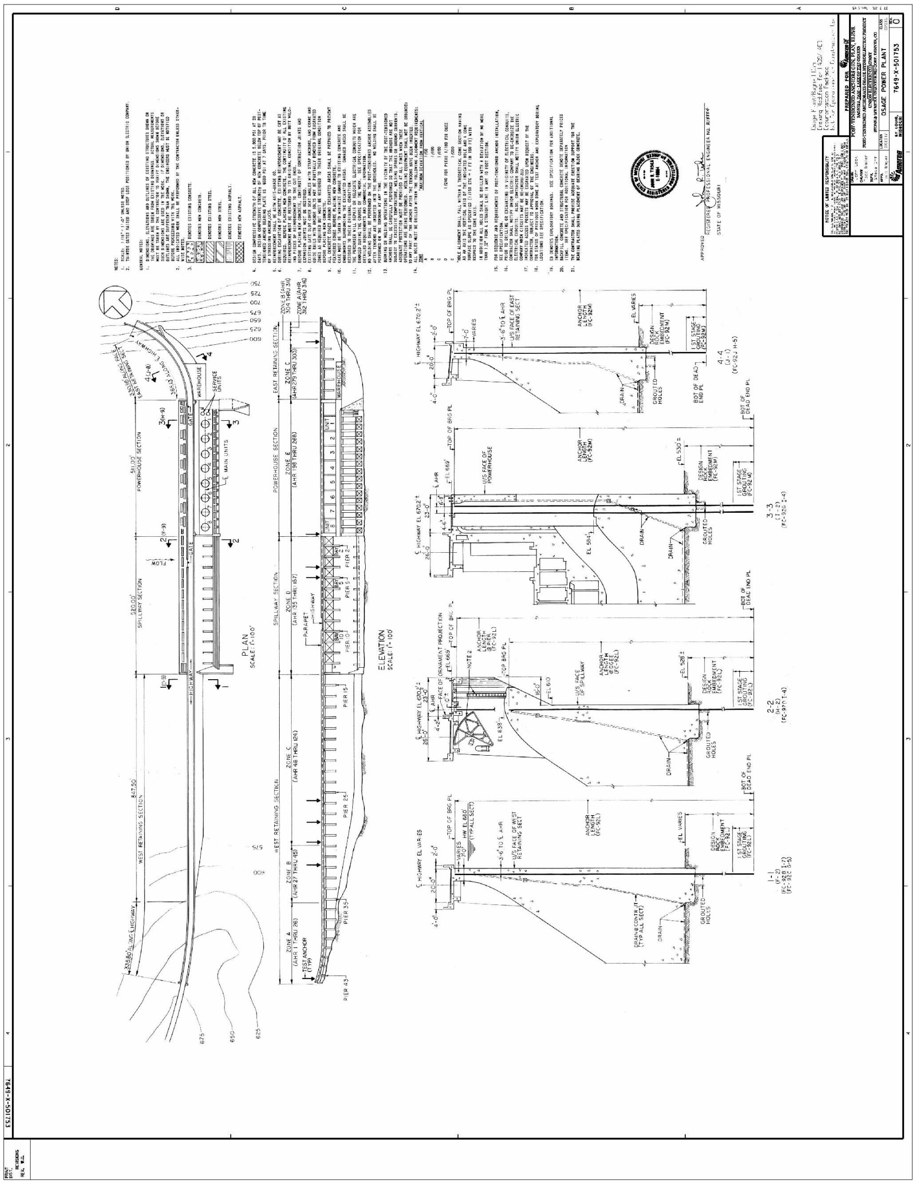
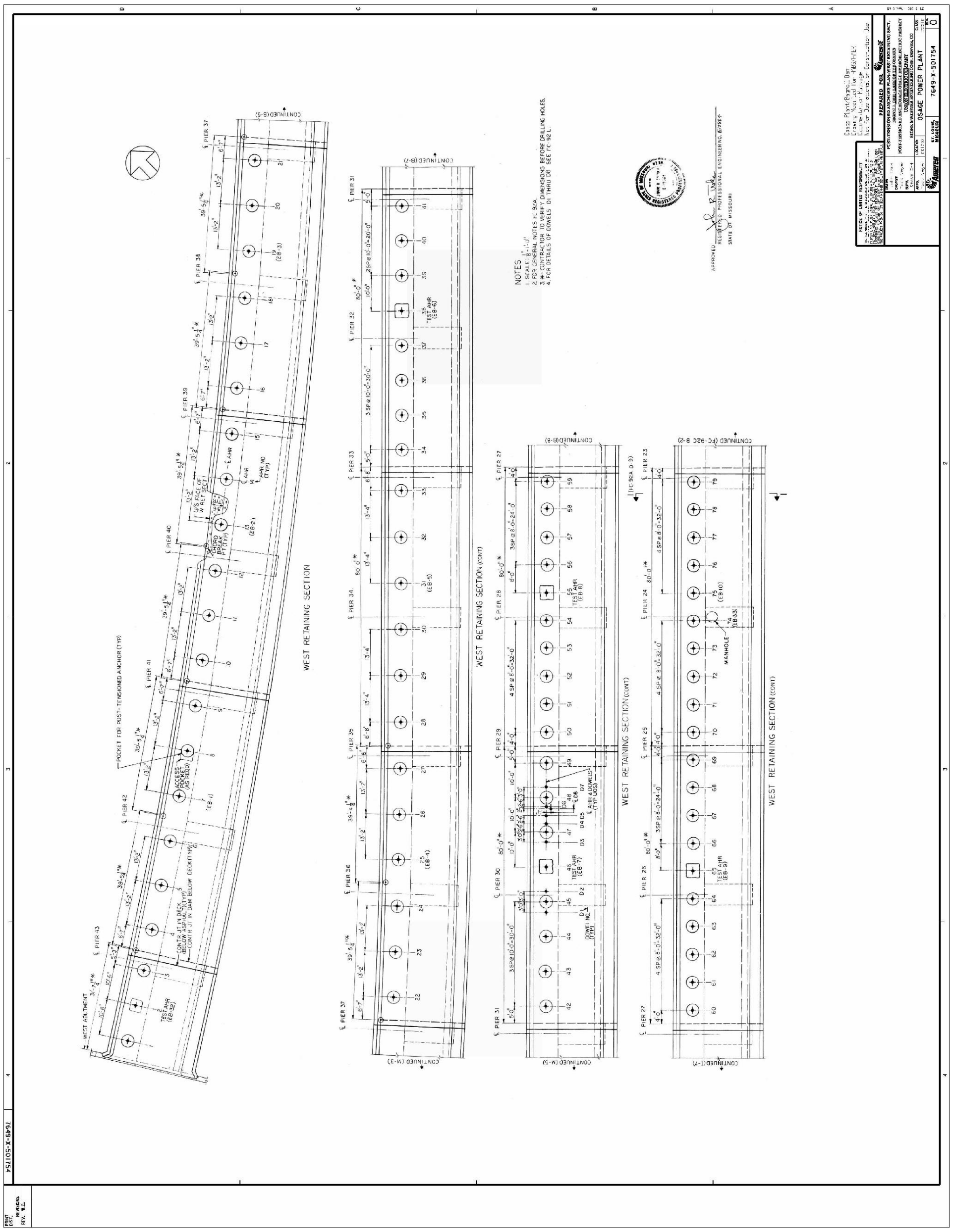
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans and elevations, dated March 17, 1982
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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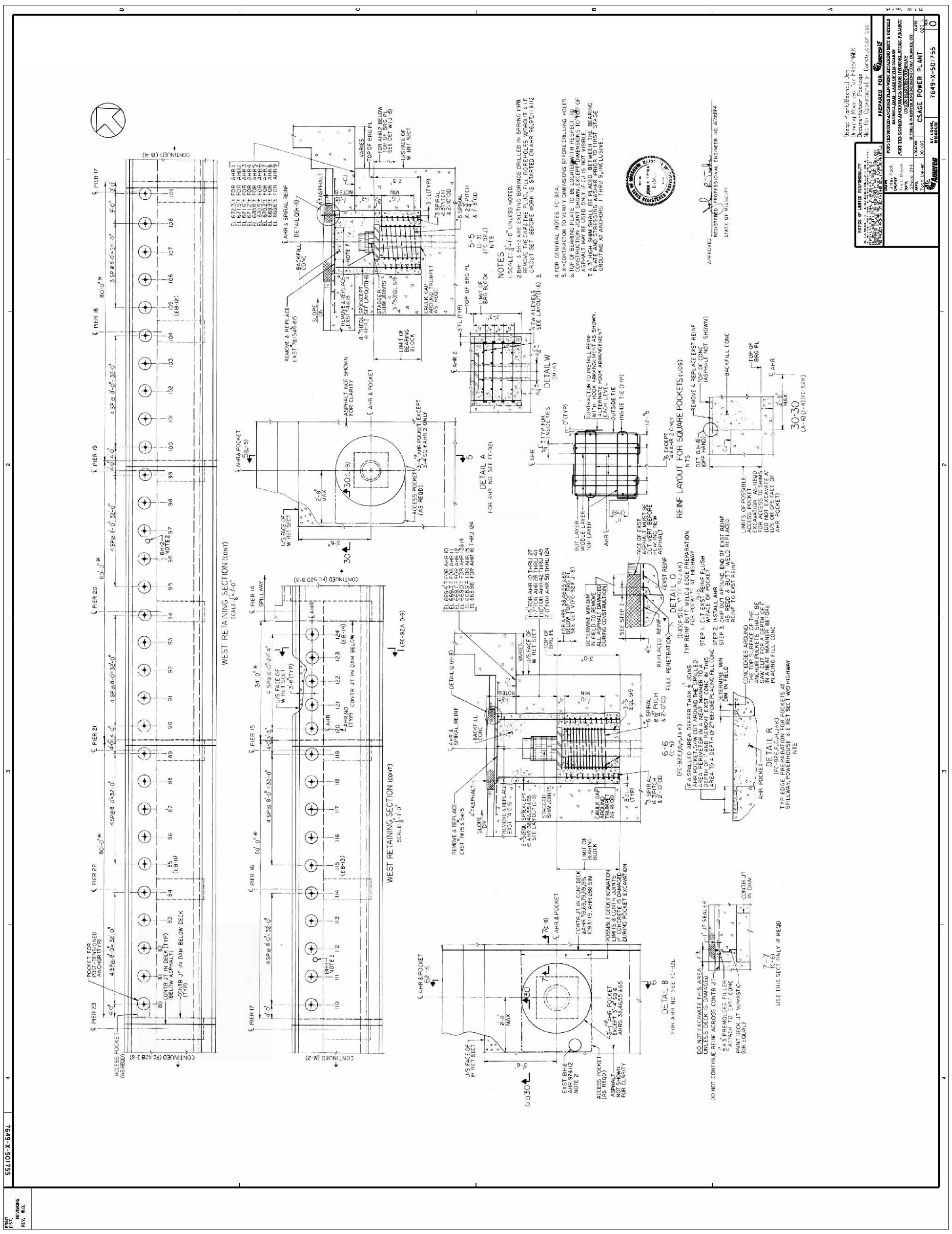
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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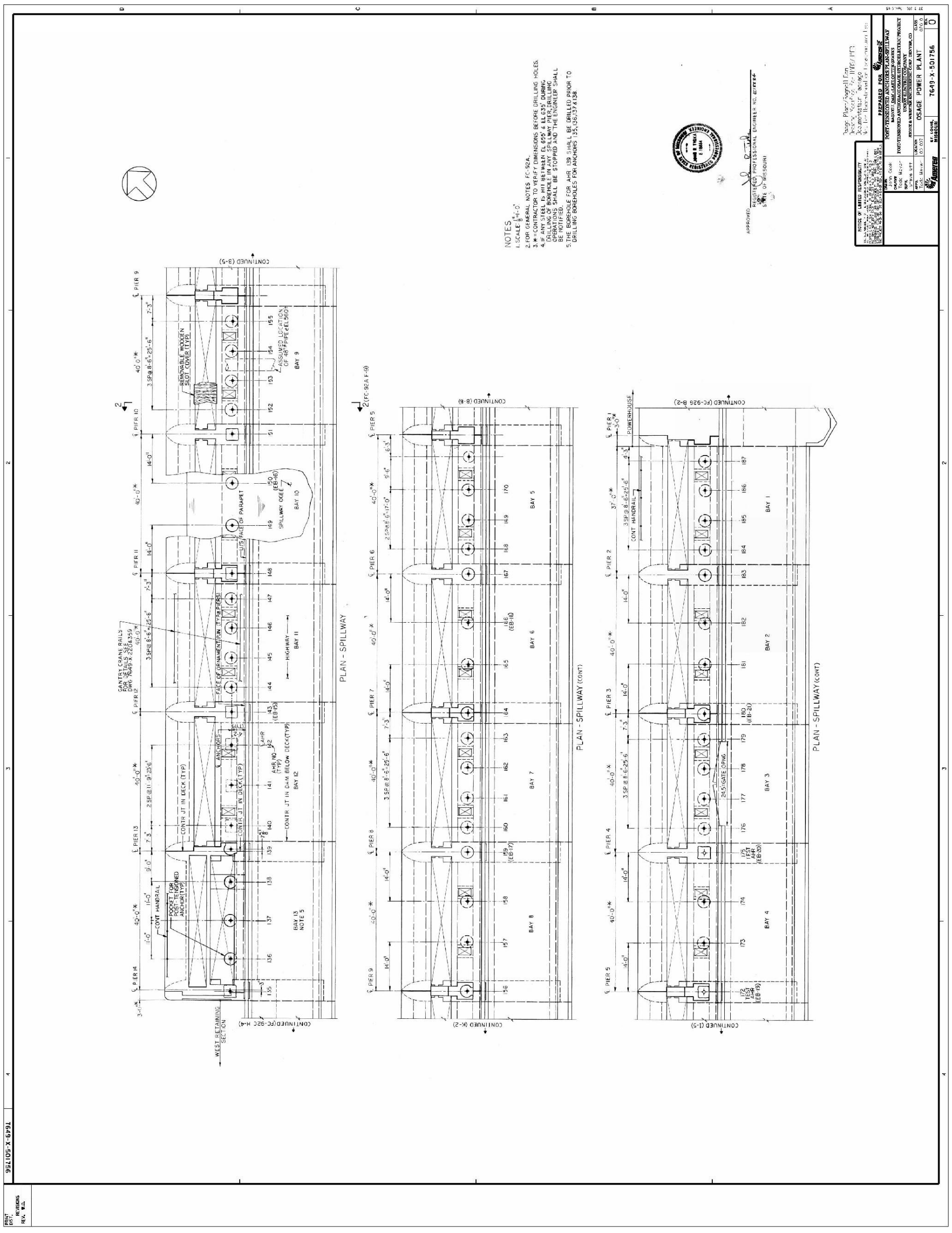
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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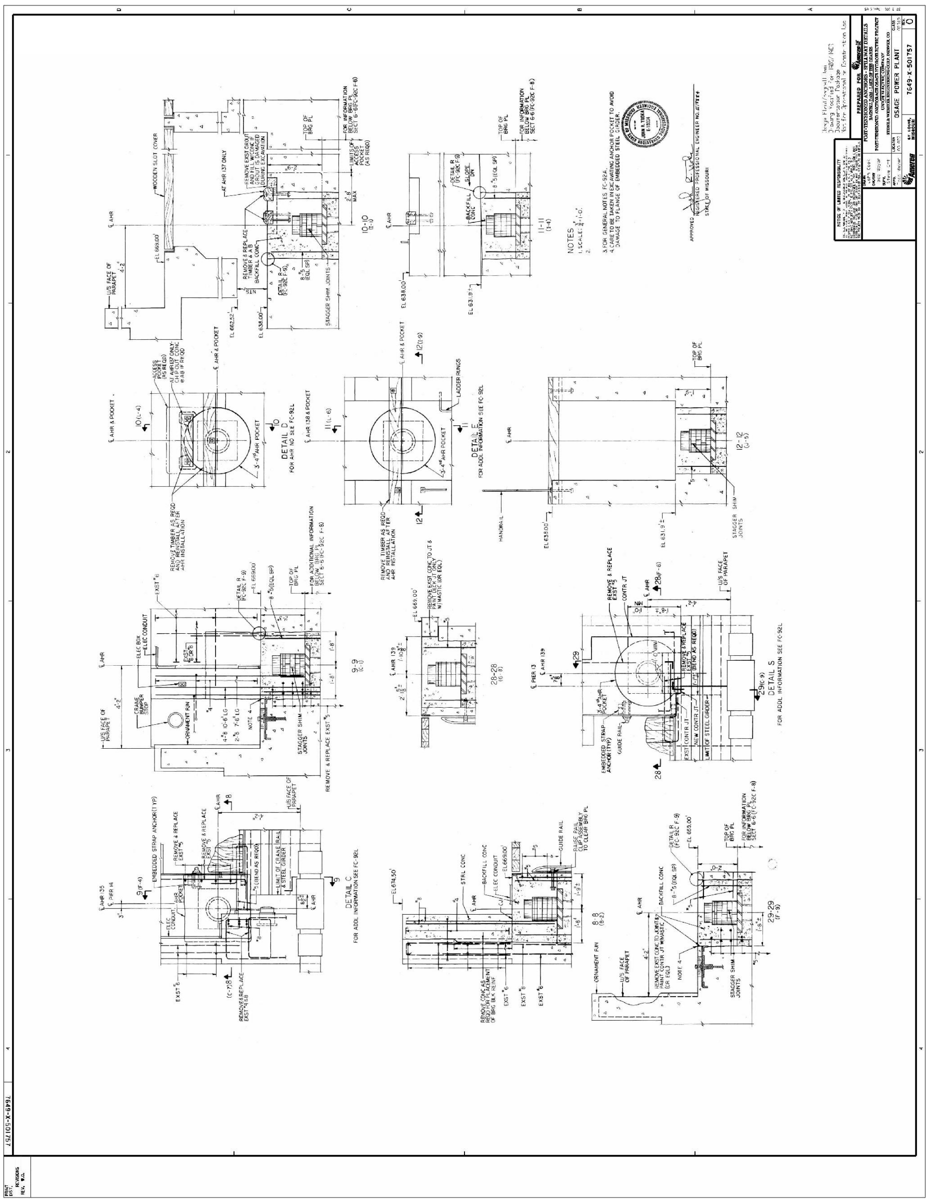
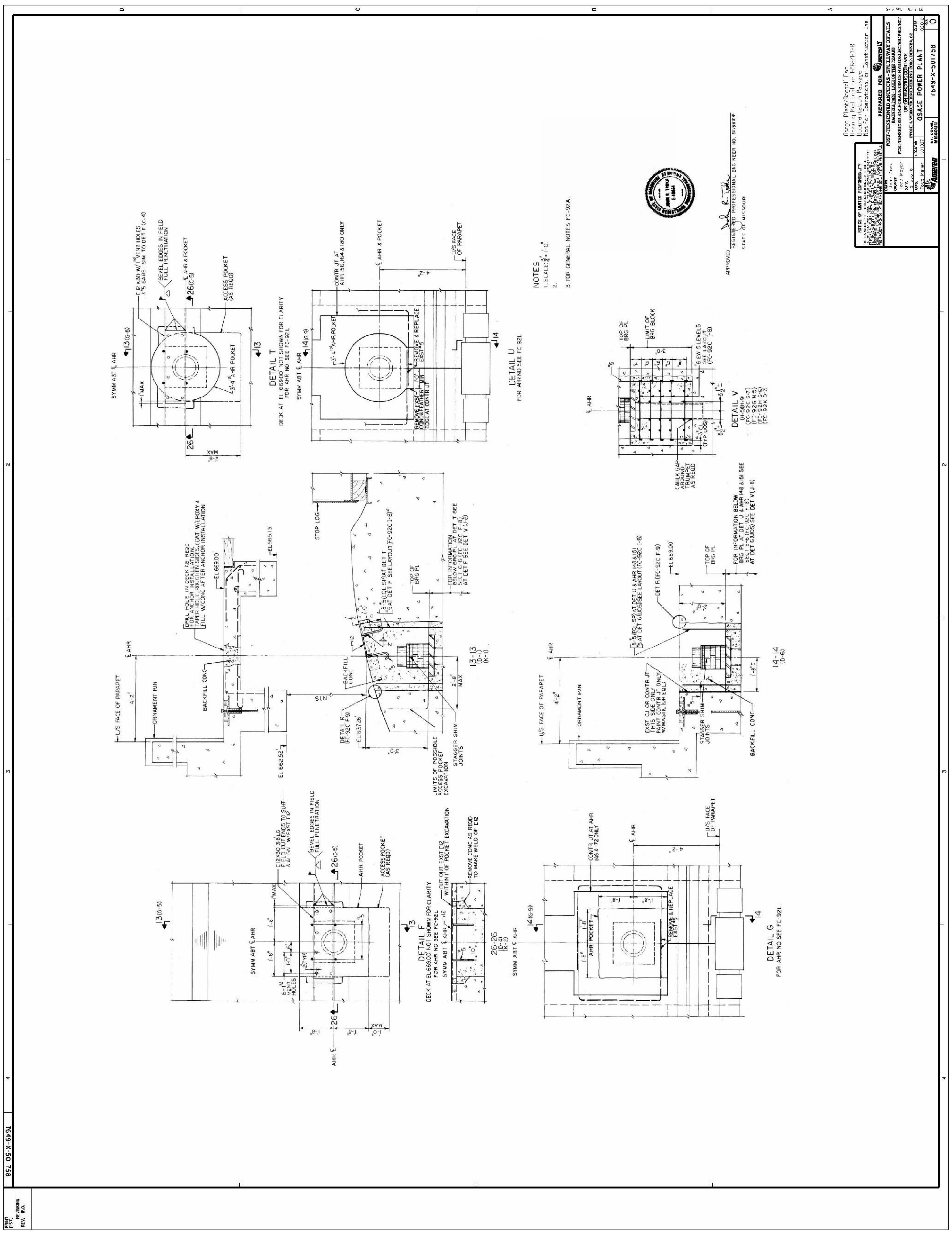
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic details, dated March 17, 1982
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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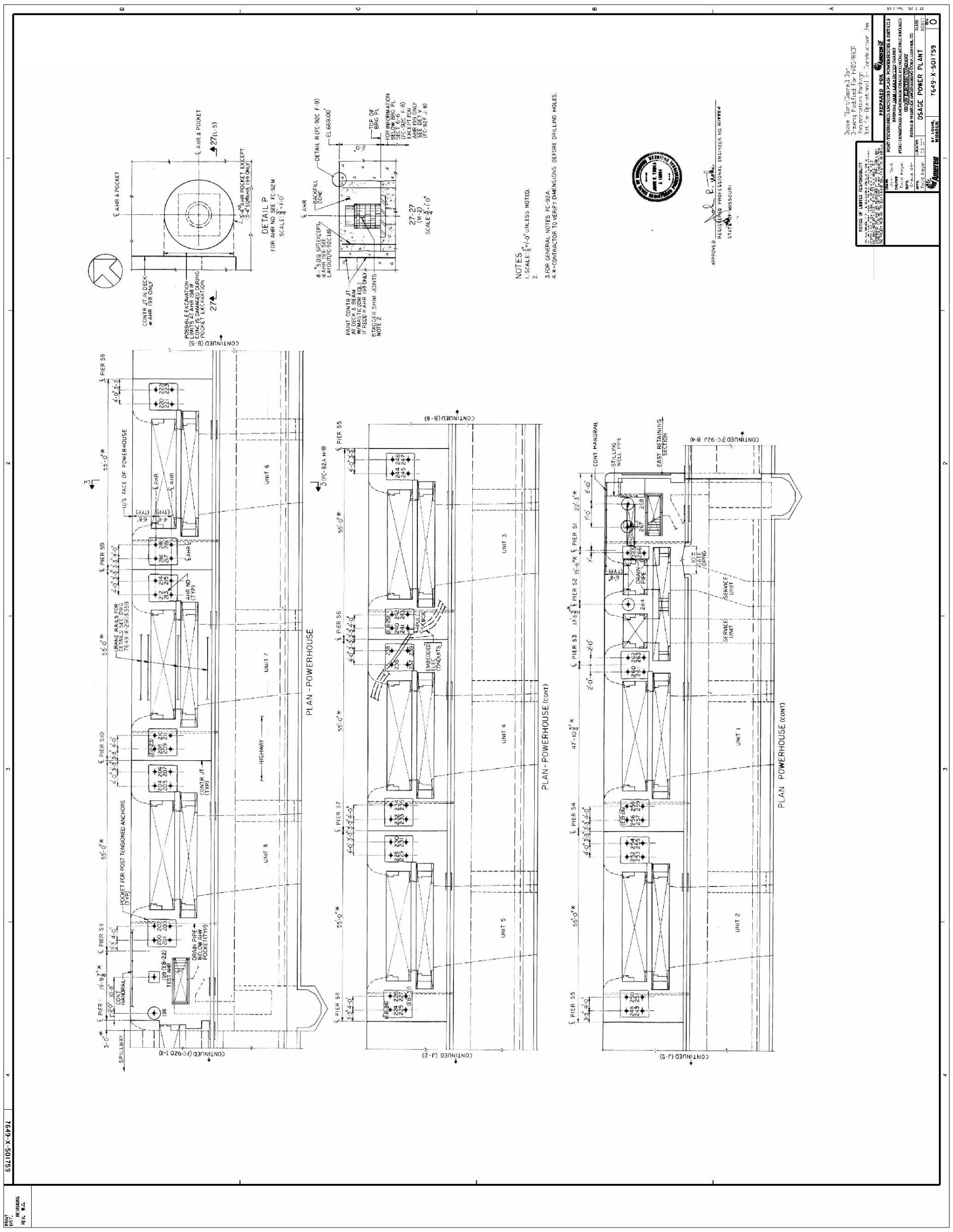
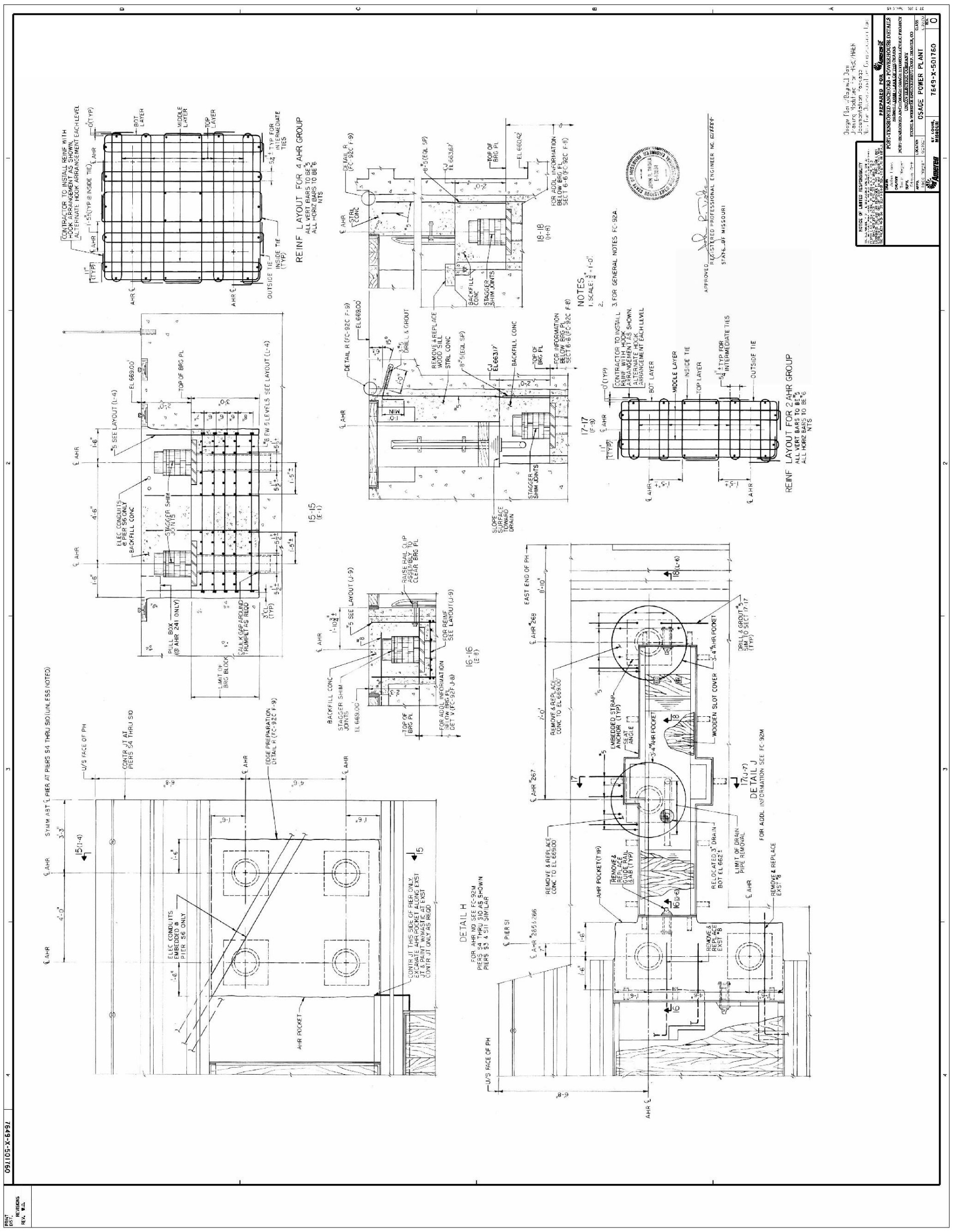
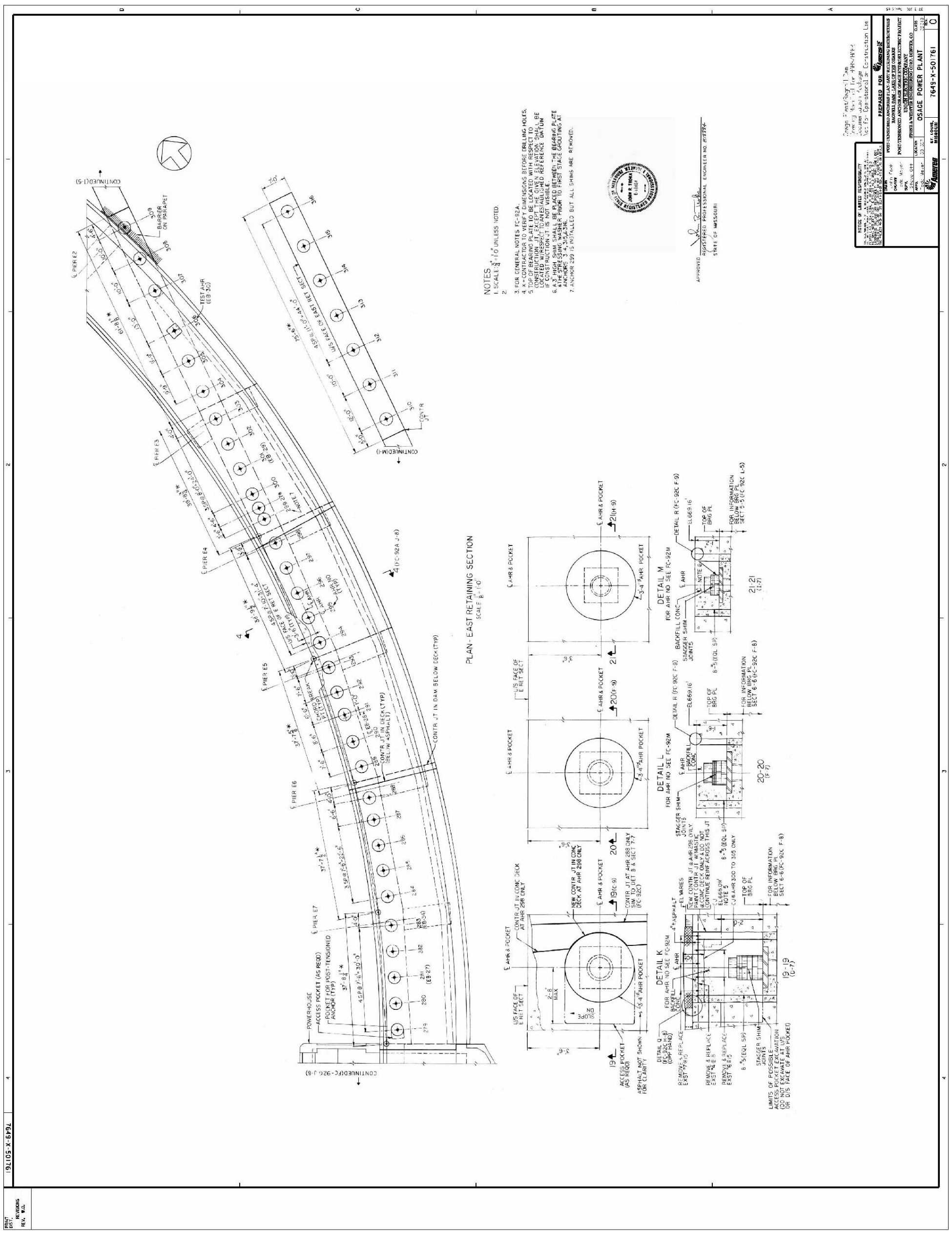
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



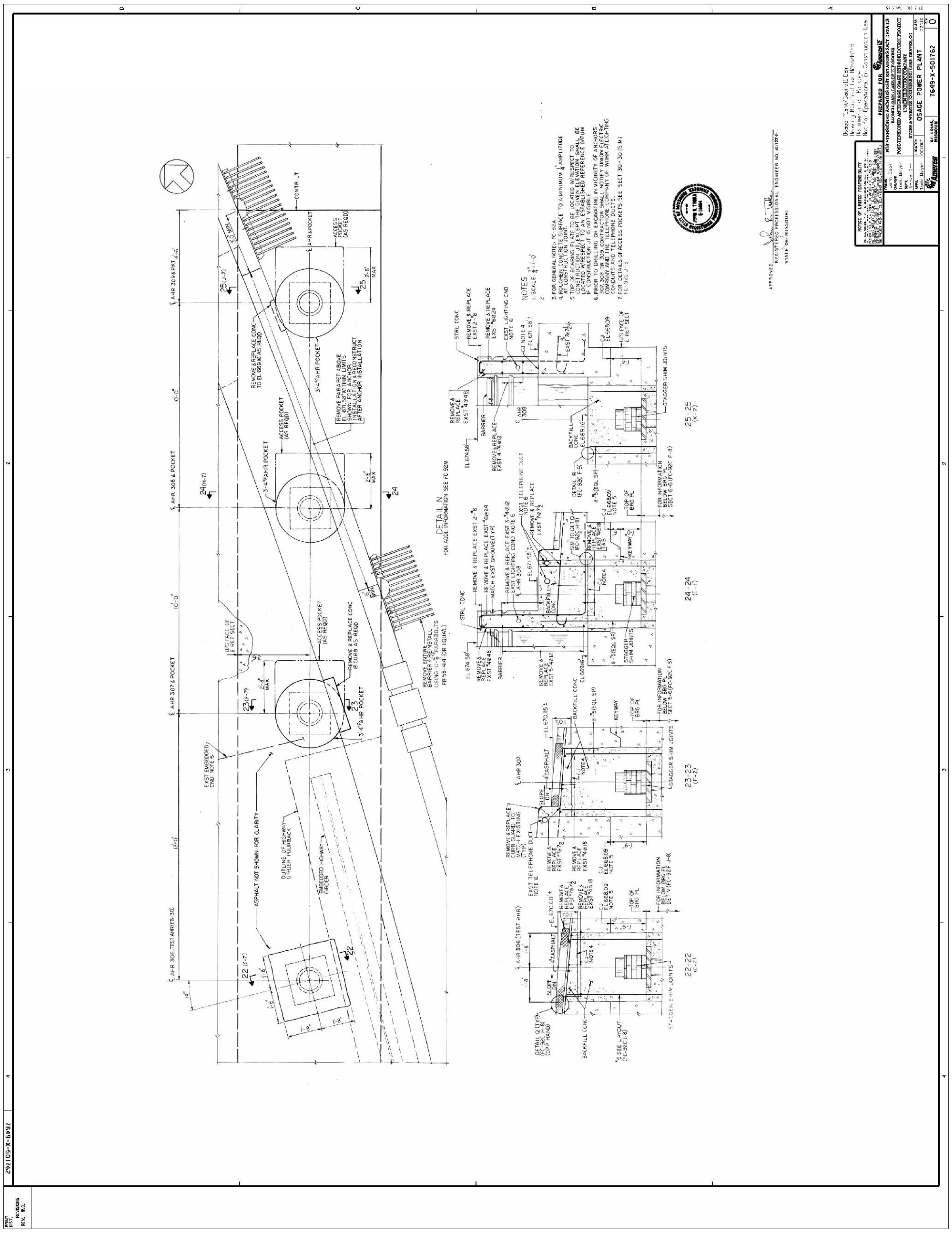
Reduced copy of historic plan, dated March 17, 1982
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic details, dated March 17, 1982
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plan, Section and Details, dated March 17, 1982
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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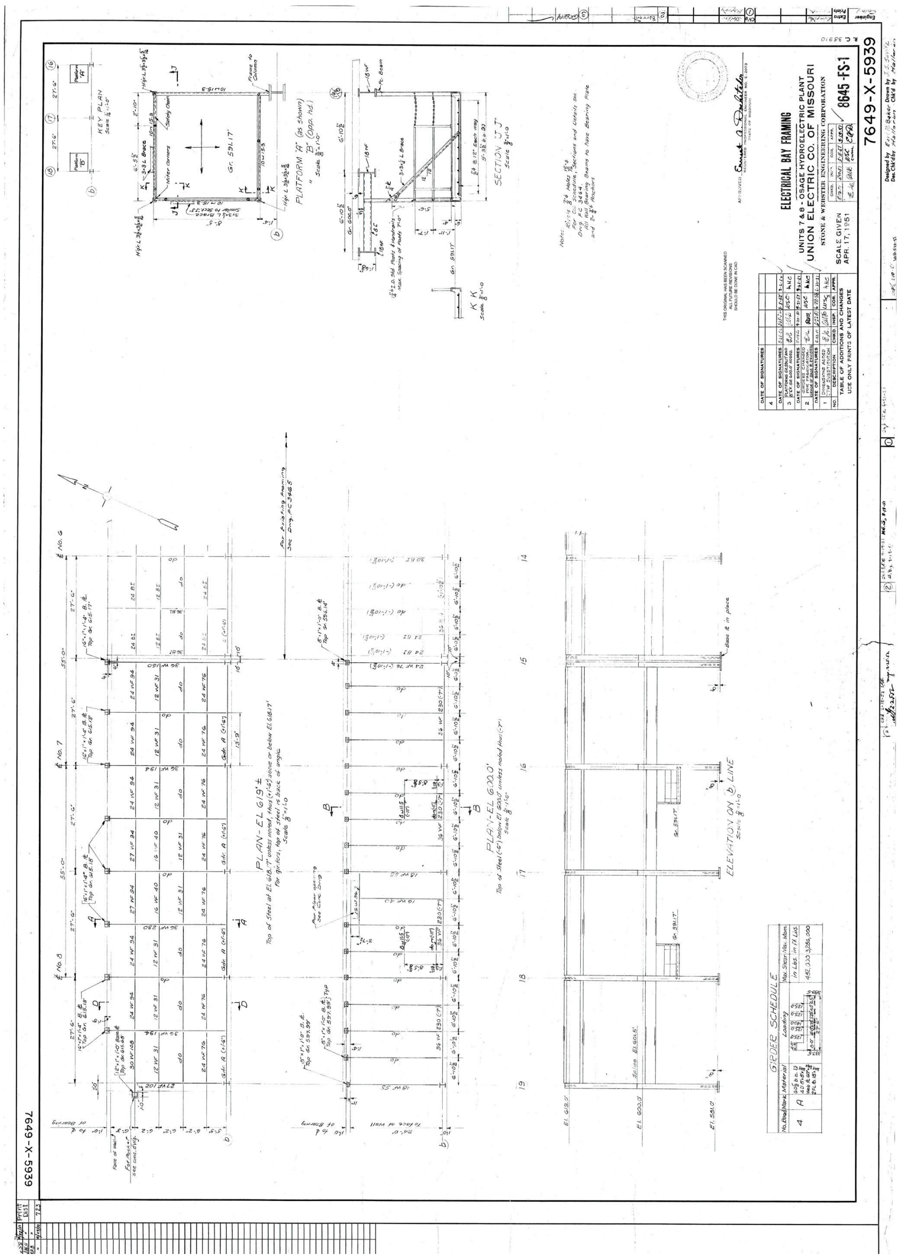
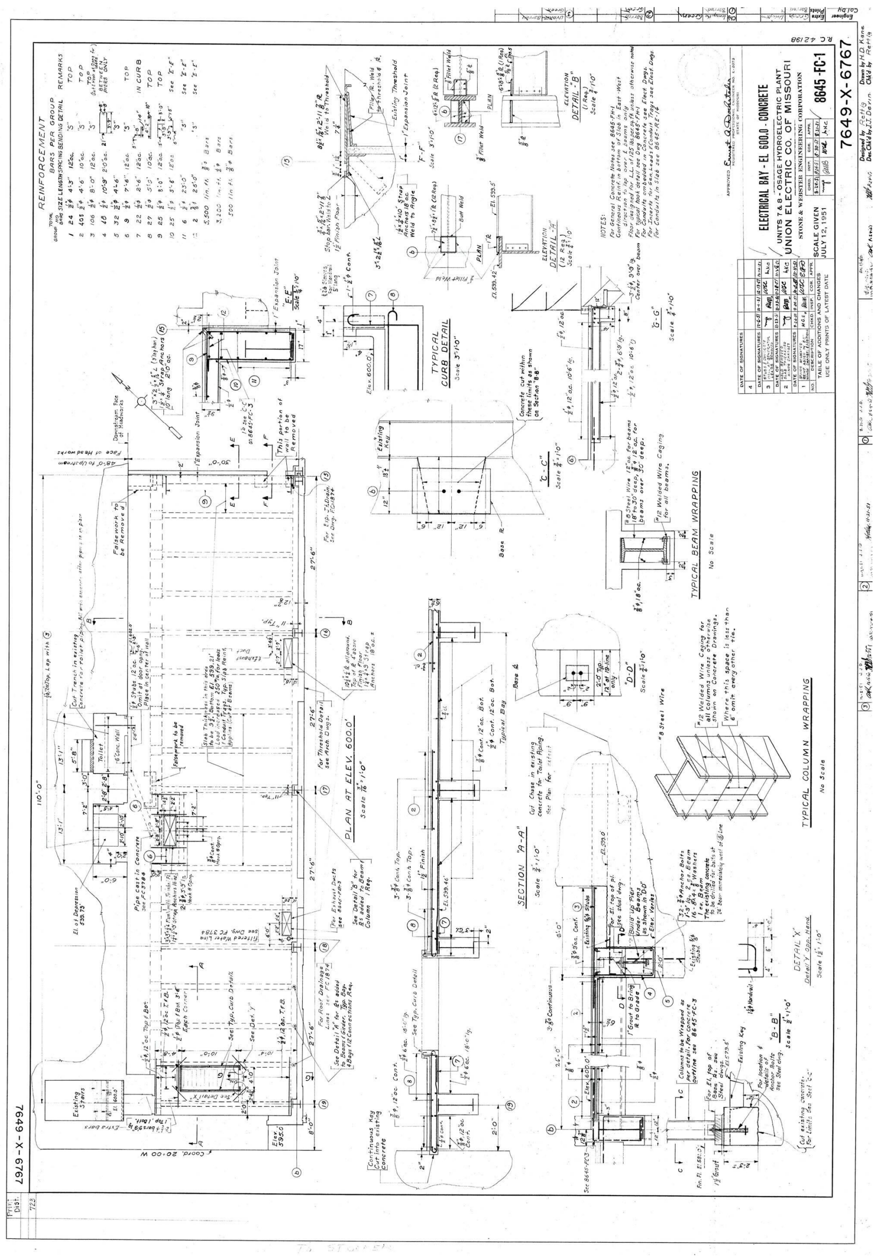
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans and elevations, dated February 25, 1952
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



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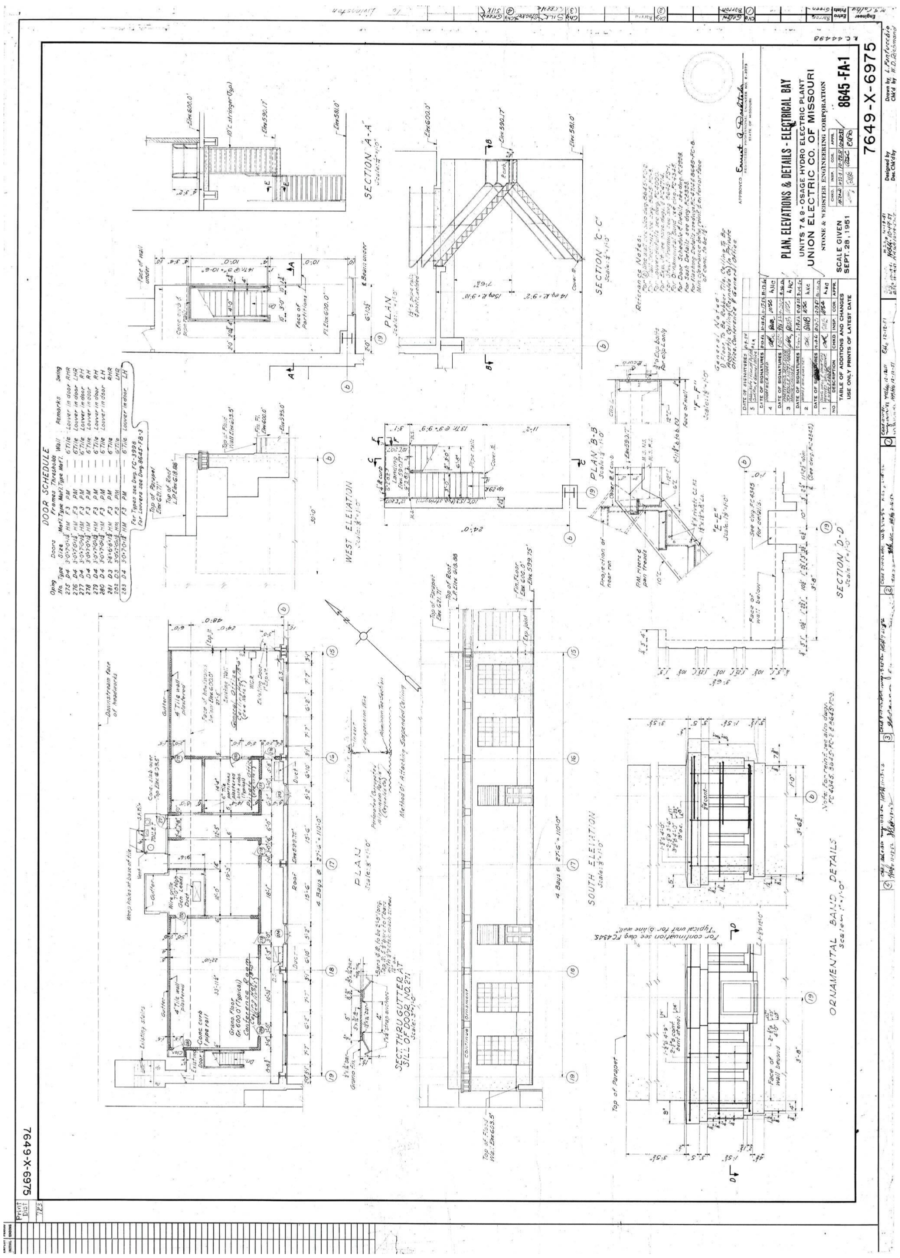
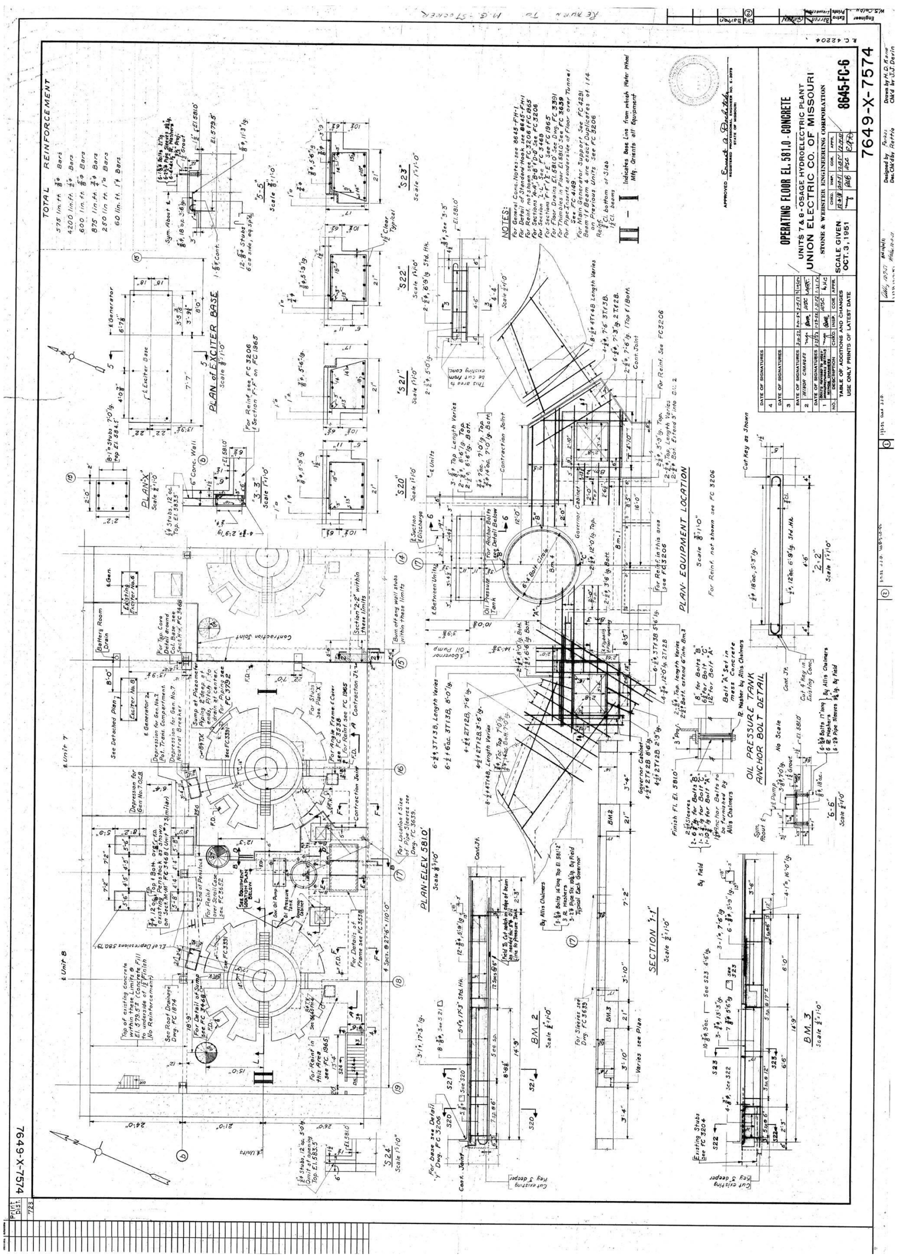
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans, elevations, and sections, dated November 13, 1952
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri



Reduced copy of historic plans and sections, dated March 10, 1952
Modified by AmerenUE for HAER documentation on January 6, 2010
Original on file at AmerenUE, St. Louis, Missouri


Union Electric Light & Power Co - Hydroelectric Station, Osage Development
Stone & Webster Engineering Corporation Builders
J.O. 5461 # 25 9-24-29 General view, looking upstream.
N.1181

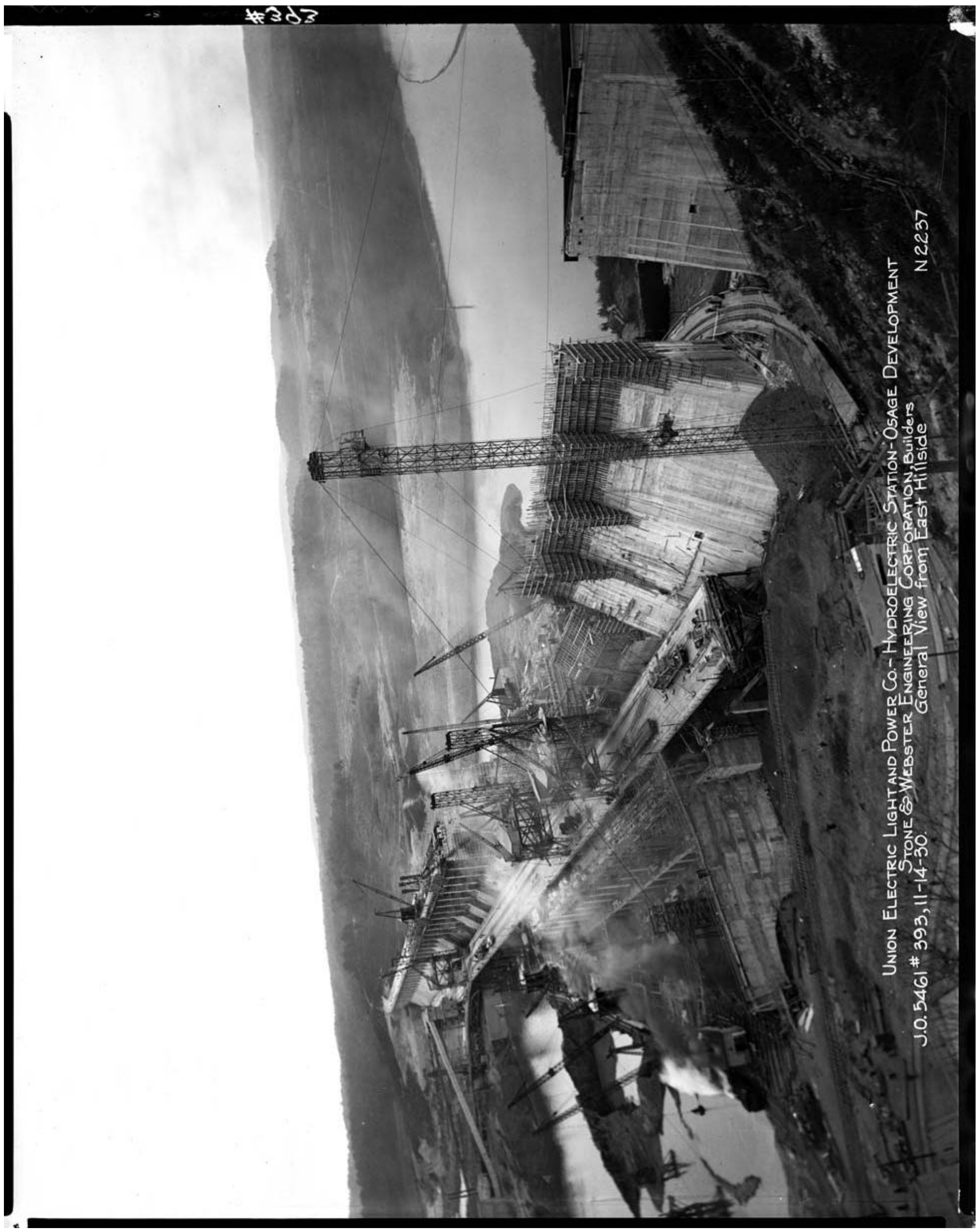

Union Electric Light & Power Co. Hydroelectric Station-Osage Development
Stone & Webster Engineering Corporation, Bldrs.
J.O. 5461 #64 11-27-29 View from Observation Platform,
looking West across Dam Site
N1459


Union Electric Light & Power Co. ~ Hydroelectric Station ~ Osage Development
Stone & Webster Engineering Corporation, Builders
J. O. 5461 #82 12-31-29 Looking West across Dam Site from Observation Platform. N1642


UNION ELECTRIC LIGHT & POWER CO. - HYDROELECTRIC STATION - OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, Builders
General View from East Hillside
J.O. 5461 * 194 5-29-30
N 2058

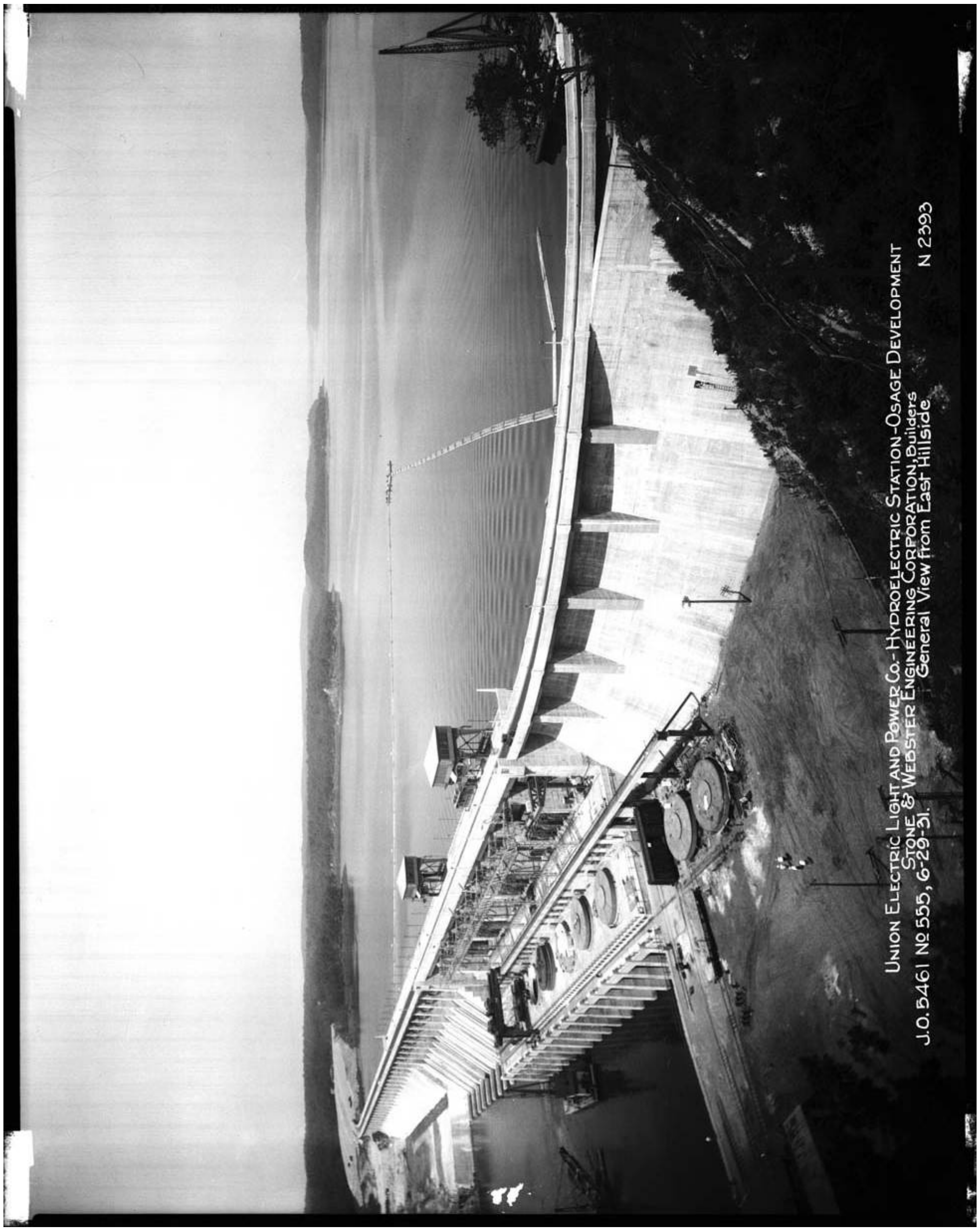

Union Electric Light & Power Co. - Hydroelectric Station Osage Development
Stone & Webster Engineering Corporation, Builders
General View from East Hillside
J.O. 5461 #247 7-31-30
N 2109

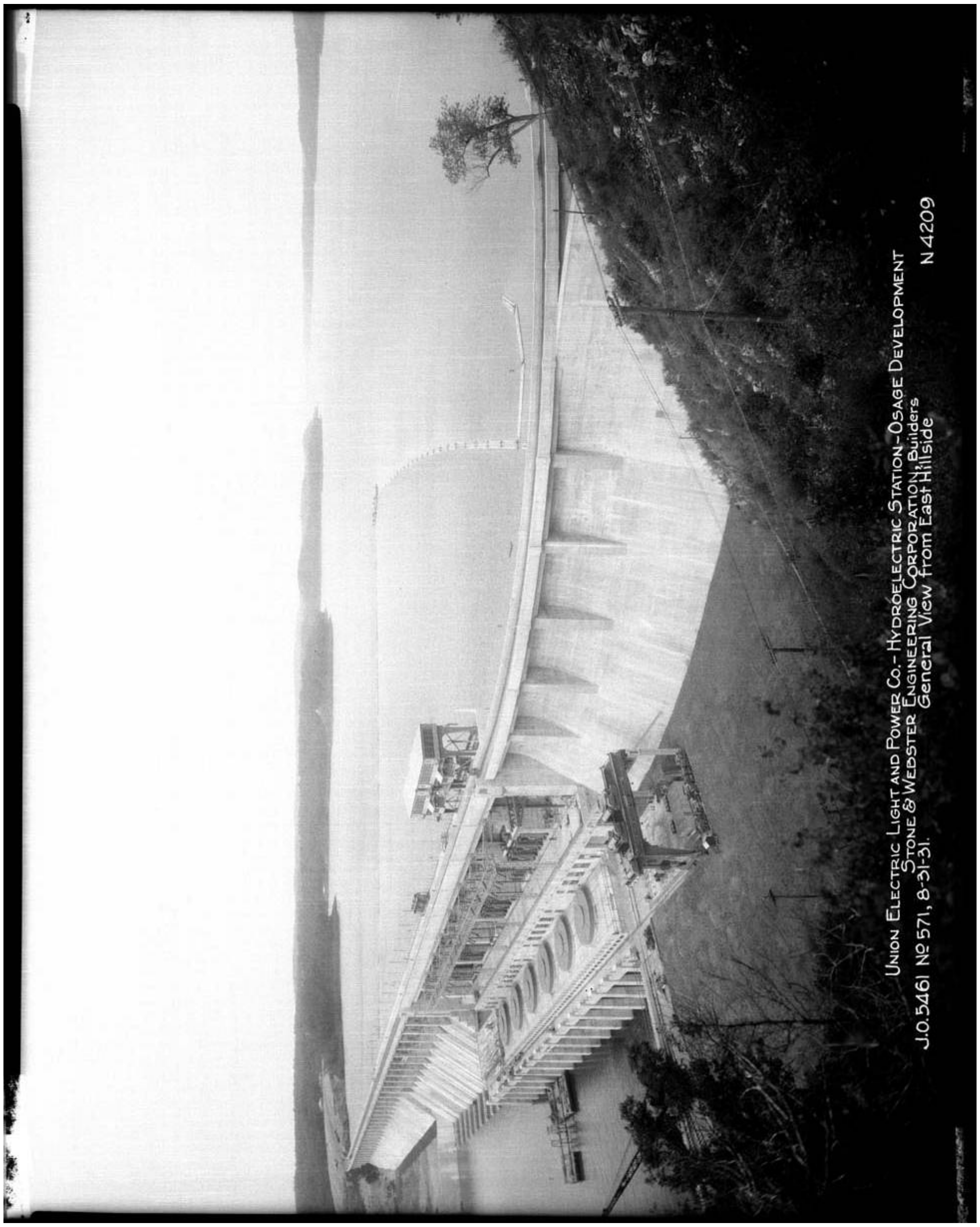

Union Electric Light & Power Co. Hydroelectric Station, Osage Development
Stone & Webster Engineering Corporation, Builders
J.O. 5461 # 328, 9-23-30 General View from East Hillside
N 2176


#393
UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, Builders
General View from East Hillside
J.O. 5461 # 393, 11-14-30.
N 2237

BAGNELL DAM AND OSAGE POWER PLANT
HAER No. MO-117
(page 94)

BAGNELL DAM AND OSAGE POWER PLANT
HAER No. MO-117
(page 95)

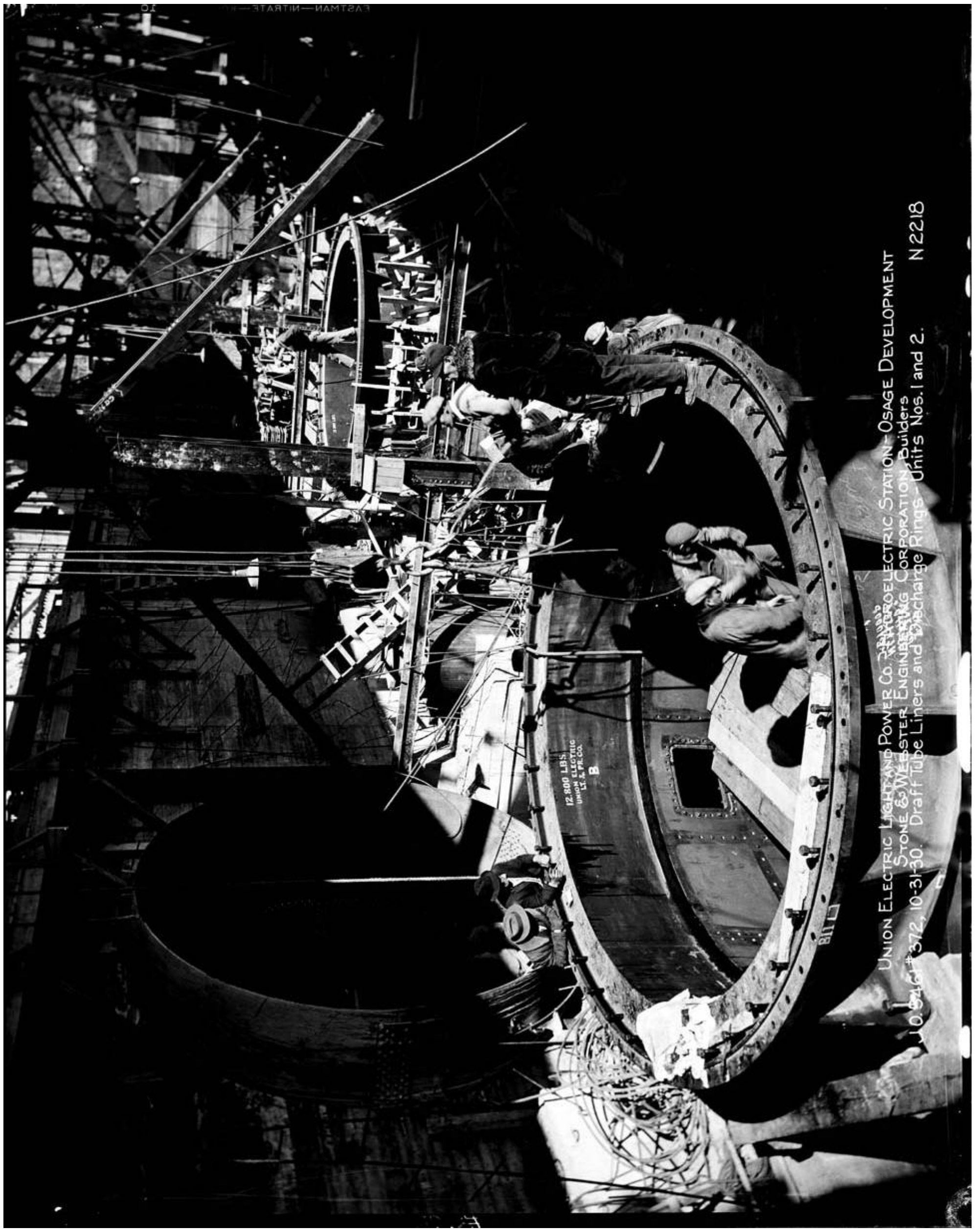

Union Electric Light and Power Co.- Hydroelectric Station-Osage Development
Stone & Webster Engineering Corporation, Builders
General View from East Hillside
J.O. 5461 No 555, 6-29-31.
N 2393

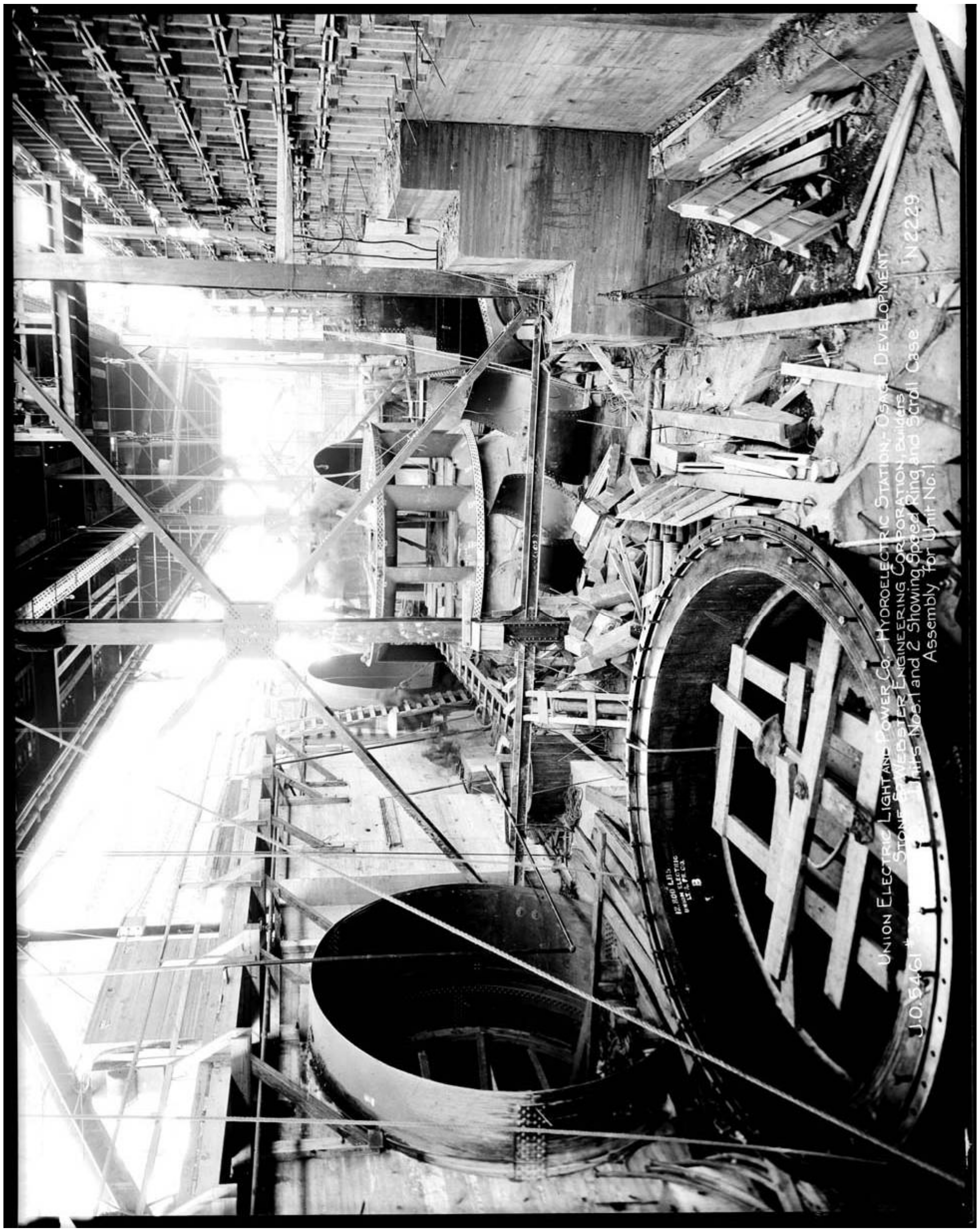

Union Electric Light and Power Co. - Hydroelectric Station - Osage Development
Stone & Webster Engineering Corporation, Builders
J.O.5461 No 571, 8-31-31. General View From East Hillside
N 4209


Union Electric Light and Power Co. - Hydroelectric Station - Osage Development
Stone & Webster Engineering Corporation, Builders
J.O. 5461 No 501, 10-15-31. Dam and Powerhouse from East Hillside
N 4229

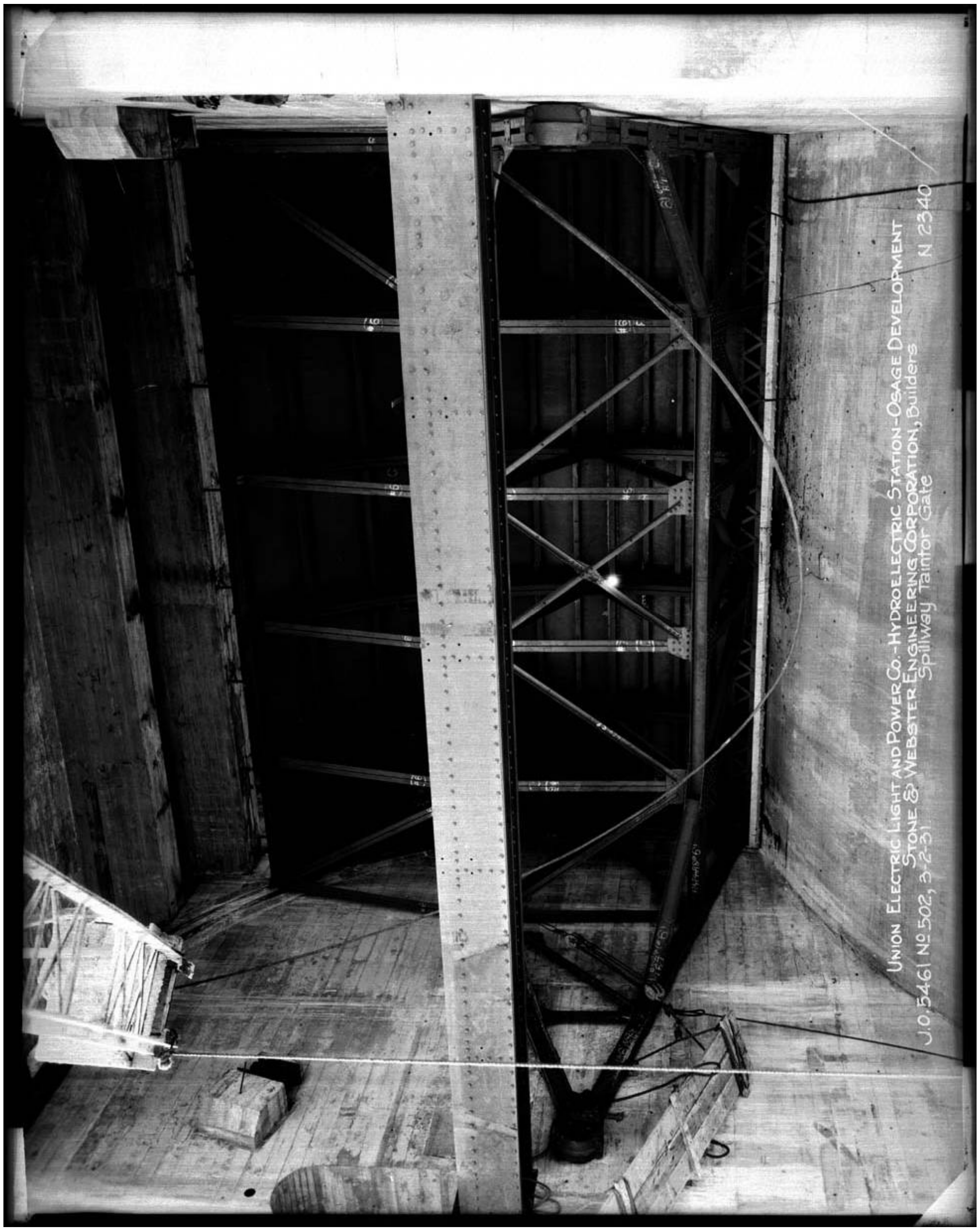

UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, builders
J.O. 5461 No 534, 5-27-31. Downstream Elevation of Dam and Power Station
N 2372

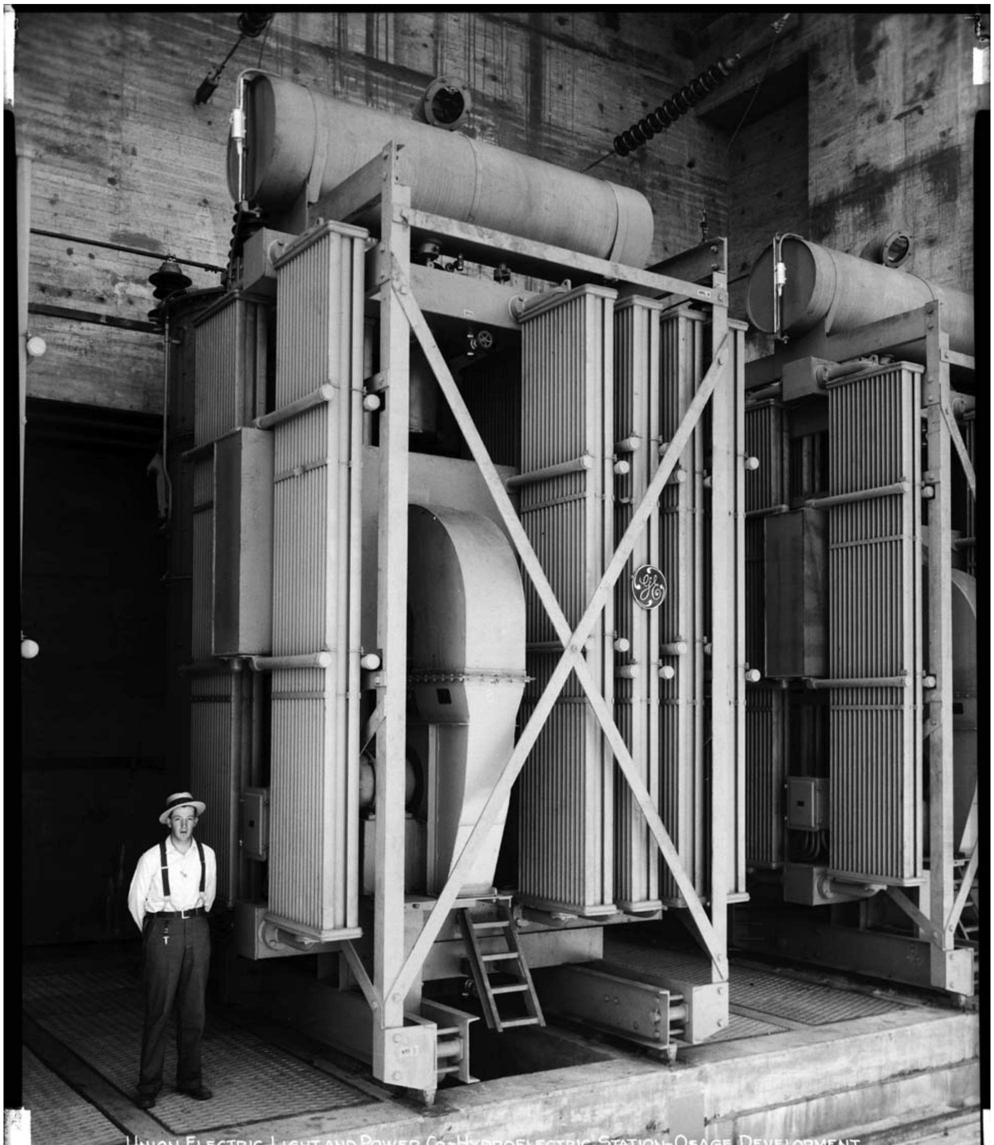

UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, BUILDERS
J.O. 5461 No 568, 7-27-31 View of Dam and Power Station from Osage-Page Tower No. 1 N 4206


Union Electric Light and Power Co. Hydroelectric Station - Osage Development
Stone & Webster Engineering Corporation, Builders
10-31-30. Draft Tube Liners and Discharge Rings - Units Nos. 1 and 2.
N 2218
12,800 LBS.
UNION ELECTRIC LT. & PR. CO.
B


Union Electric Light and Power Co. - Hydroelectric Station - Osage Development
Stone & Webster Engineering Corporation, Builders
Units Nos. 1 and 2 Showing Speed Ring and Scroll Case
Assembly for Unit No. 1.
J.O. 5461
N 2229

BAGNELL DAM AND OSAGE POWER PLANT
HAER No. MO-117
(page 103)


UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, Builders
Spillway Taintor Gate
J.O.5461 No 502, 3-2-31
N 2340


UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, Builders
J.O. 5461 No 537, 5-28-31.
Main Power Transformer
N 2375


WHITING
150 TON
AUX. HOIST 20 TON
UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, BUILDERS
J.O.5461 No 538, 5-29-31. 150 Ton Crane Handling Rotor for Generator No 4
N 2376


UNION ELECTRIC LIGHT AND POWER CO. - HYDROELECTRIC STATION - OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, Builders
J.O.5461 No539, 5-28-31. Headgates for Unit No3 from Penstock N2377


Union Electric Light and Power Co.-Hydroelectric Station-Osage Development
Stone & Webster Engineering Corporation, Builders
Governors-Units Nos. 1 and 2.
J.O.5461 No.545, 5-29-31.
N2381


Union Electric Light and Power Co.-Hydroelectric Station-Osage Development
Stone & Webster Engineering Corporation, Builders
Main Control Room
J.O. 5461 No 544, 5-29-31.
N 2382


Union Electric Light and Power Co.-Hydroelectric Station-Osage Development
Stone & Webster Engineering Corporation, Builders
Station Service Control Room
J.O.5461 No545, 5-29-31.
N2383


Union Electric Light and Power Co-Hydroelectric Station-Osage Development
Stone & Webster Engineering Corporation, Builders
J.O. 5461 No 559, 6-29-31. View of Main Generator No1 with Drip Pans and Pipe Covering Completed. N2397


UNION ELECTRIC LIGHT AND POWER CO.-HYDROELECTRIC STATION-OSAGE DEVELOPMENT
STONE & WEBSTER ENGINEERING CORPORATION, Builders
J.O. 5461 No 561, 6-29-31. View of Spare Water Wheel
N 2399

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