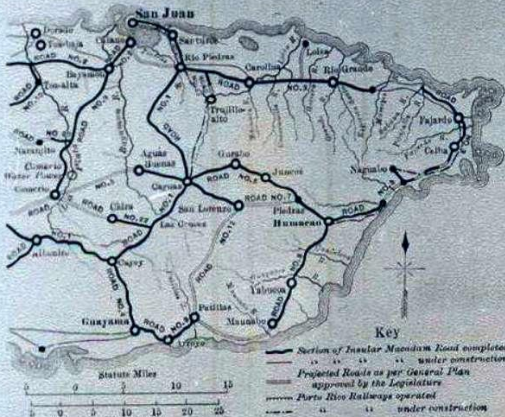


TRAMWAY AND POWER DEVELOPMENTS IN PORTO RICO

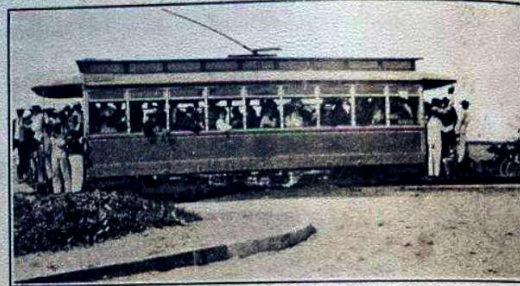
A decade has elapsed since the termination of Spanish rule in Porto Rico. Nearly the whole of this period has witnessed administration by the United States under peaceful conditions and the progress of the island during the period in the two features upon which its prosperity most

and passenger traffic between the two towns and a new water power plant to generate power to operate the road and supply light and power in San Juan and vicinity are the most important developments of recent date in Porto Rico. Caguas has not heretofore had railway connection with the seaboard. All transportation of tobacco and other produce has been by native ox carts at a heavy and increasing rate which has now reached \$14 per ton.

This San Juan-Caguas railway is the first to penetrate the interior of the island, and will be a part of the modern electric street railway system now serving San Juan and its suburbs. There is also the belt line steam railroad



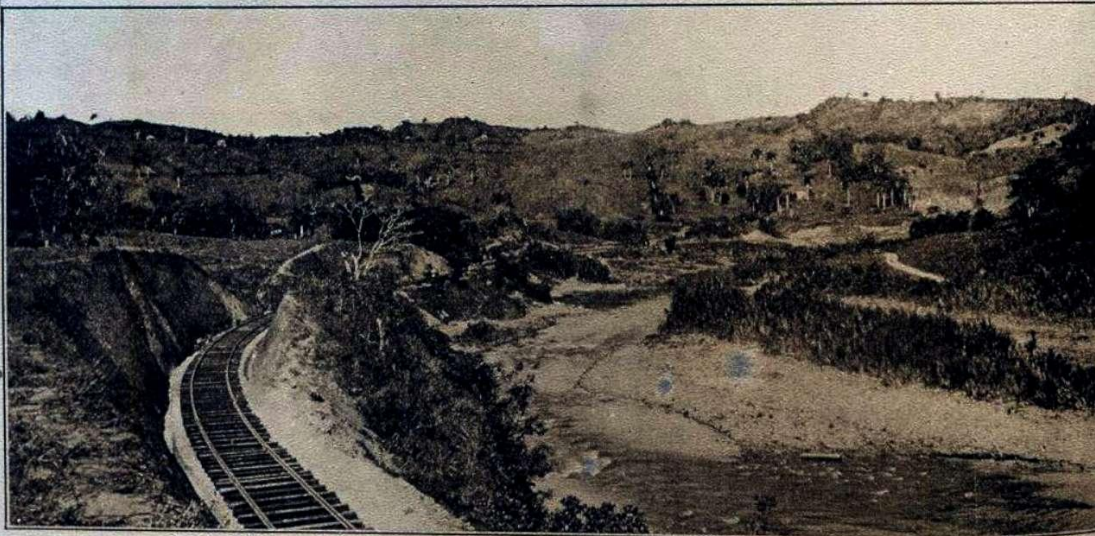
ROAD AND RAILWAY MAP OF EASTERN PORTO RICO



CONVINCING PROOF OF THE ELECTRIC RAILWAY'S POPULARITY IN PORTO RICO

depends, namely, agriculture and transportation, is practically without precedent in any comparable territory in the world. Millions of American capital have in recent years found employment in Porto Rico in tobacco and sugar growing and in railway development. The value of annual exports has tripled since the American occupation,

operated by the American Railway Company, nearly completing the circuit of the coast, which meets the needs of transportation between coastwise points, but there have been no transverse lines until the present developments; the trans-island traffic, both passenger and freight, has been left entirely to coaches, wagons and ox-carts over



A VIEW FROM THE CAGUAS RAILROAD ALONG THE PIEDRAS RIVER

due very largely to the increasing diversion of money and energy from coffee and sugar to tobacco cultivation. The area planted in tobacco has more than quadrupled and the tobacco exports now reach \$4,000,000 annually, though but a minor part of the total production. The tobacco producing country is the high land of the interior, and one of the chief centers is the town of Caguas, distant some 26 miles from San Juan.

The construction of an interurban railway for freight

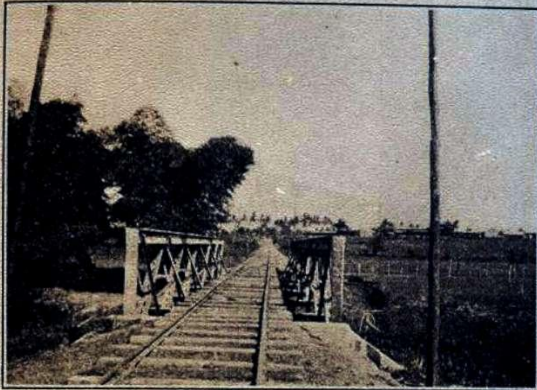
the famous system of military roads. A main wagon road extends from San Juan on the north to Ponce on the south coast. Caguas is on this road, but the passenger fare to San Juan is \$2 and the freight rate, as before mentioned, is heavy.

Tobacco is the most important freight moved over this route. With the increase of tobacco production in Porto Rico there has been more domestic manufacture. Formerly Porto Rican tobacco was largely shipped to Cuba

and thence exported as Cuban tobacco of the well known "Veulta Abajo" brand. Now this has ceased and nearly 90 per cent of the tobacco grown in Porto Rico is used by native tobacco manufactories, most of which are located in the San Juan district. There are three large and modern cigar factories in San Juan. Cheap labor, low rents and freedom from duty into the United States account for this development of domestic tobacco manufacture. The product is largely used locally. Still the value of the

At the same time two new subsidiaries, the Comerio Water Power Company and the Caguas Tramway Company, were formed.

The two established companies have for some time supplied all the railway, light, heat and power facilities in San Juan and vicinity, each operating a steam driven plant. The present undertaking of the Porto Rico Railways Com-



ALONG THE LINE OF THE PIEDRAS-CAGUAS RAILROAD



THE UPPER FALLS OF COMERIO, LA PLATA RIVER

cigars shipped to the United States is, as has been stated, nearly \$4,000,000 annually. These San Juan factories are supplied mostly from the Caguas district where numerous large sorting, drying, curing and packing warehouses are situated.

The heavy freight traffic in the face of seemingly prohibitive transportation charges and the fact that the people have the "traveling habit," as evidenced by the high per capita returns of the tramway lines in San Juan, have all

pany has included the installation of a new hydro-electric source of supply, besides the construction of the new railway to Caguas. The Comerio Water Power Company was formed to carry through the water power development, and the Caguas Tramway Company is the builder of the new railway.

The street railway of the San Juan Light & Transit Company, the most important electric railway in Porto Rico, was the key to the extension to Caguas. This system was built some years ago by the present engineers and is thoroughly modern in construction and equipment. It includes about 10 miles of standard gage track, laid with 70-lb. T-rails, excepting a small section in the city laid with girder rails. The line makes a circuit of important streets in San Juan and runs thence through San Turce to Rio Piedras. There is a short branch line extending to a recreation park, with a theater and other amusements, managed by the company, at an attractive site on the ocean front. The new line 18 miles long extends from Rio Piedras to Caguas.

The rolling stock of the San Juan road consisted of seventeen Brill semi-convertible, double-truck passenger cars and an equipment of coal and work cars. This has been increased recently by the addition of eight semi-convertible teak-wood cars, fitted with double trucks and four 40-hp motors. An express car, also used as an electric locomotive fitted with four 75-hp motors has been added.

Power for both railway and lighting purposes is supplied by a steam plant located at San Turce on the road to Rio Piedras. This plant contains 1100 hp of Cahall and Babcock & Wilcox boilers. The generating apparatus

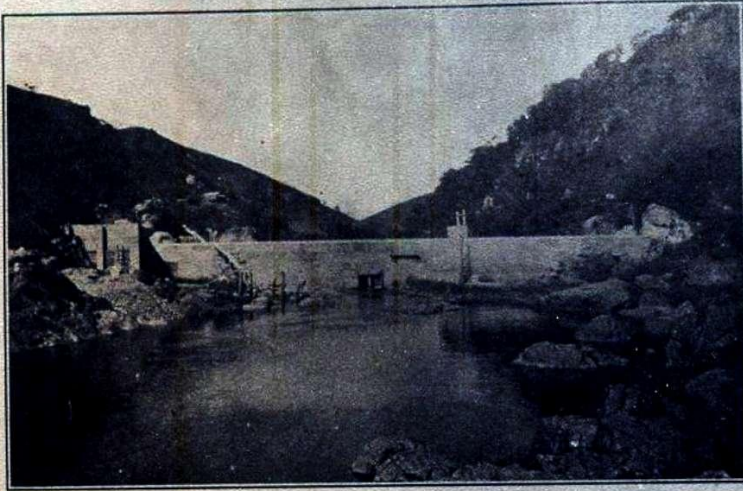


A SCENE ON THE MAIN STREET OF SAN JUAN, PORTO RICO

argued for the construction of a railway from Caguas to San Juan.

In 1906 the construction of railway facilities was made possible by the organization of the Porto Rico Railways Company, Ltd., a corporation of Canadian interests with which J. G. White & Co., of New York, is associated as engineers and constructors. In the Porto Rico Railways Company, Ltd., were merged the San Juan Light & Transit Company and the Porto Rico Power & Light Company.

consists of two simple automatic engines connected to two 225-kw, 2200-volt, two-phase, 60-cycle Westinghouse alternators, and another engine connected to a 250-kw, 550-volt Bullock railway generator. There was until recently a 200-kw railway unit, but it has been replaced by a 500-kw, 2200-volt, two-phase Westinghouse-Parsons steam turbine.



COMPLETING THE DAM AT COMERIO FALLS

The condensing apparatus consists of a Wheeler surface condenser for the older engines and a Worthington barometric for the turbine. The power for the operation of the San Juan railway system is furnished by the 250-kw engine driven unit and motor generators in the new sub-station. The alternators supply part of the electric light and power service in San Juan and vicinity, the remainder being furnished by the separate plant of the Porto Rico Power & Light Company.

The lighting and power system of the Porto Rico Power & Light Company supplies alternating current, single-phase at 2200 volts and three-wire direct current at 220/110 volts. The direct-current system supplies most of the customers. This company has the contract for the street lighting of San Juan, which consists of direct current multiple arc lamps. There are also a large number of commercial lamps in use, both direct and alternating.

The equipment of the power house of the Porto Rico Power & Light Company consists of 470-hp boilers, two tandem compound engines and one simple automatic engine, from which are driven by belts, four 45-kw, 125-volt Edison bi-polar generators, one 200-kw, 250-volt GE generator and one 75-kw, 2200-volt, 60-cycle General Electric a. c. generator.

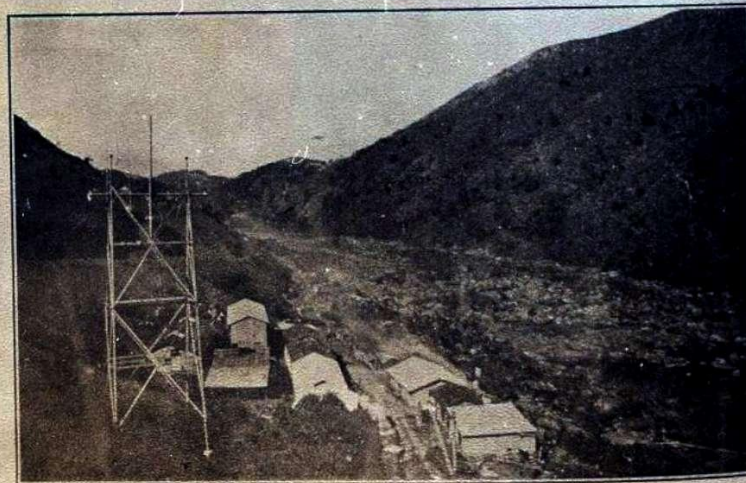
The equipment of the sub-station at San Turce consists of nine 200-kw, 20,000/2300-volt, 60-cycle General Electric oil insulated, water-cooled transformers and two 300-kw railway motor generator sets. The motors are the 2300-volt synchronous type and the railway generators give

600 volts direct current. This sub-station is connected with the steam plant so that power can be supplied by steam in any emergency affecting the transmission line of the new water power plant.

The new hydro-electric plant of the Comerio Power Company, which will supply the bulk of the power for railway and lighting purposes in the remodelled system is very advantageously situated at Comerio Falls on La Plata River, one of the largest streams of the island, 20 miles from San Juan and about 12 miles from Caguas. The capacity of the water wheels is 3000 hp. The plant will operate under a head of 180 ft. The installation consists essentially of the dam located at the head of the falls, a long tunnel, two penstocks and the power house proper located in the gorge below the falls.

The dam is concrete and of the ogee type, approximately 40 ft. high and 300 ft. long. The entrance of the tunnel through steel head gates set in concrete is at the west end of the dam. The tunnel is of horseshoe shape, is concrete lined and has a sectional area of 30 sq. ft. and a length of 2600 ft. A petty reservoir formed by a concrete dam 28 ft. high receives the water as it emerges from the tunnel.

The penstocks, of which there are two, emerge through the base of this dam and descend to the power house on a slope of one in two. They are 54 ins. in diameter and 500 ft. long, and are constructed of tank steel varying in thickness from $\frac{1}{4}$ in. to $\frac{3}{8}$ in., supported and anchored in con-



COMERIO PLANT UNDER CONSTRUCTION, SHOWING ALSO A TRANSMISSION TOWER AT THE LEFT

crete piers. The main gates at the upper ends of the penstocks are 60 ins. in diameter and are provided with bronze facings and seatings with ball-bearing stands.

The power house is constructed of rubble masonry, cement coated, and its sub-structure is built into solid rock. The main hydraulic equipment consists of four horizontal wheels of the Francis inflow type, built by the I. P. Morris

Company, each having a capacity of 750 hp and a speed of 450 r. p. m. under a 175-ft. head. Type Q Lombard governors are used. The turbines are arranged two on each penstock, and they discharge vertically into the tail pit through conical draught tubes.

The main electrical equipment consists of four 400-kw units, direct connected to the water wheels. The size of units was chosen to meet the varying demand in its several stages from operation of the railway and commercial power units during the day to the full lighting and railway operation at night. Current is generated at 2300 volts, three-phase, 60 cycles and is stepped up to the transmission pressure of 20,000 volts by six 300-kw oil-insulated, water-cooled transformers. There are two 40-kw exciters driven by Pelton type water wheels of 64 hp each and running at a speed of 450 r. p. m.

One of the most serious problems entering into the construction of this plant was that of transporting the heavier machinery to the site. The nearest government road is 4 miles away, and the hauling by cart over the steep grades and through fords was attended with difficulty.

The 20,000-volt transmission system to San Turce substation is perhaps one of the most interesting features of the entire work under description. It is a double line carried on structural steel transmission towers at a height of 40 ft. The wires are No. 4 copper and the spacing is 60 ins. There is a grounded conductor placed above the circuits for lightning protection and a private telephone line is installed on the towers. The towers are spaced twelve to the mile. They are constructed of structural steel mem-

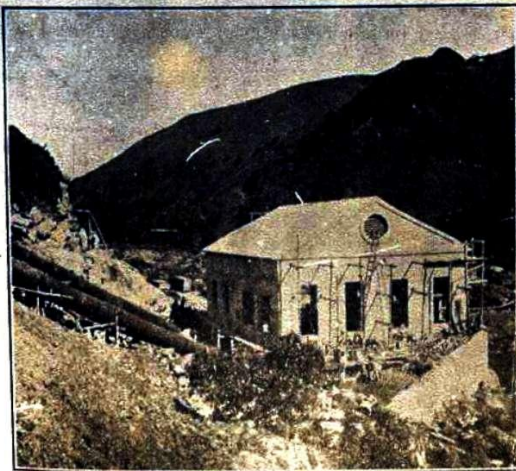
San Juan tramway is standard gage, so through passenger service between San Juan and Caguas demands standard gage. Eventually both gages will be maintained, but it has been decided to operate it for the present by steam as a meter gage road.

The route from Rio Piedras lies for the most part along



PLATFORM TRAILERS FOR SUNDAY TRAFFIC

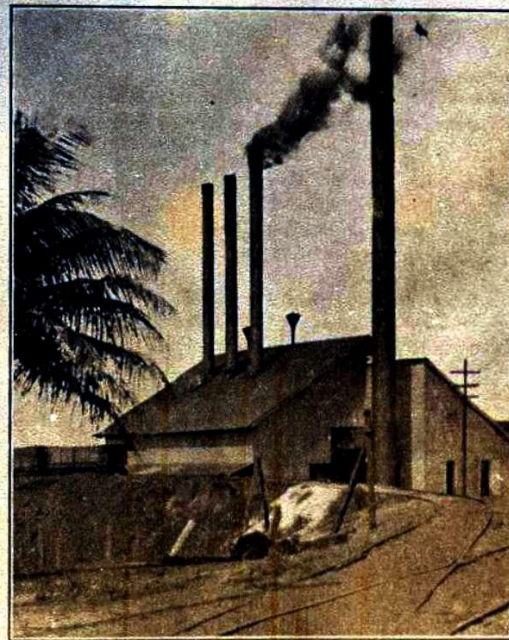
the Rio Grande River, and the country is broken so that a large amount of grading and bridging has been done to keep below a maximum of 3 per cent. The earth excavation averages approximately 8000 yds. per mile and the rock about 3500 yds. There are numerous steel bridge



COMERIO FALLS POWER PLANT NEARING COMPLETION

bers, very heavily galvanized, under the engineer's own specifications for tropical climates. The towers were made by the Ritter-Conley Manufacturing Company, of Pittsburg.

In the construction of the Caguas railway it has been necessary to meet two binding requirements. Meter gage is necessary to permit through freight arrangements with the American Railway Company, the system of the latter company being built to that gage. At the same time the



SAN TURCE PLANT OF THE SAN JUAN LIGHT & TRANSIT CO.

spans varying in length from 70 to 100 ft. besides many smaller structures. All the pier's and abutments are concrete. The line is laid with 66-lb. rails, with continuous joints on long leaf yellow pine and black gum ties, 6 ins. x 8 ins. x 8 ins., creosoted to withstand the effects of the climate. The ballast is rock and gravel.

The entire engineering and construction of the railway and power properties is in charge of J. G. White & Co.

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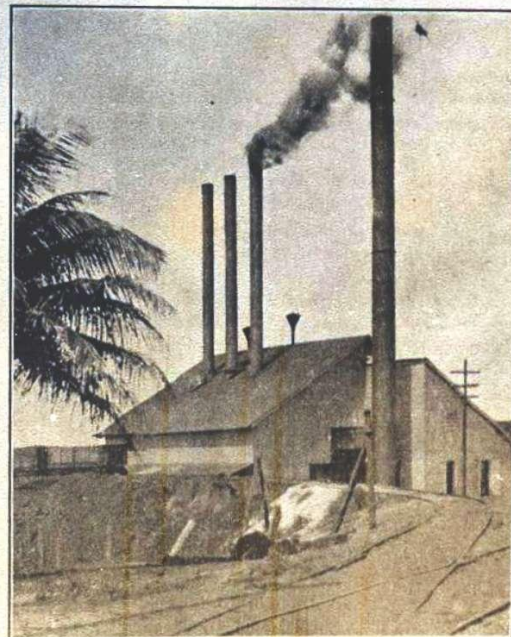
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