THESIS

Efficiency and Inefficiency in the Operation of the Bureau of Power and Light of Los Angeles, California.

Prepared By

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Class of

One Thousand Nine Hundred and Twenty-four.

Department of

Engineering and Economics.

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EFFICIENCY AND INEFFICIENCY IN THE OPERATION OF THE BUREAU OF POWER AND LIGHT OF LOS ANGELES, CALIFORNIA.

I. Statement of the Problem.

In work of this nature it is advisable to state definitely the problem attempted in order that the reader may have a clear understanding of the object of the work undertaken. The problem involved is to determine the efficiency and inefficiency in the operation of the Bureau of Power and Light of Los Angeles, California, as it exists at the present time. This will be more on the order of a government investigation than a purely engineering thesis. An engineering thesis consists of reports based on experiments and tests, etc., while the present undertaking will consist of investigation of the facts concerning the organization, operation and conduct of the business of the Bureau of Power and Light. The facts presented were optained from several sources: (1) the writer's knowledge of the business; (2) books written on municipal ownership; (3) reports published by the Bureau, and (4) personal interviews with men connected with the organization. I have endeavored to draw conclusions from the facts thus obtained, as to the present status of the Bureau of Power and Light.

II. The Writer's Qualifications.

The writer's qualifications for attempting a consideration of the problem, are as follows: (a) I was an employee of the Bureau of Power and Light for two different periods. The first period was for seven months, from April to December, 1921; the position was that of topographical draftsman, the work of which consisted of recording, on specially prepared cloth-maps, the property necessary for distribution

of power and light within the city limits of Los Angeles, and also of making up cuts of new extensions for blue prints used in the field by the construction crews, recording street light circuits from various sub-stations, and other work of like nature. The second period was for three months, from July to September, 1922, as Junior Electrical Engineer. This work consisted of assisting in the preparation of a report submitted to the Railroad Commissioners on Condemnation Proceedings against the Los Angeles Gas and Electric Corporation. My investigations have included the reading of books on municipal ownership, the gathering of information from the reports given out by the Department of Public Service, and personal interviews with the men connected with the different departments of the organization.

I wish to take this opportunity to express my appreciation of the interest and the help of Mr Russell G. White, electrical engineer in the distribution department, who supplied me with a great deal of information and data.

III. Sources and Distribution of Power.

A. The Sources of Power.

In 1904, Los Angeles was confronted with a serious problem. The rate of increase of population became greater than anticipated and consequently there was a greater demand for water, with no adequate means of meeting the demand. For ten days in July of that year the consumption of water exceeded the inflow by 4,000,000 gallons. This excessive consumption was checked temporarily by the use of meters, allowing only a certain number of gallons per day to be used by the consumers.

Mr William Mulholland, Superintendent of the Water Department, and Mr Fred Eaton, former City Engineer and Mayor of Los Angeles, had

studied the problem and made careful investigation of all possible sources of water supply. They finally concluded that the Owens Valley water source was the most feasible of all sources considered. In July, 1905, a report proposing an aqueduct was submitted to the people of the city and was enthusiastically accepted. After the bond issue had been supported by the people and money obtained from the sale of the bonds, work commenced on the building of the aqueduct on October, 1, 1908.

The Aqueduct was completed within the estimated time of five years and at the estimated cost of approximately $23,000,000; the waters were turned into the San Fernando Reservoirs on November 5, 1913.

The water supply for the Aqueduct comes from the Owens Valley. This valley lies on the east side of the Sierra Nevada mountains, partly in Inyo and partly in Mono County, and is in the central portion of California, north and south, and on the desert side of the range. The valley is about 120 miles long, from 6 to 12 miles in width, and lies at an elevation between 3,500 and 6,500 feet. Owens River receives all the water from the watershed on the east side of the High Sierras.

Los Angeles has the water rights in Long Valley, which is to the northwest of Owens Valley, and the watershed of which is one of the sources of the Owens River. There is a possibility of constructing a reservoir in this valley that will rank among the notable ones of the United States. This reservoir should be built. So far this season the weather has been very dry, with very little snowfall in the mountains. If there is no appreciable amount of rainfall and snowfall before the season is over, Los Angeles will again be suffering for want of water. The Long Valley Reservoir site is 50 miles north of the present intake to the Aqueduct and has a watershed of 391 square miles. Its estimated

capacity is 340,980 acre-feet and it would require a dam 160 feet high. This reservoir alone would supply continuous flow of the full aqueduct capacity for 427 days.

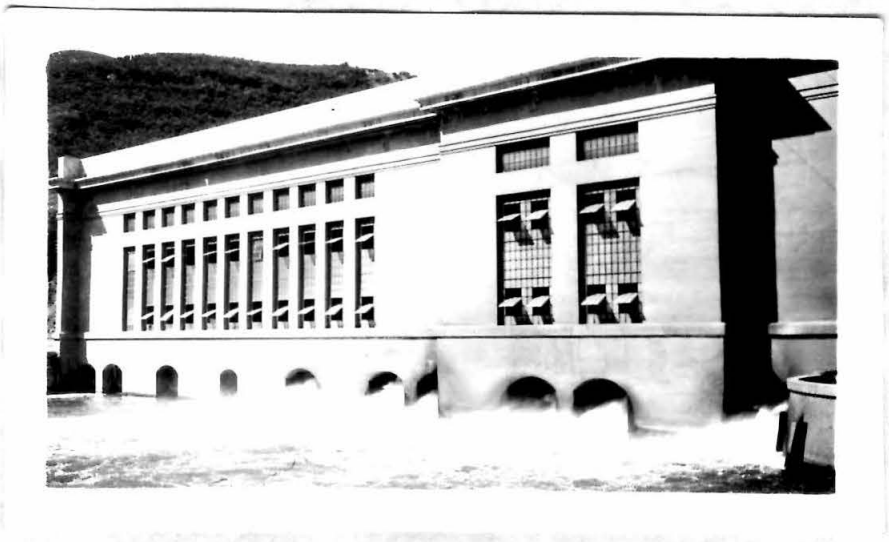
The intake on the Owens River is 35 miles north of Owens Lake. The reason for this distance is due to the fact that Owens Lake has no outlet and the water in the lake and vicinity is saline. There are 23 miles unlined and 37 miles lined with concrete. The capacity of the Aqueduct is 900 second-feet from the intake to the first reservoir, which is called Haiwee Reservoir. The large capacity of the Aqueduct and the Haiwee Reservoir serves the purpose of taking care of the flood waters during the rainy season and the melting of the snow in the Sierras. The capacity of the Haiwee Reservoir is 63,800 acre-feet. One acre-foot is the equivalent of water on one acre to the depth of one foot and is equal to 325,850 gallons. Sixty-three thousand, eight hundred acre-feet is equal to 20,890,000,000 gallons, enough water stored to run the Aqueduct at full capacity for 80 days.

The Aqueduct, from the Haiwee Reservoir, follows the base line of the High Sierras, crossing many canyons by means of syphons and passing thru the ridges by means of tunnels, in order to keep the required gradient of flow. One of the famous syphons is that in Jawbone Canyon, about 19 miles north of Mojave. Its length is 8,095 feet and it has a maximum head of 850 feet; that is, there is a pressure acting against the steel pipe equivalent to a column of water 850 feet high, or equal to 366 pounds per square inch. The Aqueduct then crosses the west end of the Mojave Desert about 35 miles southwest of the town of Mojave; it crosses the Antelope Valley and then empties into Fairmount Reservoir on the north side of the Coast Range.

The capacity of the Aqueduct from Haiwee Reservoir to Fairmont Reservoir is 430 second-feet, which serves the purpose of taking care of losses in the Aqueduct and of supplying the reservoir with sufficient water to regulate the supply of 400 second-feet to the power houses below. The capacity of this Reservoir is 7,620 acre-feet and its purpose is to regulate the hourly fluctuations of water thru the power plants to meet peak load conditions.

A tunnel carries the water from Fairmont Reservoir thru a ridge to the Coast Range. This tunnel, called the Elizabeth Lake Tunnel, is 26,870 feet long, and transmits the water to the San Francisquito Canyon, in which are located two of the power houses. Before the water goes thru the power plant, it enters a huge surge chamber at the head of the penstocks. This is to take care of the sudden changes that occur in the penstock due to changes in demand for water by the generators.

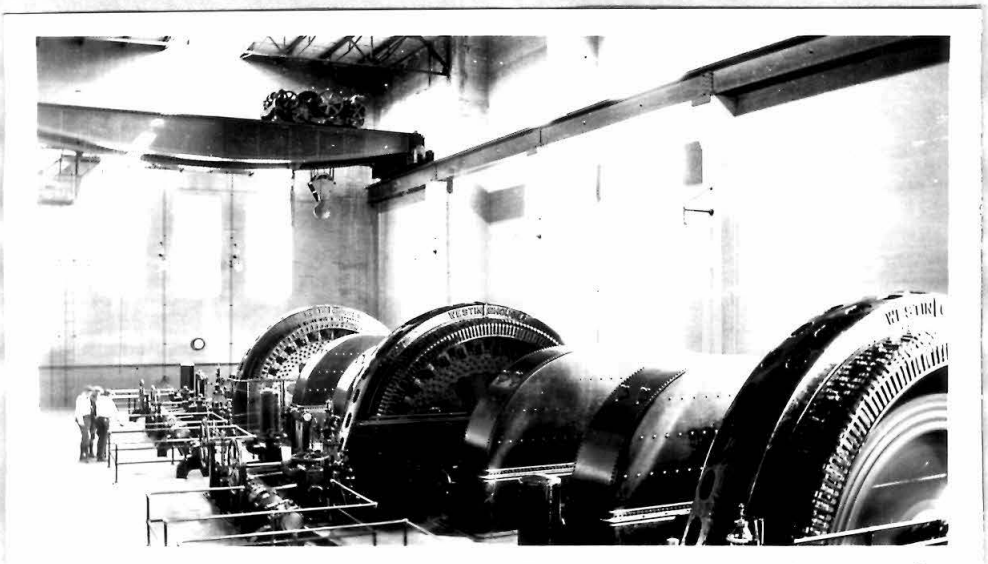
The actual source of hydro-electric power, at the present time, starts at power house No.I, in the upper end of San Francisquito Canyon, about 47 miles from Los Angeles.



South Front of Power House No.I, San Francisquito Canyon.

There is power developed in Owens Valley, but it is not brought into Los Angeles; plans are laid to bring power in from Owens Valley at some future date.

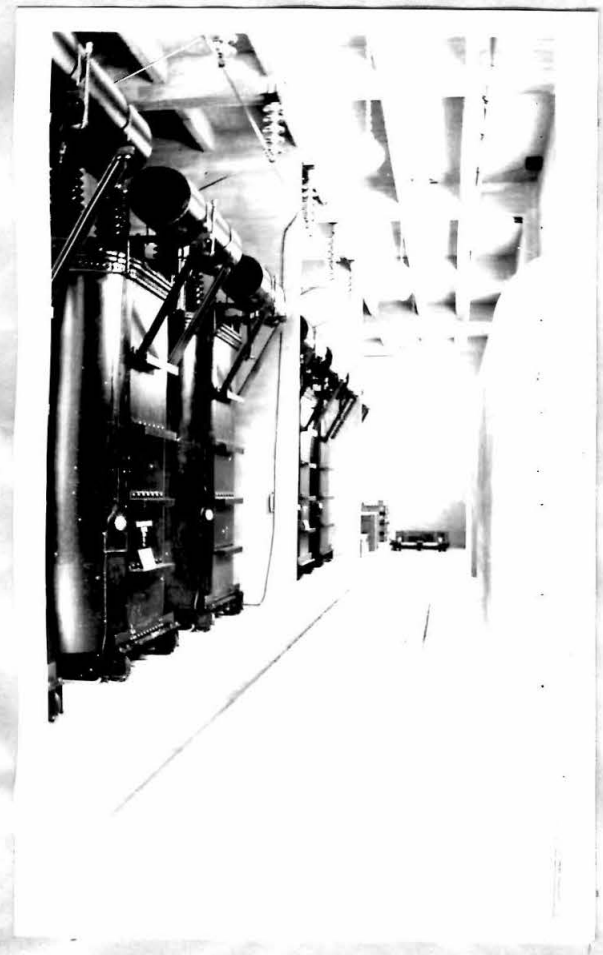
After the water leaves the surge chamber it is divided first into two penstocks; then later each of these penstocks is divided, so that there are four in all entering the power plant. There is approximately a 900 foot head, which permits the operation of impulse turbines. Three units of these impulse-wheel driven generators, as shown in the accompanying picture, were originally installed. Each unit has a maximum



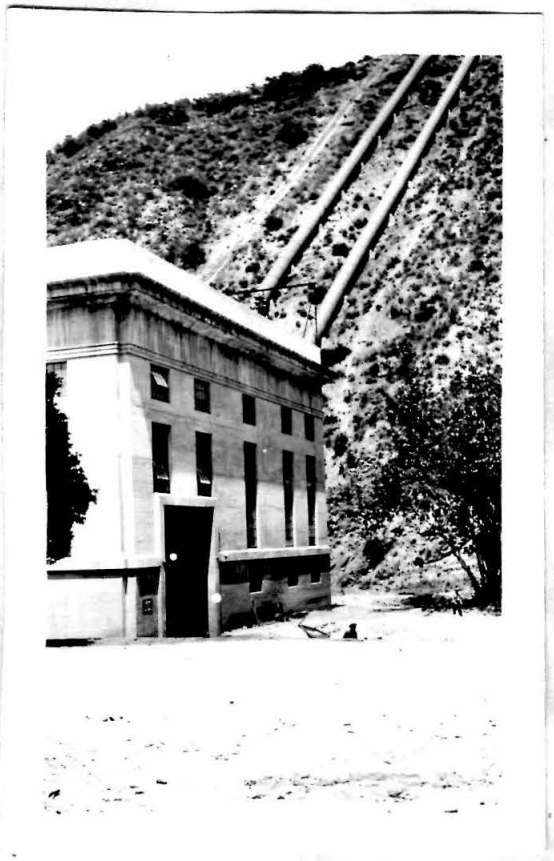
Three units Impulse Turbines - Westinghouse Generators.
9,375 K.V.A. 6600 Volts
Power House No I.

output of 9,375 K.V.A. Later, another unit was installed with output of 12,500 K.V.A., making a total of 40,625 K.V.A. for the plant. K.V.A. (1,000 volts x amperes) is the unit rating of an alternator at 100 per

cent power factor. K.W. (1,000 watts) is the unit for electrical power delivered, the power factor being taken into consideration; it is less than the K.V.A. generated by the alternator. The generators shown, generate at 6600 Volts, for which connections are made to bus-bars and from the bus-bars the voltage is transformed or stepped-up to 110,000 volts by means of huge transformers shown in the picture. From the transformers the power is sent out on high tension transmission lines nearly fifty miles to the city. Power is transmitted at a high voltage in order to make the transmission losses less, thereby increasing the kilowatt-hours received at the central receiving sub-station. About 7 miles farther down in the same canyon or 40 miles from the city, is another power house, No 2. After the water leaves the power house No. I, it is again taken up in the Aqueduct and later supplies the penstocks leading to power plant No. 2, as shown in the following illustration. This plant is of a different type from No. I, due to the fact of the difference of head. The head here is 515 feet. Reaction turbines are used, which depend upon the volume of water leaving the turbine, rather than upon the pressure of the water striking the impulse wheels.



Banks of Transformers for the Generators shown previously, to step the Voltage from 6600 to 110,000 volts.



Power House No. 2, San Francisquito Canyon, showing two Penstocks that are supplied by the Aqueduct water and that operate two Reaction Turbines of 17,500 K.V.A. Capacity and 6600 Volts.

There are two units, the vertical type generators each having an output capacity of 17,500 K.V.A. or a total of 35,000 K.V.A. for this plant. The transformation of power is similar to that at No. I, and is tied in with the high tension transmission system from No. I.

The Aqueduct water, after leaving power plants Nos. I. and 2, continues on to Dry Canyon Reservoir, which is southeast of San Francisquito Canyon. The capacity of this reservoir is 1,325 acre-feet. Its purpose is to regulate back to uniformity the irregular flow that may be discharged from the power plants. The outlet consists of a floating weir which allows only 400 second feet to flow out at any time. From Dry Canyon the Aqueduct goes on thru the Coast Range, crossing the Boquet Canyon in a syphon as shown in the picture. This syphon is typical of those on the line of the Aqueduct north of Mojave Desert. Until lately the water was aerated by falling over the Cascades northwest of San Fernando, but the

Syphon for the Aqueduct crossing Boquet Canyon, in the Coast Range.

water has again been harnassed just above the Cascades and directed into ~~street~~ steel pipes which carry it a short distance to the San Fernando power plant.

The San Fernando power plant has recently been constructed and put into operation. It is located just north of the San Fernando Reservoir and is about 25 miles from the city. There is a drop of 300 feet, which permits the use of reaction turbines, of which there are two units in this plant. They are of the vertical type and each is capable of generating 3,500 K.V.A., or a total of 7,000 K.V.A. for the plant. This system is tied in with the high tension line from the San Francisquito power plants and thence carried to the city, to the central receiving station.

The Aqueduct continues a short distance and empties into San Fernando Reservoir No. I, with a capacity of 15,940 acre-feet, and from thence another short distance into San Fernando Reservoir No. 2, which has a capacity of 23,000 acre-feet. This is the terminus of the Aqueduct; the water having served one purpose of developing hydro-electric power for the city, is ready to serve another purpose, that of supplying the city with its daily need of water. A trunk line

carries the water from the reservoir No. 2, into the city, supplying the mains and the whole distributing system.

There are two smaller power plants from which Los Angeles derives electrical power; one, the River power plant, which has one unit of 3,600 K.V.A. capacity, and the other located in Franklin Canyon, in the Santa Monica Mountains, west of Los Angeles, which has one unit of 2,500 K.V.A. capacity.

The total generative capacity for the whole system is the sum of the capacities of all the units, which amounts to 88,725 K.V.A. This is the maximum amount that can be generated for peak loads and is less than that delivered at the city. The present capacity for generating electricity is not large enough to supply the needs of Los Angeles. The Bureau of Power and Light has met this difficulty by buying power from the City of Pasadena and from the Edison Company. A short time ago, Los Angeles sold power to Pasadena, but conditions have changed; Pasadena has enlarged her plant and it generates more power than the city of Pasadena needs. Consequently, the surplus power is sold to the city of Los Angeles to help meet the increase in demand due to the great growth of the city. Los Angeles could buy 9,000 K.V.A. from Pasadena as of January, 1, 1924. The city bought from the Edison Company as of January 1, 1924, electrical power amounting to 42,500 K.W. at a power factor of 70 per cent or $\frac{42,500}{70}$ = 60,700 K.V.A. On January 1, 1924, the total electrical power for peak loads, from which Los Angeles could draw, amounted to 158,425 K.V.A. Of this amount approximately 150,000 H.P. maximum supply, was available, with which to meet the demands for power and light in the city limits of Los Angeles.

The following figures for the past two years are interesting in that they show the percentage of electric energy furnished by the Power Bureau out of the total amount used in the city exclusive of railway power.

	1922	1923
Bureau of Power and Light Production from its own plants and delivered in Los Angeles	Kilowatt hours 229,277,887	Kilowatt hours 219,740,335
Total Kilowatt used in City exclusive of railway power	414,604,008	518,438,086
Percentage of total	55.30%	42.39%

The reason for the drop in percentage for 1923 is to be found in the fact of the dry season which reduces the water supply for generation of electrical power and also in the increase of the use of electric power in Los Angeles.

B. Distribution of Power.

The electric power generated at power plants along the line of the Aqueduct, comes into the city over the 110,000 volt transmission lone and terminates at the Central Receiving Sub-Station shown as No. I, on the accompanying map. From this central point 33,000 volt lines transmit the power to the various sub-stations located thruout the city.

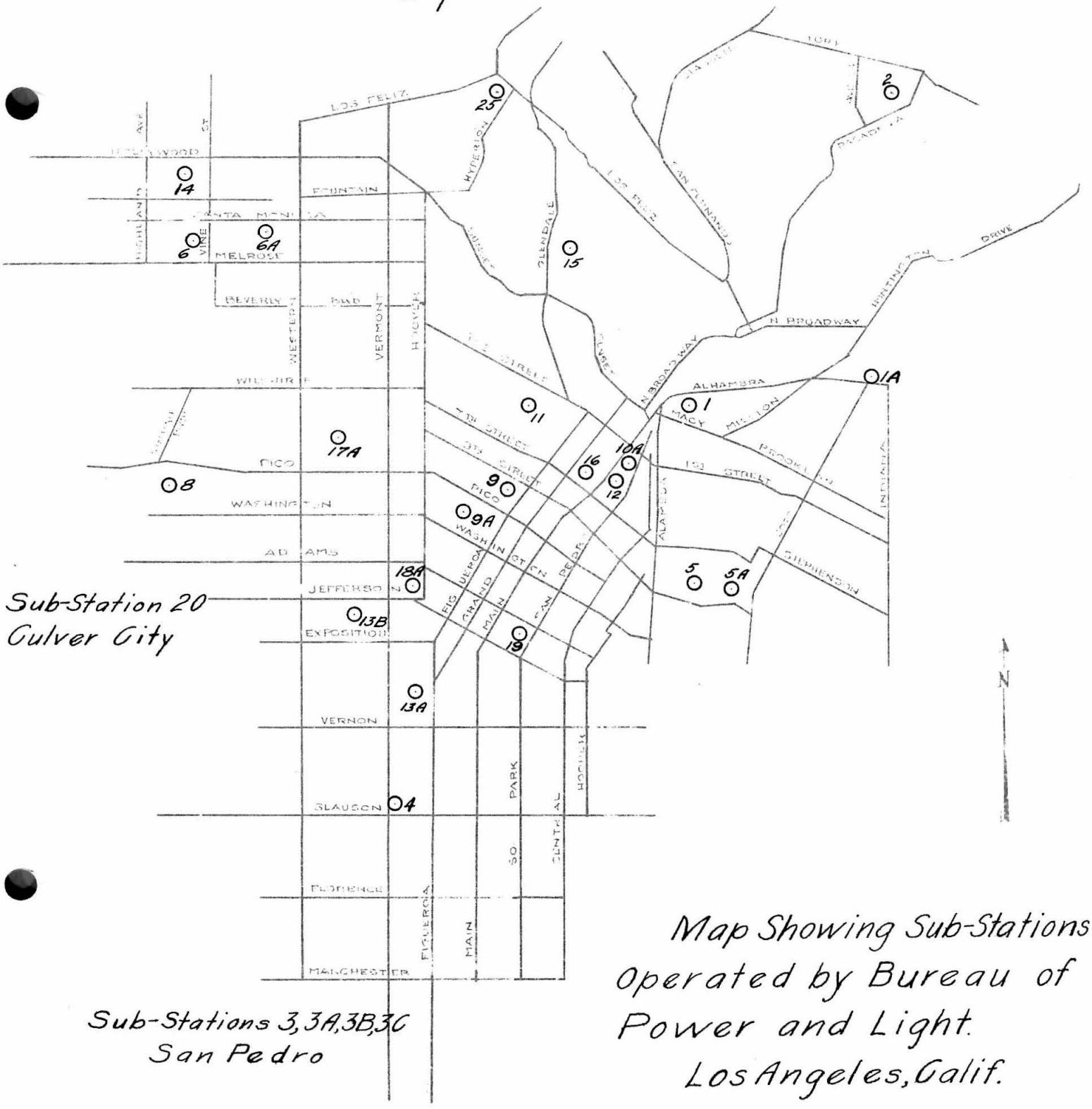
The approximate locations of the sub-stations are shown by circles on the map and tne corresponding numbers are given, according to the plan of existing stations. Those which have a letter after the assigned numbers are proposed to be abandoned. In taking over the

Edison Company's distribution system, the city received all of its sub-stations, and this developed a problem in reorganizing and unifying the two systems. The city's original stations are numbers, 1,2, 3,4,5,6 and 9; the others were formerly the Edison Company's. In readjusting and changing the loads from one to another the Distribution Division will find that some of them are not necessary and can therefore be abandoned.

The sub-stations supply the feeders at 2200 and 4400 volts according to the load demand. Those in town supply the primaries, then by means of transformers, the voltage is stepped down to 220; the three wire secondary hook-up, with one wire grounded, either 220 volts or 110 volts, may be had by the consumer. The sub-stations serve another purpose in furnishing power for street lighting. Each station has its several street lighting circuits so as to cover practically the whole city.

The Bureau of Power and Light now operates about 25 sub-stations, not all shown on the map; others are located at San Pedro, Culver City, and San Fernando Valley. It operates also approximately 91 miles of 110,000 volt, 160 miles of 33,000 volts, 148 miles of 15,000 volt, and 20 miles of 10,000 volt transmission lines.

Sub-Stations 21,22,23
San Fernando Valley



Sub-Station 20
Culver City

Sub-Stations 3,3A,3B,3C
San Pedro

Map Showing Sub-Stations
Operated by Bureau of
Power and Light.
Los Angeles, Calif.

IV, Organization of the Power Bureau.

The following is from the report on the construction of the Aqueduct. "Realizing the necessity for the determination and adoption of general plans to be followed in proposed power developments along the Aqueduct and on natural streams, in order that the location and construction of the Aqueduct might conform to the best advantage to such plansfor power development, and in order that temporary works for by-passing the water of the Aqueduct might be avoided as far as practicable at the various power sites, and realizing, further, the necessity for starting the heavy construction work in connection with the earlier power developments, in order that the city might realize benefits from its power opportunities at the earliest practicable date, the Bureau of Los Angeles Aqueduct Power, in the Department of Public Works, was created in September, 1909, with William Mulholland, Chief Engineer of the Aqueduct, as Supervising Engineer, and E.F. Scattergood, Electrical Engineer of the Aqueduct, as Chief Electrical Engineer."

General plans for power development were worked out by the engineers of the Power Bureau and adopted by the City. In order to carry out the plans it was necessary to have funds. These were provided by the issuance of power bonds to the amount of $3,500,000, authorized in April, 1910, but due to litigations the funds were not available until 1912. This was not enough money to meet the popular demand, but was all the provision the charter would permit at that time. In March, 1911, the charter was amended so as to permit the authorization of power bonds in larger amounts. The amendment to the charter appears below:

"The provisions of the City Charter as amended in 1911, contemplated that the Board of Public Service Commissioners shall have full

charge of all and any electric power generating and distributing works which might belong to the City. In December, 1914, the Board of Public Works, having completed the construction of the electric works provided for by the $3,500,000 of funds derived from the sale of the power bonds authorized prior to the amendment of the Charter in March, 1911, the City's electric works and Power Bureau organization was transferred from the Department of Public Works to the Department of Public Service, and the Bureau of Power and Light, operating under the direction of the Chief Electrical Engineer, was created in the Department of Public Service. The completion of the City's electric generating and distributing system, as well as the operation, maintenance and extension of the same, will be under the direction of the Board of Bublic Service Commissioners."

The following are the sections (in part) from the Charter of the City of Los Angeles, as amended in 1911:

ARTICLE XVIII

(Amended 1911)

Department of Public Service.

Section 192 - There is hereby established a department of the government of said city to be known as the Department of Public Service, which shall be under the management and control of a Board of Public Service Commissioners.

(a) Said Board shall consist of five members who shall be appointed by the Mayor, subject to confirmation by a majority of the Council.

(b) The appointment of said commissioners shall be made without regard to political opinions, but with reference to their fitness for such office.

(c) The term of office of the Public Service Commissioners shall be four years; provided, however, that upon the taking effect of this

article the Water Commissioners of said city then in office, shall be and become the Public Service Commissioners of the city, and shall continue in office as commissioners until the expiration of the terms for which they were appointed, respectively.....

The Mayor shall, subject to confirmation by the Council, fill all vacancies by appointment for the unexpired term.

(d) The Commissioners shall organize by electing one of their members president, who shall hold his office for one year and until his successor is elected, and they may appoint a secretary, who is not a member of the Board, and fix his compensation.

(e) The president of the Board of Public Service Commissioners shall be the executive officer of the department, and shall perform such duties as the Board may prescribe. He shall devote so much of his time to the duties of his office as may be necessary for the proper supervision and direction of the business of the Department. The secretary of the Board shall keep a record of the proceedings of the Board, and may certify such proceedings under his hand to be authenticated by seal, if a seal be adopted and provided by the Board for that purpose, and shall perform such other duties as the Board may prescribe.

(f) The Board shall maintain an office and prescribe office hours for the convenience of the public. The Board shall hold a regular stated meeting once in each week. The members of the Board shall serve without compensation except that the president of the Board shall receive a salary of $3,000 per annum, payable in equal monthly installments.

(g) The Board of Public Service Commissioners shall have power: To manage and control all water, water rights.....and all electric plants, works, systems and equipments, and all electric power belonging

to the city. To construct, operate, maintain and extend water works .....; also electric plants, works, systems and equipment, and other means for supplying the city and its inhabitants with electricity for light, power and heat and other purposes. And to acquire and take by purchase, lease, condemnation or otherwise, and in its own name to hold, as special trustee for the city, any and all property situated within the limits of the City, that may be necessary or convenient for such construction, operation, maintenance or extension.

To supply and distribute any surplus water or surplus electric power, belonging to or controlled by the City, and not required for use within its limits, to consumers outside of the city, for their own use, and to municipal corporations outside of the City, for municipal uses, or for resale, or distribution, by such municipal corporations, to consumers within their limits, respectively; such surplus water and electric power to be so supplied and distributed, for use outside of the city, under schedule of rates, fixed as hereinafter provided, which shall be of uniform operation, as near as may be, and shall be fair and reasonable, taking into consideration among other things the nature of the use, the quantity supplied, and the value of the service.....

To regulate and control the use, sale and distribution of water and electricity.....collection of water and electric power and light rates, granting of permits.....

To appoint, employ and for good cause remove as chief engineer of water works, who shall be the successor in office of the superintendent of water works, an electrical engineer and such assistants, employees and laborers as the Board may deem necessary: to fix their compensations, prescribe their duties and to require of any or all of them adequate bonds for the faithful performance of such duties.

To sue and be sued, and to require the services of the City Attorney, free of charge, in all cases to which the Board is a party.

To control and order the expenditure of all moneys received from the sale or use of electric power, or otherwise in connection with the operation and management of the electric power works and systems of said city; provided that all such moneys shall be deposited in the treasury of the city, to the credit of a fund to be known as the"Power Revenue Fund" .....and shall only be drawn from said fund upon demands authenticated by the signatures of the president and secretary of the Board, or, in the absence of the president, by signatures of two members and the secretary.

(j) Three members of the Board of Public Service Commissioners shall constitute a quorum for the transaction of business; but no contract shall be made, no bill audited, nor any act done involving the expenditure of money, or the insurring of debt, unless three members of the Board vote in favor thereof.

The Board shall not make any contract or expenditure, for supplies, goods, materials, machinery or merchandise, involving the sum of more than $500, unless it shall first have caused a notice to be published in a daily newspaper, printed and published one or more times in the City of Los Angeles, inviting proposals to furnish the same. And the regular contract therefor shall be let to the lowest regular, responsible bidder who shall furnish satisfactory security for its performance, satisfactory to the Board; provided that the Board may reject any and all the bids.

Section 193 - There is hereby created in the Department of Public Service, a Bureau to be known as the Bureau of Water Works and Supply. Said bureau shall have charge and supervision thru the chief engineer,

but under the direction and control of the Public Service Commissioners, of the water, water rights, water works and systems of the city, and of the distribution of water belonging to the city.

Section 193-A - There is hereby created in the Department of Public Service a bureau to be known as the Bureau of Power and Light. Said bureau shall have charge and supervision thru the electrical engineer but under the direction and control of the Public Service Commissioners, of the power and lighting systems, works, lines and equipments of the city and of the distribution of electricity for light, power and other purposes belonging to the city.

Outline of the Organization of the Department of Public Service.

Mayor

(George C Cryor)

Public Service Committee of the Council

(Three members)

Board of Public Service Commissioners

(Five Commissioners, Secretary and Controller)

Bureau of Water Works and Supply

Chief Engineer

Superintendent of Distribution

Chief Mechanical Engineer

Superintendent of Irrigation

Engineer in charge of Los Angeles Aqueduct

Assistant Engineer

Superintendent of Meter and Service

Bureau of Power and Light

Chief Electrical Engineer

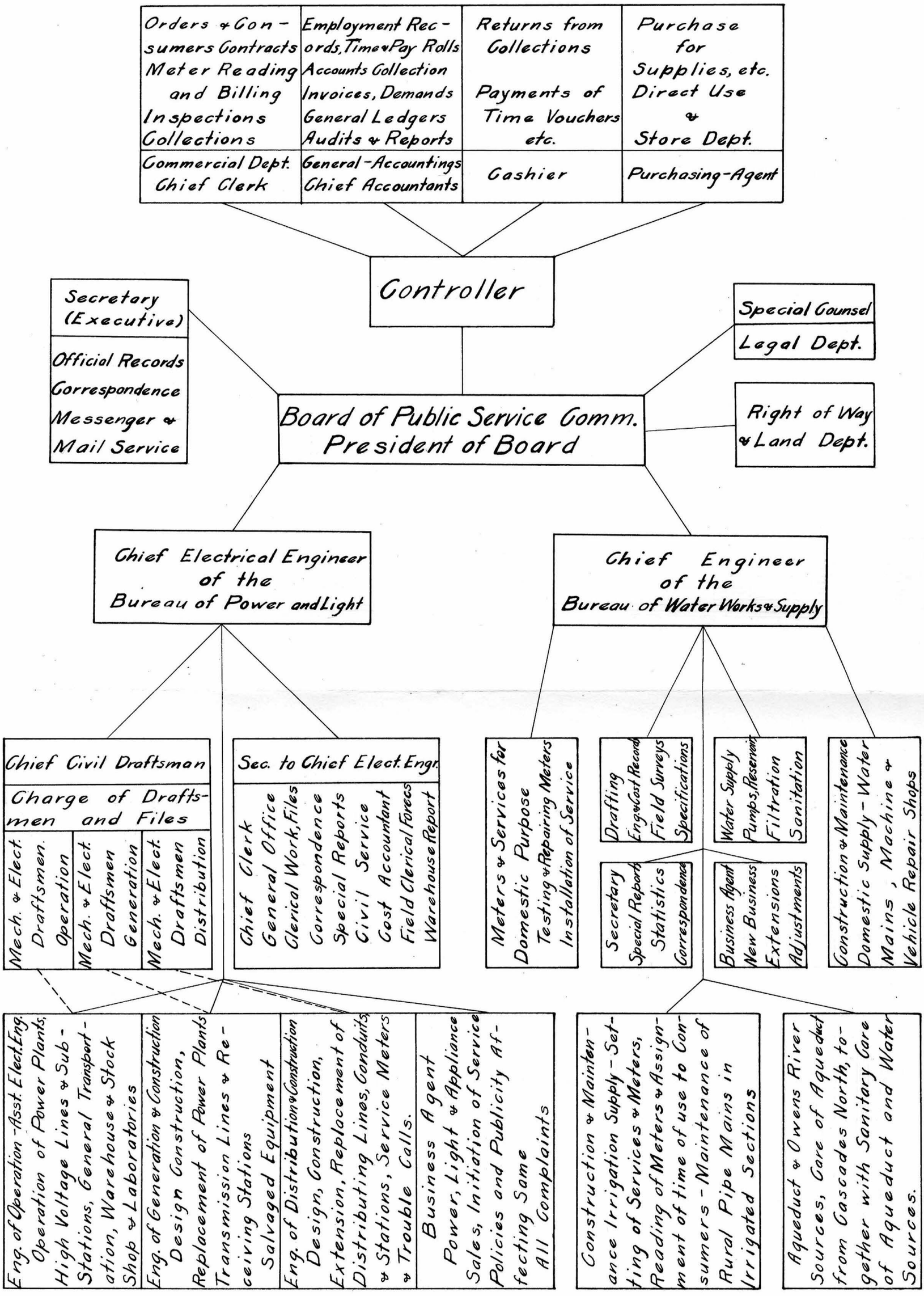
Secretary

Assistant Engineer of Distribution

Assistant Engineer of Operation

Assistant Engineer of Construction

Business Agent



Organization Chart
Bureau of Power and Light

Legal Department
(Special Counsel and two Deputy City Attorneys)

Right of Way and Land Department
(Right of Way and Land Agent)

Commercial, Accounting and Purchasing Department

Assistant Business Agent - Business Agent's Division

Chief Accountant	Accounting Division
Purchasing Agent	Purchasing Division
Chief Clerk	Commercial Division
Personnel Clerk	Personnel Division

V. Conduct of the Business.

An illustration of the typical way in which the business is conducted is given in the following paragraphs. New extensions and reconstructions, repairs and maintenance, overhead and underground, will be considered in connection with the necessary authorizations. Most Authorizations originate in the business office for new business in enlarging the Distribution System.

The authorizations that originate in the business office for new business must contain:

Name of Consumer
Location where work is to be done.
Collection Address
Kind of Service Desired (Power, heat or light)
Amount of power, light or heat required
Estimated revenue for the first year
Future prospects for other consumers, that can be served from extensions proposed, together with any other information that the engineering department, or anyone handing any portion of it desires.

The authorization is then sent to the man in charge of the Distribution Engineering Office, who in turn gives it to the chief

draftsman, for the purpose of making a pencil sketch. This sketch is made from the record maps and shows the location of houses or tract to be served. The existing lines are marked on the sketch, and a proposed or preliminary layout is marked on the sketch in accordance with the definite scheme or plans of the entire Distribution System.

The pencil sketch is forwarded to the field crew with authorization attached. It is then taken to the field and the ground is gone over thoroughly; the location of all the existing poles is plainly marked on the sketch and any conditions that make it impossible to construct lines as laid out by the office engineer are noted and the layout changed so as to give the best result with least deviation from the officeengineer's lines. At the same time the poles are marked on the map, a specification sheet is made out, which gives the height and grade of pole, that is, light, heavy or medium weight pole, and all construction necessary on each and every pole to make a complete addition to the existing lines in accordance with the standards of construction which have been drawn up by the Assistant Distribution Engineer and approved by the Electrical Engineer in charge of the Bureau of Power and Light. Furthermore, changes to or removals of the existing distribution system are marked on the specification sheet, map or sketch. The authorization is them forwarded to the engineer in charge of estimating work.

The estimator makes up a complete price list of material installed and removed in accordance with current prices of materials and labor, from the specifications and the map made out in the field. All prices are totalled, adding percentages for supervision, supply and transportation, etc. A complete summary of the estimate is made on the original front sheet of the authorization, taking into consideration the material value and also the credit value for removing material, giving a total

of actual expenditure for the proposed extension. There are five copies of the front sheet made and distributed as follows: to the cost division, the general office, the distribution engineer and office engineer, the business office and the accounting department. From the front sheets are made special lists on colored paper, which are sent to the various divisions. Four colored copies of the material list go with the front sheet of authorization, the extra copies being for the warehouse and construction department; two copies of the credit sheet go to the cost division, warehouse and construction section; three copies of specification sheets are made up for office files and the use of the construction department.

A tracing is made from the sketch and sent to the field; all poles to be set, all wires to be strung, all construction to be placed on poles, are copied on the tracing from the specification sheet. The tracings are sent to the blue printers, prints are made from these, and later used in the field where the work is to be done.

After the authorization is typed it is forwarded to the engineering department of distribution, which approves of it from the viewpoint of the engineering work laid out. Then it is forwarded to the business office; the business agent approves of it according to expenditures necessary, against the revenue. Then it is forwarded to the cost accountant, who advocates the various expenditures according to his system of cost accounting. The authorization is forwarded to the Chief Electrical Engineer, who approves of it according to the general scheme of the entire Bureau of Power and Light. The authorization is then distributed to the various divisions.

An engineer's order is written by the general office of the distribution system, authorizing the construction engineer to proceed with

the construction work laid out and approved. After construction work is completed a notice is given to the Electrical Inspector, whereupon either he or his assistants make a field check of work reporting to the general office any irregularities in construction and deviation from standard construction, any violation of State law, of the Railroad Commission or of the Industrial Accident Commission. If there is any serious defect in construction reported by the inspector, the office engineer requests the construction section to make the changes so as to conform with the inspector's report.

Authorizations for sub-stations, both construction and reconstruction, are originated by the engineer in charge of sub-station design at the request of the Electrical Engineer or the Assistant Electrical Engineer in charge of electrical distribution. The engineer and estimator assisted by draftsmen under the engineer in charge of sub-station designs, make up a complete design and lay-out with an estimate of the cost of the work proposed and with a complete set of working blue-prints. The above authorization is typed and approved in practically the same manner as the authorization mentioned above. After it is approved an engineer's order is issued from the general office, authorizing the electrical foreman to install electrical equipment and to proceed with construction work as prescribed in blue prints and estimates. All inspection on this class of work is done by the Electrical Engineer in charge of distribution, and his assistants.

Power house design and construction, high voltage construction, distribution lines above 33,000 volts, are handled by the Construction Division Engineer in a manner similar to that for the sub-station work.

Purchasing - Procedure for all articles above $500.00

First, specifications must be made up consisting of information, an in-

struction for bidders, proposal, proposed schedule, specifications, detail specifications; specifications should contain a complete description giving all details in regard to quality of material, quality of workmanship, approved methods of testing materials, both raw and finished products, and quantity of material to be purchased under the award of contract. The specification has to be forwarded to the Chief Electrical Engineer for his approval. It is then presented to the Board for their approval. Then it is advertised in accordance with the city oridnance governing materials to be purchased. The specifications are mailed or delivered to all persons capable of delivering material desired. The Specification is filled out by bidders, giving all details as to price, discount, etc., requested in the specification and is then returned to the Board in a sealed envelope on or before a certain date and hour set by the Board, at which time the bids are opened. A complete tabulation of all bids is made up so as to give a just and legal comparison of prices, and all other information requested in the specification. The party originating the specification makes his recommendation to the Chief Electrical Engineer as to the party which, in his own judgement, should receive the award of the contract for material outlined in the specification. The Chief Electrical Engineer makes his recommendation to the Board, governed more or less by the party originating the specification, asking the Board to take the necessary steps of awarding a contract to the successful bidder. The contract is prepared by the Legal Department. After the contract is awarded, the general warehouse issues a requisition on the purchasing agent to issue the necessary purchase order for the delivery of the entire material or any portion of the material requested or specified. Thence it passes to the Accounting Department.

For smaller purchases or emergency the Assistant Electrical Engineer writes a requisition to the warehouse. The warehouse in return writes a requisition to the purchasing agent and advertises for bidders.

Proceedings necessary for an employee to receive his salary from the Bureau of Power and Light.

Time cards are made out, one for each day, stating the number of hours worked, the job number or authorization number. The time cards are then given to the time-keeper on the job, who checks according to number of hours and job or authorization number; the statement then approved by foreman in charge of the work, the cards are forwarded to the general timekeeper of the distribution division. He enters the number of hours worked on a time roll. The time roll consists of a sheet for each individual employee and at the end of each two weeks period, each sheet must be approved by the Electrical Engineer in charge of distribution, or his authorized assistants. The time roll is then forwarded to the Paymaster's Department which makes up a voucher or demand upon the City Treasury to be paid out of the Power Revenue Fund. The vouchers are forwarded to the Controller or Comptroller, who approves the voucher from the viewpoint of the Bureau of Power and Light. They are then forwarded to the Civil Service Commission which approves the vouchers according to whether an employee is legally entitled to the demand according to his record as filed in the Civil Service Commission. The vouchers are forwarded to the City Treasury, where they are approved as to the money on hand in the Power Revenue Fund. They are then returned to the Paymaster's Department for distribution and may be obtained by signing one's name to the list prepared for such. The vouchers may be cashed at any bank, at the Cashier's Division of the Department of Public Service or the City Treasury, and at last the employee receives his compensation by signing his name to the voucher.

VI. Question as to the Efficiency of the Organization and the Manner of Conducting the Business.

In the preceding pages I have dealt with the facts concerning the organization of the Bureau of Power and Light. It is an organization for the purpose of manufacturing a product which is sold for the benefit of the citizens of Los Angeles, for the convenience, happiness and usefulness of the ultimate consumers. It is a commercial business enterprise and as such there are definite principles governing it. The remainder of the problem is to show to what extent sound business policies are carried out in this enterprise.

There are two types of organizations that carry on the business of public utilities; one is private ownership, the other, municipal ownership. The means of showing the efficiency of one is by comparison of the results that have been obtained by the operation of each in the past. There always has been a great deal of discussion as to whether municipal ownership is more successful than private ownership from the point of view of the benefits derived by all concerned. That is a problem in political science and only that phase of it which is related to the organization will be treated here.

The question arises, What are the determining factors in the success of a utility company? Two main factors that deserve mentioning are: first, the service rendered the public, which involves the distribution of light and power, in this case, in the desired quantities, and at a reasonable rate of charge for the service; second, the financial status of the organization over a period of time, its permanency and reliability.

When the Power Bureau was organized in September, 1909, and the distribution system put into operation in April, 1917, it entered into

competition with the Southern California Gas and Electric Corporation and the Southern California Edison Company, both private utility companies. The one main thing in favor of the Bureau of Power and Light was the comparatively low original investment for the development of hydro-electric power. This (mentioned in a previous page) consisted of the construction of power houses and equipment transmission system and distribution system. The construction of the Aqueduct, reservoirs, etc, was financed by the Bureau of Water Works. Not only the first cost, but also the cost of operation of the municipal system, was low. This low cost of manufacturing electric power enabled the supplying of it at a low rate, which meant that the other two companies had to reduce their rates or suffer loss of business. The Edison Company could not supply power at the rate the city charged and make a profit; in fact it meant a loss to the company. Consequently, as a result the Edison Company sold their distribution system to the City in May, 1922. The Los Angeles Gas and Electric Corporation received permission from the Railroad Commissioners to cut their rates. They are still in the field supplying part of the inhabitants of Los Angeles with electrical power, and they remain the City's only competitor. However, condemnation proceedings are under way for the purchase of the Gas Company's steam power plant and distribution system.

It is an unquestionable fact that the municipal system supplies electric power at a very low rate, both for residential lighting and for commercial and industrial power, and also it can supply the power in large quantities for industrial purposes, a fact which is partly responsible for the great industrial growth and prosperity of Los Angeles. The following will convey an idea of the low rates in comparison with those of other cities and other companies. According to the research

of Mr Scattergood, the use of electricity in the average home amounts to 25 kilowatt hours per month. For that consumption the citizen of Los Angeles pays $1.41 under prevailing rates. Back in Boston, where the consumer is dependent upon the old line power and gas companies for service, and where the element of competitive municipal ownership has not entered into the field, the charge for the same service is $2.63, or nearly twice as much as the Los Angeles rate. In San Francisco, the rate for service is $1.80. The 39 cents differential between these two California cities may not appear as any great saving taken as an individual item, but, multiplied by the number of consumers, it meant that in the single year 1922, for instance, householders of Los Angeles under municipal ownership, paid $3,500,000 less for electrical fuel and light than did their neighbors of the sister city of the north.

The following taken from a report made by Mr Scattergood will show the benefits derived from municipal ownership. "Passing over those periods when the private power companies charged 12 1/2 cents and later 11 cents per kilowatt hour for their power before municipal ownership and operation became embedded in the city charter, the chronological history taken from the city records, of the steady decrease of power and light rates in the city is as follows:

"In 1910, the power rates of the private companies, including the Edison, were 9 cents per kilowatt hour. In 1910, the City Board of Public Utilities forced a cut to 7 cents. This was effected by ordinance July 1, 1910. The companies protested that the 7 cent rate would ruin them and be confiscatory. They offered to cut to 8 cents. But the ordinance became effective. The companies vainly threatened to kill the ordinance by litigation and it was in 1910 that the first power bonds were voted.

"July 1 1912 - Companies' rate cut to 6 1/2 cents per kilowatt hr

"July 1 1913 - Companies' rate cut to 6 cents per kilowatt hr

"July 1 1914 - Companies' rate cut to 5 1/2 cents per kilowatt hr and this rate remained in effect until October 11, 1920. Power bonds were voted in this year for generating plant and distribution lines.

"December 13, 1916 - City's Municipal Power rate initially fixed at 5 cents per kilowatt hour."

Due to a power shortage and a power corporation litigation against the Bureauof Power and Light in October, 1920, the City's rate was increased to 5.6 cents, which is the prevailing lighting rate, and the companies' rate to 6.2 cents.

"The Edison's rate was 6.2 cents when the city took over its power distribution lines and business here. Immediately the city reduced the rates to the former Edison patrons from the Edison rate, 6.2 cents, to the city's rate, 5.6 cents.

"But the influence of the City's public ownership enterprise also forced down the Edison's rates outside Los Angeles. From 1910 to about the middle of 1923, the Edison's rate outside this city was 9 cents for a total of about seven and one-half years; about 8 cents for two years or so, and 7 cents for about three and one-half years. The Edison's present 6.5 cent rate went into effect November 1923.

"Before Pasadena started her municipal power bureau, the Edison was charging better than 12 cents per kilowatt hour. Pasadena completely won her fight, driving the Edison out, and forcing the rate down to 5 cents.

The following schedules will show the quantities of electric energy which may be supplied and the respective rates:

COMMERCIAL POWER SCHEDULE

The following is a schedule of COMMERCIAL POWER RATES for electrical energy measured in KILOWATT HOURS CONSUMED IN ANY ONE MONTH:

For the first	100,	4.5 cents per K. W. H.
For the next	200,	4.0 cents per K. W. H.
For the next	200,	3.5 cents per K. W. H.
For the next	500,	2.7 cents per K. W. H.
For the next	500,	2.4 cents per K. W. H.
For the next	500,	1.8 cents per K. W. H.
For the next	1,000,	1.6 cents per K.W.H.
For the next	3,000,	1.2 cents per K. W. H.

For furnishing electric current for power purposes under the foregoing schedule, a minimum charge of fifty cents per month per horsepower of installed capacity shall be made; provided, that the minimum charge in any case shall not be less than One Dollar and Fifty Cents ($1.50) per month.

The above rates are applicable to any one consumer whose total monthly consumption, as recorded by meter, does not exceed 6,000 K.W.H. monthly.

NOTE:—IF THE MONTHLY CONSUMPTION FOR POWER EXCEEDS 6,000 K.W.H., the following INDUSTRIAL RATE applies:

INDUSTRIAL POWER SCHEDULE

The following is a schedule of INDUSTRIAL POWER RATES, for electrical energy measured in kilowatt hours consumed in any one month:

K.W.H.	Cents per K.W.H.	K.W.H.	Cents per K.W.H.
6,000	1.77	100,000	1.05
8,000	1.61	150,000	1.00
10,000	1.48	200,000	0.96
15,000	1.37	300,000	0.91
20,000	1.29	400,000	0.90
30,000	1.23	500,000	0.89
40,000	1.18	700,000	0.88
50,000	1.14	1,000,000	0.87
70,000	1.09	1,500,000 or more.	0.86

For intermediate kilowatt hour consumption there shall be charged the corresponding intermediate rate.

The above rates are applicable to any one consumer whose total monthly consumption, as recorded by meter, exceeds 6,000 K.W.H.; provided, that when the consumer's load factor exceeds thirty-five (35) per cent there shall be allowed a discount of one (1) per cent from the above rate for each two and one-half (2½) per cent increase of said load factor, said discount, however, not to exceed sixteen (16) per cent; provided, further, that the load factor of the consumer shall be determined from time to time by tests or shall be determined monthly by means of proper recording meters.

For furnishing electric current for power purposes under the foregoing schedule, a minimum charge of fifty (50) cents per month per horsepower of installed capacity shall be made.

For furnishing electric power to a consumer whose maximum demand during peak hours shall not exceed ten (10) per cent of his maximum demand during the month, the rate shall be in accordance with the schedules, less twenty (20) per cent. The peak hours shall be considered to be the hours between 4:30 P.M. and 9:30 P.M.

The above rates are applicable to Alternating Current service.

In districts where Direct Current is supplied an additional charge of 20 per cent is made to above light and power rates.

DOMESTIC AND COMMERCIAL LIGHTING RATES

The following is a schedule of DOMESTIC and COMMERCIAL LIGHTING RATES for electrical energy measured in kilowatt hours consumed in any one month:

For the first 100	5.6 cents per K. W. H.
For the next 150	5.3 cents per K. W. H.
For the next 250	4.8 cents per K. W. H.
For the next 500	4.1 cents per K. W. H.
For the next 1000	3.2 cents per K. W. H.
For the next 1000	2.4 cents per K. W. H.
For all in excess of 3000	2.0 cents per K.W.H.

This brings us up to the point, the principal bone of contention in the controversy: Do these rates take into consideration the actual cost of producing and distributing electric power, plus all operating and maintenance expenses and plus a reasonable amount for income or surplus? If these rates are not sufficient to pay all costs entering in, including the sinking fund for retirement and interest on the bond indebtedness, they are deceptive to the public, because the public or the taxpayer, who, in most instances, are the consumers of light or power, have to pay for the deficiency in the form of taxes. The bonds and interest have to be paid when they fall due and if there is not a sufficient allowance to account for these out of the earnings of the organization, they have to be met from the taxes paid by the taxpayers who supported the bonds. This is the weapon that municipal ownership may use in order to continue in business or to prevent its entering bankruptcy. The extent of indulgence in the use of this weapon determines the efficiency or inefficiency in operation.

The income from the rates charged for light and power, decides the earning capacity of the organization and this involves the second factor in determining the success of the utility company. It is a difficult task to get accurate figures that will prove the justice of the rates charged, due to the fact that uniformity in municipal accounting is lacking. The figures may be juggled, so as not to be representative of the true facts, and a city may boast of a great saving to taxpayers from reduction in rates by the competition of municipal ownership.

The Audit-Report prepared by the nationally famed public accountants, Price, Waterhouse & Company, declares and certifies that the accounts of Los Angeles City's Municipal Power and Light Bureau are correctly kept and show large surpluses of earnings despite their low

power and light rates. The following is a statement of the Power Bureau's Income Account for the past two years prepared by Price, Waterhouse and Company.

CITY OF LOS ANGELES

Department of Public Service

Bureau of Power and Light

INCOME ACCOUNT

For the Two Years Ending June 30, 1923

	1922	1923
Income:		
Gross revenue from power distributed under agreement with the Southern California Edison Company	$5,230,717.92	
Municpal lighting	202,584.88	$ 539,121.82
Municipal power	51,369.62	109,569.89
Other municipalities	42,210.02	35,438.58
Commercial lighting	718,194.11	4,662,832.66
Commercial power	626,953.64	2,346,454.95
Miscellaneous	8,910.55	69,189.07
	$6,880,940.74	$7,762,606.97
Deduct: Expenses:		
Production	$ 127,326.84	$ 143,500.46
Transmission	79,397.78	62,275.31
Power purchased	967,659.91	1,204,798.11
Expenses in connection with power distributed by Department:		
Distribution	327,955.69	1,099,220.83
Commercial	131,865.22	458,624.86
Expenses in connection with power distributed under agreement with the Southern California Edison Company:		
Distribution and other expenses	965,975.72	
Taxes	375,278.28	
General expenses	272,401.56	470,635.76
	$3,247,861.00	$3,439,055.33
Deduct:	$3,633,079.74	$4,323,551.64
Interest and depreciation allowances paid under agreement with the Southern California Edison Company:		
Interest	$ 768,596.27	
Depreciation	281,370.45	
Interest on bonds (less proportion of bond premium amortized)	419,780.17	$ 994,331.00
Other interest	13,135.53	13,568.30
Provision for depreciation of plant and equipment	176,593.82	622,029.00
Fire losses	49,353.61	
	$1,708,829.85	$1,629,928.30
Net Income	$1,924,249.89	$2,693,623.34

The account given above shows the earning capacity of the Bureau of Power and Light for the past two years. The following prepared by

the same auditors, shows the standing of the Power Bureau in regard to the taxpayers.

Investment of the City of Los Angeles:

Details of the changes in this account during the period under review are reflected in the attached balance sheet and a summary of the balance at June 30, 1923, is as follows:

Payments by City from proceeds of taxation:		
Appropriation for preliminary investigations, etc...	$ 80,010.39	
Bonds redeemed.....	2,200,000.00	
Interest on bonds.....	4,112,525.50	
	$6,392,535.89	
Less: Payments into City Treasury by the Bureau....	$2,839,692.00	$3,552,843.89
Surplus arising from operations of the Bureau for the period from March 31, 1917, to June 30, 1923.....		6,423,203.76
		$9,976,047.65

The figures taken from the same report are interesting in regard to the benefits derived by Municipal Ownership. Since the Bureau began operation in September 1909, the saving in rates to taxpayers - consumers - amounted to $20,000,000. The Bureau's assets exceed its liabilities by more than $10,000,000, showing the net worth of the organization during the few years of operation.

The total assets of the municipally owned Bureau of Public Service are as follows:

Bureau of Water Works and Supply	$63,794,341.04
Bureau of Power and Light	35,340,448.88
Total assets	$99,134,789.92

A few wordsmay be said at this point about the management of the organization, because, after all the financial standing is dependent upon its management. The degree of success of any business depends upon the manner in which it is managed. The executives and the employees are responsible for the working together or cooperation within the organization to make it function as a whole and to produce the results desired. The efficiency attained is due to knowledge, the skill and training of

the executives and the employees. In theory the municipal organization should acquire, by means of the Civil Service, men as well trained and fitted for their respective places, as those of a private organization. In practice this does not hold true; in a private organization there are trained executives, well paid for their services, who select and choose their employees, thereby attaining more efficiency in the management from top to bottom of the scale of employees.

The Bureau of Public Service, being a municipal organization, gets its employees thru the Civil Service. Consequently, its employees are in some instances, inferior, compared with those in private organizations and furthermore the lack of centralized authority in some of the departments in the organization and the so-called "red tape", all tend to a certain extent, to increase the inefficiency in the operation of the various departments. On the other hand the Bureau of Public Service fortunately has some earnest, conscientious and capable men in its organization; the business within the organization is carried on with by far a greater efficiency than is generally found in a municipal business enterprise, due principally to the supervision and management of the engineers, Mr Mulholland and Mr Scattergood.

There is one phase of the Bureau of Public Service that it is well to emphasize and that is the supervision of the two burueaus, the Water Bureau and the Power Bureau, by well qualified engineers. The reason for the importance of this fact is the elimination of political influence and the permanent supervision by the Chief Engineers in charge. These engineers are well paid for their services. They are in reality the executive heads of the two Bureaus, with the exception that their policies and plans must be submitted to the Board of Public Service Commissioners for the Commissioners' judgement and decisions.

VII. The Writer's Own Views.

The previous sections have shown the organization of the Bureau of Power and Light, what it has to sell and the operation of it as a Municipal Utility Company, and also the results of the operations since its inception. In my estimation it is a going concern, considering the benefits derived by supplying cheap light and power, and the earning capacity of the organization. Furthermore, the various situations in which the Power Bureau has been placed have been a detriment and a handicap in preventing it from being a more successful organization. It has had to fight its way all along the line; for instance, every bond issue has been bought by private interests.

The diffcult position the Power Bureau is in today is due to the failure of the support of the bond issue last spring by the citizens of Los Angeles. However, this was a fault of the Bureau of Power and Light; it asked for $35,000,000 of bonds; $25,000,000 for the Boulder Canyon project and $10,000,000 for improvements and extensions. The Boulder Canyon Project at that time was under litigation, nobody knew what the outcome would be. That amount of money without definite plans as to its expenditure, coupled with the publicity of private interests, merely scared the people out of voting in favor of the bonds. Had the Bureau asked for a reasonable amount for improvements and extensions, or possibly an amount for a well planned scheme of power development in the Kings River district, no doubt the situation would be different today.

Consequently, the Power Bureau has had to draw heavily from its surplus in order to meet the demands for improvements and extensions, which has left the treasury short of funds. A private organization can sell stocks and bonds whenever it desires, to obtain additional capital with which to go ahead with improvements. On the other hand a municipal

organization depends upon the good will of the people to vote its bonds for additional capital. When this fails its only means of increasing its business is to draw upon its surplus. This is a good thing in one sense of the word, in that there is no mortgage on the increase of assets of the business. Using money from the surplus to increase the business can be overdone and this is the cause of the present situation of the Power Bureau. Furthermore a power and light utility company requires a great deal of capital for its improvements and extensions and power development, especially so for a rapidly growing city like Los Angeles.

A municipal organization assumes the responsibility of supplying the needs of the city with electric power. Los Angeles is growing at the rate of 100,000 per year, and this, in turn increases the demands for light and power. The Bureau of Power and Light has met some of this demand by buying electric power from the Edison Company. At the present time it is purchasing about 42 percent of the city's power output. The cost for Edison power is twice what the city could generate it. If the city could develop more electric power it would save this extra amount paid the Edison Company and add a further increase to its earnings.

The solution of the problem as I see it, is for the city to gain and keep the good will of the citizens of Los Angeles; to present to them the present situation and the need for a steam generating plant to meet immediate need, which can be used later on as a standby plant in case of water shortage, and also the need of new extensions on the distribution system. Furthermore it should submit a reasonable amount of bonds for the approval by the people in the coming election, this amount to be sufficient to cover the absolute necessary needs of the Bureau of Power and Light.

I have mentioned before in the thesis that the Condemnation Proceedings are under way for obtaining the steam generating plant and dis-

tribution system of the Los Angeles Gas and Electric Corporation. This system tied in with the present system of the Bureau of Power and Light would increase its capacity to help meet the demands for power and light by supplying the needed steam plant. To have two distribution systems in the city, one in competition with the other, is not economical to the city. For instance, two systems on one street require an unnecessary amount of material, poles, lines, etc., and cause confusion in service to the people on the street. While the city of Los Angeles has its present extensive and fairly efficient municipal organization I believe it to be the best policy for supplying light and power under the one system and to the advantage of the people.

There is no doubt in the minds of most people, but that the Bureau of Power and Light has been a good thing for the city of Los Angeles. It has supplied cheap power and light and it has made a good showing in its earnings. The Power Bureau should be enjoying the benefits from the prosperity of the city by increasing its earnings from the increased demands for power and light. If the Power Bureau goes at it in the right attitude of giving service to the people, I believe it will eventually win out. If the interests of the citizens are best served and the greatest good to the greatest number secured by the Bureau of Power and Light, that plan, regardless of minor considerations or of personal interests, will prevail.

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