

REPORT
OF THE
COMMITTEE OF ENQUIRY
INTO THE
PROPOSED EXTENSIONS
OF THE
GANGES CANAL HYDRO-ELECTRIC GRID.

JANUARY 1934.



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PRINTED AT THE ADVERTISER PRESS,

SAHARANPUR.

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CHAPTER I.

Introductory.

1. The Ganges Grid Extension Enquiry Committee consisting of the following members was appointed by the Government of the United Provinces to scrutinise the estimates of capital expenditure, working expenses and revenue of the contemplated expansion of the Ganges Canal Hydro Electric Scheme:—

- | | |
|--|-----------------------|
| 1. Major H. G. Howard, M.C., Chief Engineer, Electricity, Madras. | ... <i>Chairman.</i> |
| 2. B. M. Staig, Esquire, I. C. S., Financial Adviser P.W. D. and Secretary to Government, Punjab, Electricity. | } <i>Members.</i> |
| 3. A. S. Trollip, Esquire, Deputy General Manager of the Bombay Electric Supply and Tramways Company, Bombay. | |
| 4. Rai Rajeshwar Bali Sahib, O. B. E., M. L. C. | |
| 5. Khan Bahadur Haji Mohammad Obaidur Rahman Khan Sahib, M. L. C. | |
| 6. A. C. Mitra, Esquire, I. S. E. | ... <i>Secretary.</i> |

2. Its terms of reference were as follows:—

(1) To scrutinise and report on the Chief Engineer's estimates of cost of the expansion of the scheme as outlined in Chapter VI (revised) of the Grid Project Report in the light of the actual capital cost of the completed first stage of the scheme.

(2) To examine the tabulated data of revenue from the sale of electricity in bulk up to date for domestic, industrial and agricultural loads, and in the light of these statistics to scrutinise and report on the departmental estimates of expansion of load as forecasted in chapter VI of the Report.

(3) To compare the terms of sale of electricity in the grid area with those existing in other licences in the United Provinces, especially with regard to the sale of industrial and agricultural power.

(4) To examine the departmental records as regards the cost of establishment and maintenance, and to report on the relation of the annual charges to the capital cost and earning power of the scheme.

3. The Committee assembled at Roorkee on the 4th January 1934. The 4th and 5th were spent in preliminary discussions and visits to the generating station at Bahadurabad and various industrial enterprises at Saharanpur. On the 6th the Committee proceeded to Meerut, visiting Bholra power station and Muzaffarnagar on the way. At Meerut on the 7th the Committee visited several farms, where tube wells both State and private had been installed, accompanied by the Commissioner of the division and the local officers of the Hydro Electric Branch, and had the advantage of helpful discussion with the Commissioner and the Collector as to the benefits already secured from the Grid scheme generally. The Committee then proceeded to Moradabad via Hapur and the following day visited several of the tube wells of Moradabad district and took the evidence of the Collector, the Director and the Deputy Director of Agriculture, the Sugar Technologist to the Government of India and Lala Har Sahai Gupta, a local zamindar interested in tube well enterprise. The Committee returned to Roorkee on the 9th visiting the Ramganga pumping station on the way. The 10th, 11th and 12th were spent in discussion and preparation of this report and in interviews with the Agricultural Engineer and Mr. Duke of the Industries Department. The Chief Engineer, Irrigation, accompanied

(2)

the Committee throughout, and he and his officers, both of the Hydel and Irrigation Branches have constantly assisted the Committee with information, written and oral.

4. The Committee has been somewhat handicapped by the fact that the time available to the members coming from outside the United Provinces had to be strictly limited in the interests of their respective employers. It was therefore impossible to prepare a very elaborate report or study the scheme in minute detail, but the general conclusions reached in the following paragraphs have been arrived at after the fullest consideration of the broad technical, administrative and financial issues included in our terms of reference.

CHAPTER II.

The Scheme and the Cost of the Works.

5. The Chief Engineer has submitted a comprehensive scheme of hydro-electric development from the Ganges Canal over a period of 18 years. The construction programme is to be in seven stages of which the greater part of the first stage has been completed and in successful operation since 1931. The remaining portion of stage I is expected to be completed by April 1935. The scheme is to be developed parallel with the load so that the programme may be retarded or accelerated in accordance with actual load conditions and unproductive capital expenditure avoided. Map No. 1 shows the layout of the first stage and Map No. 2 the ultimate system as now projected by the Chief Engineer.

6. We are of the opinion that the scheme is fundamentally sound from both the economic and technical points of view. Commendable foresight has been shown in its preparation. The difficulties however of forecasting, with any degree of accuracy, the load conditions which may exist in the hydro-electric area over a period of 18 years are obvious; so many factors may tend to improve or render less favourable the figures now submitted. Varying world economic conditions, an abnormal industrial development, due to a policy of State subsidies, an unexpected general demand for a particular product, or a prolonged period of abnormal cold weather, rainfall or drought, are among the factors which may tend to modify the load forecast. As already noted, a favourable feature of the whole scheme is that each stage is to be financially proved before proceeding with the next. Heavy and risky capital expenditure is thus avoided. At the same time a sufficient margin between generating capacity and demand should always be maintained to provide reasonably for unexpected demands. For this provision has been made. The present margin between demand and effective capacity is, however, somewhat close and is discussed elsewhere in the report.

7. Beyond the above comments, it is proposed to confine our examination to the programme laid down for the next five years, this period being considered the maximum over which it is feasible to advance any useful opinion.

POWER GENERATING PLANT.

8. It is observed that the generating plants, already in operation or under construction, are essentially base load plants and designed to take the minimum flow of the canal, hence the maximum economic value of each plant is at 100 per cent load factor. Such a system load factor is not attainable in practice. It is understood that the minimum flow occurs in the months of January, February and March, while considerably higher flows may be expected during the other months of the year. The system load curve at present shows that the highest demand for power is outside the months of minimum flow, and this condition may become even more pronounced if agricultural load and other industries are developed as projected. Having the above in mind it is believed that if the question of special provision for peak load is studied, the economic value of the scheme may be increased, by lowering the cost per effective K. W. installed.

9. Before dealing with projected plants the effective plant capacity to meet load demands of the immediate future may be examined. The allocation of spare generating capacity in a power system is admittedly a matter of policy, but it will be found invariably that an operating Engineer will tend to demand more spare capacity, as a measure of extreme precaution, than is economically justified. In the case of the system under review the installed capacity under Stage I is to be 8900 K.W. but of this no less than 4 generating sets totalling 2400 K.W. are set aside as standby plant, and each of these sets is a valuable base load unit. Partially to offset this, a credit of 1000 K.W. of old oil engine plant and 10 per cent overload capacity on the effective plant is taken. In the first place 10 per cent overload capacity cannot be taken advantage of in a plant

designed for minimum flow, except as a percentage spare for a particular unit in that plant. Water is not always available for the overload capacity of a particular plant to act as a system standby.

10. In view of the satisfactory operation of the generating plants to date we would recommend that the effective generating capacity of Stage I be increased by the provision of fewer base load units for standby purposes, and utilising the overload capacity of each set as a plant standby. The situation may be more clearly set out as follows:—

STAGE I.

	Installed capacity.	Reserved as spares.	Over-load capacity without water.	Oil.	Total effective capacity.
(a) As proposed by the Chief Engineer	K.W. 8900	K.W. *2400	K.W. 650	K.W. 1000	K.W. 8150
(b) As proposed by the Com- mittee	8900	†1000 ‡790	....	1000	8900

† 1 set of 1000 K.W.
or 1 set of 600 K.W.
and 1 set of 375 for
system spares.

* 1 set of 1000 K.W.
2 sets of 600 "
1 set of 200 "

‡ Overload capacity
for plant spare.

11. If the above distribution is accepted the effective generating capacity of stage I may be increased from 8150 to 8900 or by 750 K. W., which would materially improve its earning power. This should result in an increase in the potential earning power and a short postponement of the next construction stage with a corresponding saving in interest charges.

12. We now propose to consider this important point with reference to the design of future generating plants. In the case of Salawa we would recommend that careful thought be given to the installation of 3 sets of 1500 K.W. instead of two. The third set would be used as a spare for its own plant during the minimum flow period—a matter of 3 months only—and as a peak load unit during the rest of the year when, as already shown, the highest demand occurs. As this unit will release base load generating capacity, the extra cost of the set is easily justified. It is also believed that careful study will show that a certain peak load capacity may be obtained during low water periods by backing up the water to the crest of the nearest surplus weir and taking advantage of the increased head and extra pondage, if necessary, by raising the canal banks which, we understand, has been successfully done at Sumera to the extent of as much as 7 feet. It has been observed that this might cause silting in the canal by lowering the velocity but such a condition would appear unlikely. The backing up would only be carried out just before the daily peak while the velocity of the water near the bed of the canal would be increased during this peak load period and prevent silting.

13. The system load should continue to be developed with the object of throwing as much load as possible outside the low water period so that full advantage may be taken of peak power. If this is done and if the above suggestions in regard to Salawa are adopted, it would appear from the load forecast that no other generating station beyond Salawa will be needed during the next five years, unless an unforeseen extension in load occurs. This would result in improved earning capacity and a saving in fixed charges by the postponement of capital expenditure on new works.

14. A statement of installed, effective and spare generating capacity may be set out as follows:—

STAGE II. (To 31st March 1938).

	Installed.	Spare.	Oil.	Overload capacity.	Total effective capacity.
(a) As proposed by Chief Engineer ...	K. W. 11,900	K. W. 3275	1000	K. W. 862	K. W. 10487
(b) As proposed by Committee ..	13,400	(i) 1500 (ii) 600 (iii) 1130	—	—	11,300

The above allows (i) one 1500 K.W. set as a complete base or peak load spare outside of the low water period and as a plant spare during the low water period, with the possibility of a certain proportion of that capacity being used for base or peak loads during that period as already explained (ii) 600 K.W. which may be used as a system standby at all times and (iii) 1130 K.W. which represents overload capacity.

15. It will be noted that in our proposals no account has been taken of the oil engine generating sets. Power generated from the existing oil engines forms an increasingly small proportion of the total power. Some of the engines are not new, and the cost of generation is probably high compared with hydro-electric power. It seems to us therefore that where an oil engine standby plant is not specified in existing agreements, it would be more economical to sell or scrap the plant and avoid the expense of maintenance. If importance is attached to the oil engine standby then it could be substituted economically by the steam plant referred to in the next paragraph.

16. Once Salawa is in operation, careful study should be given to the economic feasibility of the installation of a steam turbine station in the southern area of the grid—possibly near Sumera—before proceeding with the construction of a new hydro-electric plant in the north. The following points should be taken into account in this connection :—

- (a) The importance of such a steam station from the point of view of the load density of the grid area and as a standby plant in the south.
- (b) The probable saving in transmission lines.
- (c) The value of such a steam station as a low load factor plant and the possibility of operating all hydro-stations as near 100 per cent load factor as practicable. Economy in transmission and generation cost might also be obtained by entering into a working arrangement with the Agra Electric Supply Company or similar concerns for interchange of power. The proposal may not prove to be feasible but deserves consideration.

17. It is believed that the above suggestions are worthy of careful study and, if given effect to, will result, as already noted, in increasing appreciably the generating capacity of the system and decreasing the cost per installed effective kilowatt.

18. We observe that the system peak now approaches closely the effective generating capacity and that it would be difficult to meet any unexpected power requirements around 1000 K.W.—a not improbable event—which conceivably might be caused by the breakdown of a large factory plant or the addition of a new one. We have no doubt whatever that in the interests of conserving and increasing revenue, Government will readily and promptly provide any funds necessary to enable load requirements to be anticipated and avoid delays in a profitable construction programme.

TRANSMISSION LINES.

19. The question has been raised as to the ultimate necessity of a 66 K.V. transmission system. After a tour over the grid area it appeared to us that if the load develops as anticipated, it will be distributed over the whole grid area and the present

37.5 K. V. lines will gradually develop into primary distribution lines. To transmit large blocks of power from the generating stations in the north to important distributing centres in the south, additional lines of higher voltage will be necessary. In this connection a very careful study of load conditions should be made before any expenditure is incurred on 66 K.V. lines.

20. In view of the design of the Grid system and the facility of feeding many important points from two or more sources of supply, the proposal to construct single circuit instead of double circuit 66 K. V. lines at the outset when required is to be commended. It is not practicable to advance any definite opinion as to what lines should or should not be constructed during the five year period and it is even less desirable to comment on the programme of line construction for the ultimate scheme, but it would appear that if the distribution of new load follows the general lines forecasted, it is quite possible that it will not be found necessary to construct any 66 K.V. lines during the five year period, except a single circuit line between Salawa, Bhola, Bulanshahr and Sumera and this may be operated initially at 37.5 K. V. with a duplication of the 37.5 K.V. lines from Bhola to Dasna as already projected. Another line from the Ramganga pumping stations to Moradabad will be needed at some future date and may also be operated at 37.5 K.V. initially forming part of the 66 K.V. system eventually. It does not appear that the construction of this line will fall within the five year period. This is merely conjecture and obviously depends upon the manner in which the load develops, but it is a possibility which should not be ignored since it would involve an appreciable reduction in the estimated capital expenditure. New lines should, as far as economically feasible, follow existing routes in order that the maintenance and operation costs may be kept at a minimum. As the lines become more heavily loaded, the installation of feeder voltage regulators might be found economically justified at certain important points and the construction of new 66 K.V. lines postponed.

21. In a system where higher transmission voltages are contemplated, appreciable economy may often be effected by ordering all large power transformers with high tension coils for the two voltages. No new transformers might be needed when the voltage was raised while the number of system spares could be reduced. For instance, the Salawa transformers may be operated initially at 37.5 K.V. while all new large transformers at Bhola, Moradabad and other important points likely to form part of the future 66 K.V. system might be specified with the two H.T. tappings.

ESTIMATES.

22. The estimates of the work as submitted by the Chief Engineer have been examined and on the basis of recent works expenditure they appear reasonable as a whole. In view however of probable changes in prices, exchange variations etc., they should be frequently checked and the whole financial structure of the scheme examined in the light of changing economic conditions. It is presumed however that a marked rise in prices of plant and equipment would justify an increase in tariffs—if found necessary—and the economic balance would be restored.

23. If our suggestions regarding a third unit at Salawa are accepted the estimate for that station will have to be increased by about Rs. 4,50,000 but, on the other hand, we expect the expenditure on transmission lines to be less than estimated. The additional investment in generating capacity will be more than compensated for by the increased earning power of the system as already explained, involving, as the proposal does, an addition of nearly 1000 K.W. to the effective generating capacity of the system.

24. The average cost—less overhead and general charges—of the rural lines has been estimated at Rs, 1800 per mile. This is a figure which has not been attained anywhere else in India as far as we are aware, but the departmental records show that this cost has actually been achieved for 150 miles of line constructed departmentally. We understand that all short 11 K. V. taps are to be constructed with steel wire which will tend to keep the cost down, while the ground wire on these lines might be excluded as it

has not been found necessary in many other parts of the country. Taking the future 11 K.V. network as a whole it is possible that the average cost may work out a little higher than Rs. 1800 per mile.

25. We have no observations to make on the plant and substation estimates; the provision seems to be adequate for the installations contemplated and all supplementary items, so often omitted from preliminary estimates of this character, have been included. No contingent percentage seems to be allowed but as there is every reason to believe that the actual overhead charges will be less than estimated, this may not prove of any consequence.

26. Generally speaking the estimates inspire confidence as it would appear that in all cases involving expenditure, when doubt has arisen, the provision has been on a liberal basis. Furthermore, the designs and layout of the future system indicate that full advantage has been taken of any recent improvements in power plant and transmission line engineering which might be utilized.

27. If a cheap rural power service is to be given it is of the highest importance that the cost of extensions, connections and transformer stations should be a minimum and we have noted that not only is the design of these lines as economical as it is possible to suggest, but there is a tendency to utilize small fittings and equipment manufactured locally instead of importing them. This is welcome, and further possibilities in this direction are, we believe, being examined.

28. We are assured that in the past every effort has been made to secure the most efficient plant at the lowest possible price and in the course of our tours, we had evidence to this effect. We welcome this and hope that this policy will continue.

GENERAL.

29. The expenditure on the widespread transmission and distribution systems is naturally high compared with that incurred on the generating plants. It is of the highest importance therefore that all possible load be developed within the present Grid area and the lines loaded up before adventures, by means of new line extensions, are made outside the area. When such extensions are considered desirable it should be carefully seen that the new capital expenditure does not affect adversely the financial structure of the scheme as originally planned. It is not enough to take an arbitrary percentage return. The annual cost should be ascertained from year to year and the operating ratio taken into account. As an example, if the operating ratio of the system is 40 per cent then only 60 per cent of the gross revenue is available for fixed charges. If these charges amount to 7 per cent then 60 per cent of gross revenue = 7 per cent of capital from which $\frac{7}{60} R = \frac{7}{60} C$ or $C = \frac{60}{7} R$ and it may be taken as a general guide that the capital expenditure on an extension should not exceed $\frac{60}{7}$ or 8.5 times the gross annual revenue.

30. As a basis for ascertaining the financial results of the scheme, we accept the Chief Engineer's estimate of Rs. 202,65,000 as safe on the basis of present prices to cover all capital expenditure necessary to complete stage II of the Chief Engineer's programme which includes the construction of Salawa and the necessary lines. This means further capital expenditure of approximately Rs. 37 lacs beyond the cost of completing the first stage as now planned. Within this cost it may prove possible to include the third generating set at Salawa, as we believe that the examination of our suggestions for economy will result in equivalent savings in expenditure particularly on high voltage transmission lines.

CHAPTER III.

Working Expenses.

ESTABLISHMENT.

31. The estimate of establishment chargeable to the working expenses shown in column 8 of the general abstract of financial results (Appendix A) is arrived at after deducting from the total estimated cost of establishment for construction and operation, the establishment chargeable to the former. In accordance with the procedure prescribed by the accounts authorities establishment charged to capital is taken at 20 per cent of the actual cost of works excluding plant and equipment plus 11 per cent of the cost of plant and equipment. In consequence, as will be seen from a perusal of the figures year by year, the establishment charged to working expenses varies somewhat arbitrarily according to the amount of capital expenditure on works, and the figures given cannot be taken as a true reflection of the share of total establishment genuinely chargeable to operation. The latter could only be arrived at if construction establishment could be entirely separated from operation. This is not feasible at least in the higher gazetted posts, though from Assistant Engineers downwards it might be practicable definitely to allot certain officers to construction and others to maintenance. In the circumstances any detailed examination of the figures shown in column 8 of the statement would serve no useful purpose. We have therefore considered, mainly, the establishment chart reproduced as Appendix B, which shows the existing organization and, generally, the Chief Engineer's estimate of approximately Rs. 9 lakhs of total establishment in 1948-49.

32. The total cost of establishment including operating staff for the year 1932-33 was Rs. 5,28,000, of which on the basis indicated above Rs. 4.6 lakhs was charged to revenue and '68 lakhs to capital. For 1933-34, of a total estimated establishment cost of Rs. 5.07 lakhs 3.39 lakhs are estimated as chargeable to revenue and 1.68 lakhs to capital. In 1948-49 of the total establishment cost of 9.06 lakhs Rs. 8.59 lakhs is estimated as charged to revenue and '46 to capital.

33. In regard to gazetted establishment while the portion of the pay of the Chief Engineer, Irrigation, and his office staff debited to the project is small in relation to the calls which it makes on his time, the total cost of direction establishment is high. The strength of other posts consisting *inter alia* of a Superintending Engineer and 4 Executive Engineers is, we consider, liberal, and we suggest that the possibility of a reduction here should be carefully examined. We are satisfied that the non-gazetted operating establishment including clerical posts is economic both in regard to the rates of pay and the number of men employed.

34. On a general establishment matter the Committee invites the attention of Government to the desirability of securing a steady flow of recruits to fill the posts of various categories up to the highest required for the operation of the project and suggests that with this object in view facilities should be readily given by way of State scholarships and study leave to young Indians of promise to enable them to obtain abroad the necessary technical qualifications and experience.

35. We have considered the possibility of reducing expenditure on establishment by combining the functions of Irrigation and Hydro-electric Engineers in the superior executive posts. After hearing the Chief Engineer's views we are inclined to the conclusion that this is not practicable in view particularly of the necessity for regular touring on the part of his Irrigation officers, who are, we understand, absent from head-quarters for 20 days in each month and who are not therefore in a position efficiently to supervise hydro-electric operation. Any economy feasible must therefore, we feel, be effected within the existing hydel organization. We may add that we are firmly of the opinion that as the power is generated from canal falls the supreme control of the scheme must always be vested in the Irrigation Department irrespective of the rank of the highest Hydro-electric Engineer engaged in its administration.

36. In this connection we have all been greatly impressed by the amount of labour, thought and energy devoted by the present Chief Engineer to every aspect of the project in addition to his duties as Chief Engineer of the Western Canals. We doubt if, ordinarily, Government can expect the same degree of industry and devotion to the interests of the hydro-electric project from every officer responsible, in addition, for the administration of a large irrigation system, and we venture to bring to the notice of Government the necessity for timely consideration of the superior organization necessary to operate the hydro-electric project when Mr. Stampe's services are no longer available.

37. In connection with certain power houses yet to be constructed the question was raised of the possibility of reducing operating cost by "remote control." It was understood that this had been considered with reference to the Umera and Palra power houses and finally ruled out in the view that the interest charges on the capital cost of the underground cables, which were deemed essential for continuity of supply, would substantially exceed the cost of the low paid establishment required to run the power houses separately. We recommend that the feasibility of "remote control" should be again carefully examined in connection with any power houses that may be constructed in the future.

38. The Chief Engineer's estimate of Rs. 9'06 lakhs as the cost of establishment in 1948-49 chargeable mainly to revenue must necessarily be speculative. It provides for a re-organization of establishment on a functional instead of a territorial basis. The superior posts include one post of a Superintending Engineer and one post of an Executive Engineer in addition to existing posts of that rank. Our present concern with it is primarily to see that it is not an under estimate and on this point we are satisfied. We note that the pay of some of the higher posts included in the detailed estimate by the Chief Engineer is taken at the old rates whereas the probability is that the incumbents at that date will be on the reduced scales now being devised for superior services. Any savings on the estimate arising from this source will improve the financial prospects of the scheme.

DEPRECIATION.

39. The Chief Engineer's estimate under this head in column 10 of the general abstract of financial results provides for no depreciation in the first two years of operation. From 1934-35 however depreciation is charged at an increased rate and this rate is applied not only to the plant and equipment purchased prior to 1934-35, but also to the purchases of any subsequent year. This errs on the safe side. The omission of depreciation from the calculation of working expenses up to even 5 years in such projects is permissible in the light of commercial practice for similar schemes and there is no objection to the two years period adopted in the present case. The lives assumed for various items of plant and equipment are reasonable. In the case of transmission lines the poles of which are made of Tata rails, the provision is very liberal. Our conclusion is that the provision for depreciation as a whole is satisfactory with reference to the prices of plant and equipment now obtaining. Its adequacy should however be examined at least every three years in the light of the estimated cost of replacement of the plant at rates then in force.

MAINTENANCE AND REPAIRS.

40. The figures in column 9 of the general abstract of financial results relating to maintenance and repairs are, for 1932-33 the expenditure actually incurred, for 1933-34 and 1934-35, the revised and budget estimates respectively and for subsequent years they are based partly on a percentage of capital cost for maintenance of certain specific items and partly on lump sum provision for unforeseen special repairs, telephone charges, rebates to licencees, etc. Telephone charges payable to the Government of India at ordinary rates amount at present to Rs. 66,000 per annum, and the possibility of obtaining concessional rates in view of the magnitude of the undertaking should be investigated. It will be noticed that the figures based on percentages etc. show a distinct increase

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on those provided for earlier years. They are in our opinion on generous lines, and the Chief Engineer stated that he had so framed them deliberately. We agree that they are not an underestimate.

OPERATING RATIO.

41. We note that the total working expenses in column 12 of the statement in 1934-35 are estimated at Rs. 8'65 lakhs against gross revenue of Rs. 16'67 lakhs, i.e., the operating ratio is over 50 per cent. Bearing in mind that the project will then be only in its 3rd year of operation and that a proportion of the capital outlay on which the estimate for the year is based will not have begun to be remunerative, the percentage may perhaps be accepted, but the objective constantly in view should be to reduce the operating ratio to approximately 35 per cent, this being considered a maximum figure after making due allowance for the nature of the project with particular reference to its separate generating stations.

CHAPTER IV.

Tariffs and Load Development.

42. Appendix C shows in a convenient form:—

- (a) Hydel wholesale rates to Licensees.
- (b) Licensees' retail rates to consumers.

We have examined a table reproduced as Appendix D prepared by the Chief Engineer in which he compares Hydel rates to consumers with those of other licensees for the same classes of load. In most cases Hydel rates compare favourably and in our opinion they are attractive to consumers.

43. We now comment on the respective rates in turn:—

(a) DOMESTIC LIGHTING.

From the evidence before us it appears that the existing rates are still attracting business. They are flat rates with a discount for prompt payment. This discount is a very desirable feature of the tariff as otherwise the cost of collection in so widely scattered an area would increase considerably. For the ultimate development of this load we are of the opinion that it will be necessary, as the saturation point at any particular rate is reached, to reduce the rate by stages of $\frac{1}{2}$ an anna to an ultimate maximum nett rate of about $4\frac{1}{2}$ annas per unit to the consumer.

In the development of this load we would emphasize the importance of Government's electrifying its own buildings—a step which would, we believe, be economical and would be an excellent measure of propaganda in keeping before the residents of the Hydel area the advantages of electricity.

(b) STREET LIGHTING.

Of the 70 towns in the Hydel area, 58 have already lighted their streets with electricity. The rates quoted to the respective municipalities for this class of load appear to us to be, in comparison with corresponding schemes, somewhat high. Street lighting at attractive rates is a valuable factor in developing the use of electricity for domestic lighting and other purposes, and we recommend that these rates be reviewed and amended if possible.

(c) DOMESTIC POWER.

The retail rate of annas 3 per unit proposed for this class of load is in our opinion too high to attract business. From our experience we would suggest a maximum rate of annas $1\frac{1}{2}$. The directions in which this load may possibly develop are for domestic refrigerators, water heating on the storage principle and room heating.

The refrigerator and water heating load can be best developed by the licensee hiring out the respective appliances to consumers.

We would suggest that, in the larger towns, the licensees should equip small show rooms with representative apparatus with which to demonstrate to the potential user the benefits of electricity.

(d) AGRICULTURAL AND TUBE-WELL RATE.

It has been observed that the Hydel rate to the Irrigation Department for State tube-wells is 7 pies per unit whereas the corresponding rate to the private tube-well owner is 12 pies per unit. Though this differentiation may have been justifiable in the past, we should like to suggest that in the absence of any reason for placing the agriculturist in a less favourable position vis-a-vis Hydel than the Irrigation branch, the same tariff should be applied to both consumers in the form of a sliding scale in steps of 500

hours use per year, and varying from a maximum of one anna per unit up to 1,000 hours usage to 7 pies for 2,500 hours or more. If the financial results in the early years of operation of the hydro scheme indicated the necessity of raising the tariff and with it the irrigation rate charged to the cultivator, we are of opinion, from impressions gained on our tour, that this could be done without affecting the sales of water and the interests of the cultivator. This is also the opinion of the Commissioner of the Rohilkhand division. Those of us who are members of the United Provinces Legislative Council would however deprecate this on grounds of policy which we consider should be directed towards reducing the rate of tube-well irrigation to the level obtaining on canals.

If large blocks of power are to be utilized at this low rate in tube-wells, the effect will be to lower the average revenue per unit for the whole system to a point which may adversely affect the revenue estimates. The annual revenue returns should, therefore, be carefully scrutinised.

(e). CINEMAS.

We consider this rate suitable. We should like to emphasize the importance of developing the cinema load as a means of disseminating educational propaganda for the benefit of the people. Electricity through the medium of the cinema film is a valuable agency in a programme of rural and urban uplift.

(f). INDUSTRIAL POWER.

We are of opinion that the industrial rates are suitable for the satisfactory development of the industrial load. The alternative tariffs provide attractive rates for industries of all load factors. From evidence we have received, we are led to the conclusion that the guarantees of 600 units per B.H.P. per annum under the sliding scale tariff, and Rs. 6/- per B.H.P. of connected load under the two part tariff though theoretically justified are acting as a deterrent to the growth of this class of business. We would therefore suggest that the guarantees be reduced, and the possibility of abolishing them altogether should be investigated.

44. On examining Appendix C we consider that the difference between the wholesale and retail rates is hardly justified in rural areas. Here Hydel is doing the bulk of the work in developing the agricultural load, and providing the necessary service lines at its own cost. In these circumstances, we are of the opinion that it would be advantageous to Government if arrangements could be made in negotiation with the licencees by which the latter would be confined to urban areas. In the event of any increase in revenue to Government accruing from such a change, we feel that Government should consider the desirability of passing on at least a portion of the benefit to the industrial consumers.

45. It would increase the interest of the staff in the commercial success of the scheme and tend to develop a "sales" mentality, if a monthly circular were distributed from headquarters showing briefly the progress achieved from month to month. This might include *inter alia* units sold, revenue secured, new consumers connected and any outstanding commercial results obtained by the electrification of consumers' installations.

46. We have examined the printed literature issued by the Development division. In our opinion the material needs to be written more from the sales point of view to enable the industrialist or agriculturist to visualise the advantages in terms of rupees, annas and pies which he will obtain by utilizing the cheap electricity available. The appeal can be considerably strengthened by the use of suitable illustrations. The proverb "the best goods ever sold never sold themselves" applies to electricity.

CHAPTER V.

The Financial Aspect of the Scheme and its Revenue Forecast.

47. The difficulties—particularly due to varying economic conditions—of preparing many years ahead a load and revenue forecast for a scheme of this nature, have already been commented upon in Chapter I, yet some figures have to be estimated for future guidance based on experience to date. As in the case of the construction programme we propose to confine our examination to the probable results over the next five years.

48. The budget figure of gross revenue for 1933-34 is Rs. 13½ lakhs and on the receipts to date we believe that this figure will be realised. Our confidence is increased by the knowledge that in past years the Chief Engineer's revenue estimates have been realised. For a scheme of this nature to earn that revenue in three years of operation is no mean achievement and, having in mind load conditions as they existed at the outset, the results are most encouraging and reflect great credit on the Chief Engineer and his organization.

49. On the present tariffs, which we have agreed are generally reasonable, the income of the scheme per peak kilowatt is Rs. 256. If the system load factor can be improved and the average revenue per unit maintained then the income per peak K.W. will be increased. There is every indication that the load factor of the system will improve and that no necessity will arise in the near future for a reduction of the tariffs, but an increasing amount of power at the lower rates will be sold and the ratio of load supplied above say 1 anna per unit (that is domestic, railway, etc) to that supplied below that figure will gradually decrease. For this reason a decrease in the figure of Rs. 256 per peak kilowatt is to be expected. The Chief Engineer has anticipated this decrease and the figure for the ultimate scheme is given as Rs. 211.

50. Examining the first stage of the scheme we note that if the Chief Engineer's figure of 8150 K.W. for effective capacity be taken, a maximum gross revenue of Rs. 256 × 8150 or Rs. 20'85 lakhs might be expected, but anticipating a decrease to say Rs. 237 per K.W. during the next two years, the gross income is reduced to Rs. 19'30 lakhs. The Chief Engineer's estimates of fixed and operating charges including depreciation come to about Rs. 17,50,000 indicating a useful margin to take care of tariff modifications and the large block of low rate load expected from the development of the tube-wells. If our figure of 8,900 K.W. of effective capacity for the system is accepted the potential earning power of stage I is increased by Rs. 1'77 lakhs. Another point deserving comment is the fact that depreciation has been charged from the third year. This is not often done in large development schemes of this nature where the large proportion of annual cost is fixed charges. As important examples of this procedure we might quote the Punjab and Madras Hydro-electric undertakings, also the British Grid where depreciation charges have been deferred during the first five years of development.

51. We consider therefore that the financial outlook is satisfactory. The operating expenses would appear to be capable of reduction since the operating ratio seems somewhat high. (It is however realized that in a system comprising so many generating plants this ratio is bound to be higher than for many other hydro-electric systems.) Further, the extent of the transmission and distribution systems is large for the generating plant installed and future extensions to the generating system—provided that the necessary load is available within the grid area—should not entail such a correspondingly large investment in transmission and distribution lines as for Stage I. Such being the case the economic value of the system would be increased by the addition of other generating capacity. This is borne out in the Chief Engineer's estimate.

52. If the total cost of Stages I and II is taken as Rs. 202'60 lacs and the annual charges and the operating cost with depreciation at Rs. 21 lacs (a *prima facie* high figure,

but based upon the Chief Engineer's estimate) the maximum earning capacity of the two stages may be taken as 10,487 kilowatts \times 230 or Rs. 24'10 lakhs after allowing for a further reduction in the income per peak kilowatt. If however the proposed figure of 11,400 K.W. be accepted as the effective K.W. capacity the maximum earning power of the two stages may be fixed at 11,400 \times 230 or Rs. 26'2 lacs giving a liberal margin for contingencies. At this stage of development the system diversity factor may be appreciably lower and the large blocks of industrial and pumping load may tend to reduce still further the unit income of the system.

Having the above comments in mind the actual load forecast of the Chief Engineer can be examined. In passing, attention may be drawn to the fact, that in all such schemes with large fixed charges, the effective generating capacity should be loaded up as soon as possible. This is one of the reasons why stage I has given such favourable results.

53. A chart (Appendix E) has been prepared by the Chief Engineer showing the increase in the load on the system and corresponding revenue (Appendix F) for the past three years. The position may be briefly summarised as follows:—

Year.	Revenue lakhs.	System demand. K. W.	Units.
1931-32	7'09	3256	86,64,000
1932-33	10'32	4172	134,94,000
1933-34	13'50	5300	180,00,000 (approx.)
...
1938-39	29'41	12000	525,00,000 (estimated at load factor 50%).

He thus anticipates an approximate increase of 125 % in the demand during the five year period. *Prima facie* this increase would not seem unreasonable although the revenue estimates for this load may not quite be reached for reasons stated in the preceding paragraph.

54. The load situation may be further examined in the light of the following figures of connected kilowatts furnished by the Chief Engineer:—

	1931-32	1932-33	1933-34	1938-39. (estimate).
State Pumping ...	1300	1400	1400	1900
Domestic ...	1220	1560	1950	2800
Industrial ...	2800	4100	5200	12700
Agricultural ...	300	600	1300	3300
State Tube-wells ...	...	100	400	2700
Railway loads ...	500	500	700	700
Miscellaneous ...	...	250	250	400
Losses ...	320	440	540	1700
Total ...	4820	7100	9600	22600
Peak ...	3200	4200	5300	12000
Diversity factor ...	3'0	3'0	2'9	2'7

Domestic supply and State pumping figures represent demand, the remaining figures connected K. W. For a growing enterprise these figures look reasonable but caution must be exercised when it is remembered that new blocks of load similar to those of state pumping, the Railway and Meerut Cantonments will not be available in the next stage of development.

55. Each load category may now be studied.

- (a) *State pumping.* This consists of the Ramganga and Kali Nadi installations already in operation and the Chief Engineer is providing for additional pumping load. No doubt can, therefore, be raised as to the reliability of these estimates provided water is needed for irrigation.
- (b) *Domestic.* During the tour, inspections were made of various towns and the Resident Engineers of the Licensees at Saharanpur, Meerut and Moradabad interviewed. These towns lie roughly at the three points of the grid triangle. Load and revenue curves of all towns were also examined. The general opinion of the Resident Engineers was that the domestic load was increasing at a satisfactory rate and not likely to reach saturation point for three or four years when the rate could be gradually reduced from 0.5-6 to an ultimate minimum of 0.4-6 and increased business should result. Bearing in mind that it is proposed to connect up other towns the domestic demand of 2800 kilowatts in 1938-39 ought to be easily reached. The question of increasing domestic load has been further discussed in Chapter III.
- (c) *Industrial.* Over the five year period the Chief Engineer anticipates an increase of 7500 K.W. or 10,000 horse power, the present connected load being 5200 K.W. or 7060 horse power. Now, excluding large factories such as sugar mills, there is 8000 horse power of small steam and oil engines in the grid area which are likely to be electrified in course of time—certainly when they become too old to operate satisfactorily. We have noted the gradual substitution of electric motors for small steam and oil engines all over the grid area and it is reasonable to assume that this process will continue. Certain industries have also been established since the advent of hydro-electric power and an expansion of oil factories appears probable.

The large sugar factories may result in a considerable increase in load, as there is an increasing tendency to meet part of their power requirements with hydel. During our tour over the grid area the Chief Engineer received an order for 30 horse power from one large factory and an enquiry for 450 from another.

The Resident Engineer of the Licensees at Moradabad did not consider that there was much further scope for small power in his district while the Engineers at Saharanpur and Meerut were more optimistic. In fact the Resident Engineer of the Upper Jumna Valley Electricity Supply Co., Ltd., anticipates an increase of 2000 K.W. or 2700 H.P. in industrial load during the next three years in the districts of Meerut, Muzaffarnagar and Saharanpur alone. His estimate is reproduced in Appendix G for reference. Having in mind conditions as we found them, the load still operated by mechanical power, and the fact that business in general appears to be improving we consider that there is a reasonable possibility of the anticipated figure being reached. The annual increase in this particular load category should be carefully scrutinised and measures taken to increase the demand by propaganda, demonstration and takavi.

- (d) *Agriculture.* In this category is included the load which it is expected to obtain from sugar crushing, chaff cutting, sugar centrifugals, small cotton gins, pumping and other small industries associated with a farm of reasonable size; and also any load which may be derived from the smaller sugar factory. The connected load at present is 1300 K. W. and the estimate

allows for an additional 2000 K. W. or 2600 horse power. Regarding the mixed load for small farms, we do not anticipate that a radical increase will occur during the period under review, but in view of the increase in this load during the past two years, i. e. from 300 H. P. to 1300 H. P., we consider that another 1500 H. P. in 5 years could be safely anticipated.

Sugar may result however in a very large extra load particularly if the smaller factories are established by land-owners as now seems likely. If the sugar industry continues to grow and does not reach the saturation point within the next five years then we consider that the load forecast is low. If, on the other hand, a depression sets in due to over production and low prices then the load estimate will not be reached. A special note has been prepared on this subject and reproduced in Appendix H so that a general idea may be formed of the possibilities of this load. As far as we are able to judge and considering that the 11 K. V. network is being continually extended, it would be reasonable to assume that the load under this category will double in five years, i.e. increase from 1300 K.W. to 2600 K.W.

- (e). *State Tube-wells.* The latest project of the Chief Engineer, which has been submitted to Government embraces a larger development than that so far discussed. Some 950 tube-wells are now projected giving an approximate connected load of 5000 kilowatts or 6600 horse power, provided that the programme is completed within the five years and a demand for the water exists. This load is of great importance in agriculture, and, for this reason, has also been the subject of a special note (*see* Appendix J). The original estimate of 2,700 kilowatts is therefore likely to be exceeded. In general, we consider that if the original load estimates for State tube-wells and agriculture are combined the total increase of 4,300 kilowatts or say 6000 horse power ought to be easily attained.
- (f). *Railway and Miscellaneous loads.* No appreciable increase has been anticipated for these loads. It would appear however that a small increase might be reasonably expected. Some Railway stations have yet to be electrified, while increased use of electricity in the workshops may be expected.

56. Our general conclusion is that under favourable economic conditions the load estimates of the next five years will be reached but, at the worst, it would not appear that the demand will fall materially below the Chief Engineer's anticipations. Should such conditions arise, it would merely result in the postponement of the construction programme.

CHAPTER VI.

Summary of Conclusions.

57. The conclusions arrived at in the foregoing report may be briefly summarised as follows:—

(1.) The scheme is fundamentally sound from an economic and technical point of view and the estimates of construction costs are reasonable on the basis of present day rates and prices.

(2.) We recommend the construction of Salawa generating station within the next 5 years provided that the load estimates are realised.

(3.) After further examination, economies in the operating establishment may prove possible in the near future.

(4.) The power tariffs as a whole are reasonable compared with those in force elsewhere in India, and sufficiently attractive to compete effectively with other forms of power and to reduce the cost of production to the industrialist. We do not advise any reduction of these tariffs until the load has developed to the generating capacity of Stage I.

(5.) With favourable economic conditions, the load and revenue forecast for the next five years should be realized. An important factor in the development of load will be the progress of the State tube-well irrigation scheme which we are satisfied is sound and consider should be encouraged.

CHAPTER VII.

Acknowledgements.

58. We wish in conclusion to place on record our admiration of the courage shown by the Chief Engineer and his predecessor in their conception of the scheme, the energy and organizing ability displayed by Mr. Stampe in bringing it successfully to the stage of development already reached and the vision and foresight disclosed in his plans for future expansion. The results hitherto have fully justified the enterprise.

59. We are greatly indebted to the Chief Engineer and his staff, to the officers of the Civil, Agriculture and Industries Departments including the Sugar Technologist to the Government of India and to certain members of the public for their ready response to our heavy demands for information and for the facilities afforded to us for considering all aspects of the scheme. The arrangements made by the Chief Engineer and our secretary Mr. Mitra for our comfort both at Roorkee and on tour, were admirable and were greatly appreciated. The members of the Committee coming from outside the United Provinces are much indebted to their colleagues of the United Provinces Legislative Council for the advice and guidance received in dealing with aspects of the enquiry involving knowledge of local conditions affecting industry and agriculture.

(Signed.) H. G. HOWARD,
RAJESHWAR BALI,
OBAIDUR RAHMAN,
A. S. TROLLIP,
B. M. STAIG,

A. C. MITRA, *Secretary.*

Dated January 12, 1934.

APPENDICES AND MAPS.

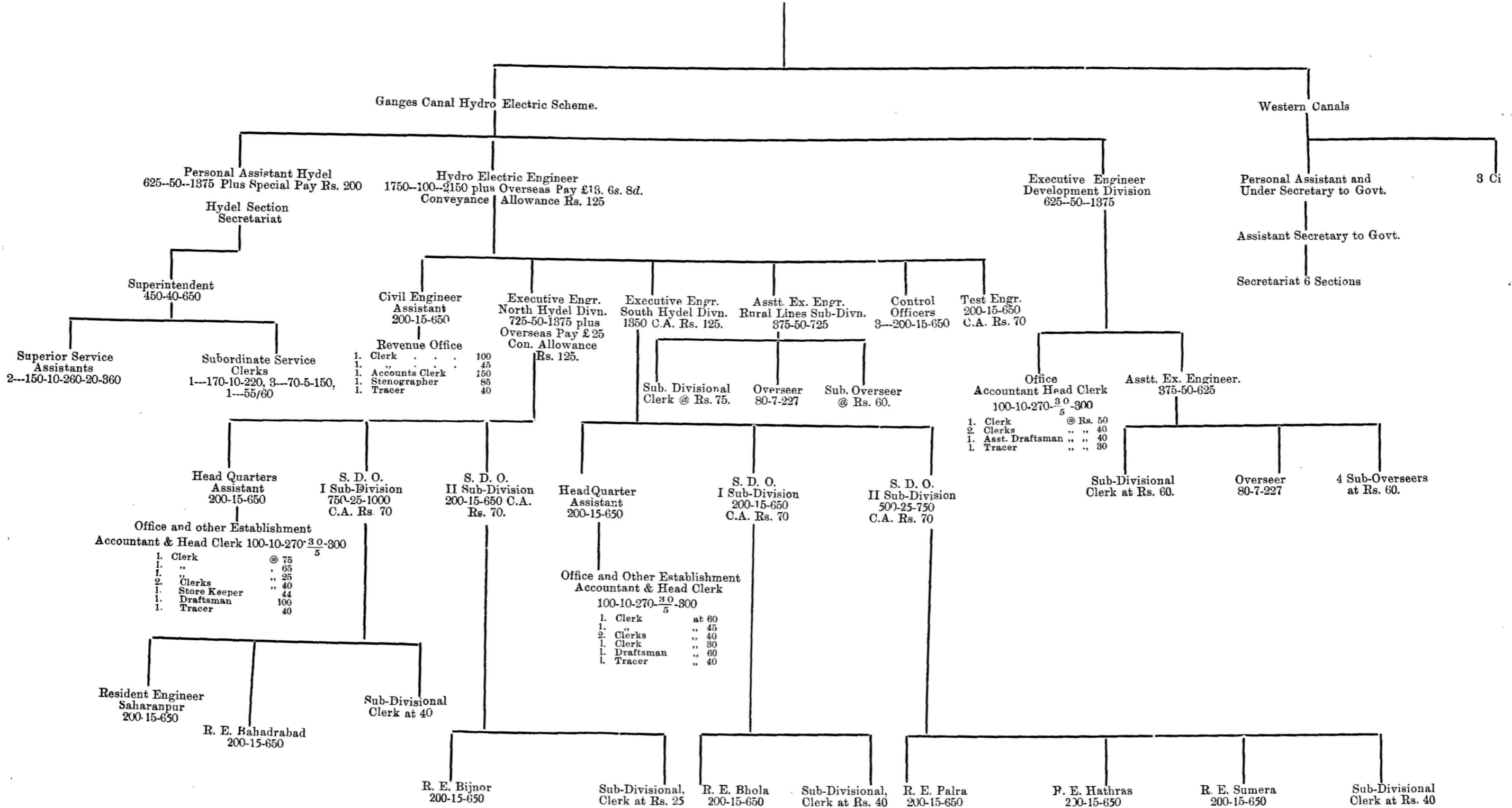
APPENDIX A.
Ganges Canal Hydro-Electric Scheme
THE ULTIMATE DEVELOPMENT.
General abstract of financial results.

YEAR.	CAPITAL OUTLAY TO END OF THE YEAR.			Accumulated arrears of simple interest to end of the year.	Total of columns 4 and 5.	Gross Revenue for the year.	WORKING EXPENSES.					Net revenue column 7—column 12.	Simple interest for the year.	Net gain or loss column 13—column 14.	Percentage of net revenue or deficit Col. 13 Col. 6
	Direct charges.	Indirect charges.	TOTAL.				Establishment including Operating Staff.	Maintenance and repair charges.	Depreciation.	Indirect charges.	TOTAL.				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	
1932-33	1,37,94,438	1,14,163	1,39,08,601	13,11,434	1,52,20,035	10,46,581	4,59,559	2,24,473	...	1,175	6,85,207	3,61,374	7,61,464	-4,00,090	2'4 %
1933-34	1,53,95,779	1,28,070	1,55,23,849	13,64,210	1,68,88,059	13,56,000	3,38,897	2,47,200	...	2,472	5,88,569	7,67,431	8,20,207	- 52,776	4'5 ..
1934-35	1,68,74,816	1,41,021	1,70,15,837	14,59,447	1,84,75,284	16,67,000	3,89,694	2,61,000	2,11,716	2,610	8,65,020	8,01,980	8,97,217	- 95,237	4'4 ..
1935-36	1,92,01,381	1,61,119	1,93,62,500	13,33,959	2,06,96,459	19,75,000	2,97,936	3,25,912	2,30,048	3,259	8,57,155	11,17,845	9,92,357	1,25,488	5'4 ..
1936-37	2,00,93,643	1,68,868	2,02,62,511	12,05,765	2,14,68,276	22,96,000	5,01,311	3,26,886	2,63,514	3,268	10,94,979	12,01,021	10,72,827	1,28,194	5'6 ..
1937-38	2,29,72,728	1,93,865	2,31,66,593	7,00,297	2,38,66,890	26,11,000	2,95,821	3,61,756	2,77,228	3,617	9,38,422	16,72,578	11,67,110	5,05,468	7'0 ..
1938-39	2,39,95,558	2,02,733	2,41,98,291	2,77,792	2,44,76,083	29,41,000	5,37,790	3,73,440	3,38,873	3,734	12,53,837	16,87,163	12,64,658	4,22,505	6'9 ..
1939-40	2,71,76,943	2,30,378	2,74,07,321	...	2,74,07,321	32,24,000	3,15,733	4,03,790	3,53,076	4,038	10,76,637	21,47,363	13,69,764	7,77,599	7'8 ..
1940-41	2,86,65,330	2,43,221	2,89,08,551	...	2,89,08,551	35,36,000	5,30,532	4,14,953	4,17,872	4,149	13,67,506	21,68,494	14,86,509	6,81,985	7'5 ..
1941-42	3,14,05,680	2,66,945	3,16,72,625	...	3,16,72,625	38,28,000	4,11,776	4,68,484	4,33,121	4,684	13,18,065	25,09,935	15,92,228	9,17,707	7'9 ..
1942-43	3,50,26,948	2,98,899	3,53,25,847	...	3,53,25,847	41,20,000	3,88,662	4,70,250	4,74,898	4,702	13,38,512	27,81,488	17,51,269	10,30,219	7'9 ..
1943-44	3,70,51,203	3,16,449	3,73,67,652	...	3,73,67,652	44,12,000	5,52,053	5,11,270	5,76,193	5,113	16,44,634	27,67,366	18,92,407	8,74,959	7'4 ..
1944-45	3,91,66,284	3,35,068	3,95,01,352	...	3,95,01,352	47,04,000	5,93,747	5,34,964	6,08,709	5,349	17,42,769	29,61,231	19,95,890	9,65,341	7'5 ..
1945-46	4,00,85,409	3,43,038	4,04,28,447	...	4,04,28,447	50,05,000	7,35,080	5,55,943	6,55,324	5,559	19,51,906	30,53,094	20,71,745	9,81,349	7'6 ..
1946-47	4,19,60,022	3,59,287	4,23,19,309	...	4,23,19,309	53,06,000	6,49,321	5,91,158	6,75,931	5,911	19,22,321	33,83,679	21,41,588	12,42,091	8'0 ..
1947-48	4,24,47,397	3,63,437	4,28,10,834	...	4,28,10,834	56,07,000	8,32,900	5,89,091	7,08,891	5,891	21,36,773	34,70,227	22,00,637	12,69,590	8'1 ..
1948-49	4,29,14,772	3,67,587	4,32,82,359	...	4,32,82,359	59,08,000	8,59,900	5,91,966	7,17,518	5,919	21,75,303	37,32,697	22,24,505	15,08,192	8'6 ..

APPENDIX B.

GANGES CANAL HYDRO ELECTRIC GRID
ESTABLISHMENT CHART
PRESENT STAGE.

CHIEF ENGINEER AND SECRETARY TO GOVT. I.B.
(2,750—125—3,000 Plus £ 13-6s-8d.
Special pay Rs. 250)



APPENDIX C.

Statement showing wholesale and retail rates on the Grid.

Class of load.	Rate.	Discount.	Nett Rate.	Rate to Licensees.	Ratio cost to Consumer Licensees.	Minimum charges.
Domestic lights and fans	annas. 6	annas. $\frac{1}{2}$	annas. $5\frac{1}{2}$	annas. $2\frac{1}{2}$	annas. 2'2	Rs. 2 p. m.
Ditto ...	8	2	6	$2\frac{1}{2}$	2'4	" 3 "
Street lighting ...	contract			$2\frac{1}{2}$	...	...
Domestic Power ...	3	...	3	$1\frac{1}{2}$	2'0	Rs. 2 p. m.
Agricultural purposes	1	...	1	$\frac{10}{18}$	1'2	600 units per B.H.P. per annum.
Cinemas ...	$3\frac{1}{2}$	...	$3\frac{1}{2}$	$1\frac{1}{2}$	2'2	Rs. 5 p. m.
Tube-wells. ...	12 pies.	...	12 pies.	$11\frac{1}{2}$ pies	1'04	600 units per B.H.P. per annum.
Industrial— (A) Sliding scale...	6'1 pies to 18 pies per unit.	...	6'1 pies to 18 pies per unit.	4'5 pies to 12 pies per unit.	1'36 to 1'50	600 units per B.H.P. per annum.
(B) Two part ...	Rs. 6 per B. H. P. connected.	...	Rs. 6 per B.H.P.	Rs. 4 per B.H.P.	1'5	Rs. 6 per B.H.P. per mensem.
	and 9 pies per unit.	3 pies per unit.	6 pies per unit.	4 pies per unit.	...	...

APPENNDIX D.

Comparative Statement showing *Hydel* rates and rates in other licences.

B.H.P. of motor.	Process for which used.	Number of months per year during which the motor works.	Average number of working hours per day.	Approximate num- ber of units consumed per month.	THROUGH RATES IN PIES PER UNIT.									
					The U. P. Electric Supply Co., Ltd. Lucknow & Allahabad.	Cawnpore Electric Supply Corporation Limited.	Delhi Electric Supply & Traction Co., Ltd., Delhi.	Uhl river Hydro- electric Scheme Punjab.	Lahore Electric Supply Co., Ltd. Lahore.	Hydro- electric Scheme Mysore State.	Pykara Hydro- electric Scheme Madras.	Tata Hydro- electric Power Supply Co., Ltd. Bombay.	The Bombay Electric Supply and Tramways Co., Ltd. Bombay.	The Ganges Canal Hydro- electric Grid United Provinces.
H.P.		Months.	Hours.	Units.	Pies.	Pies.	Pies.	Pies.	Pies.	Pies.	Pies.	Pies.	Pies.	Pies.
5	Brass polishing ...	12	8	750	17'3	25'3	16'2	14'76	27	12	14'56	...	24'0	13'7
10	Flour mill ...	12	10	1875	15'8	18'00	16'2	13'31	16'2	12	12'9	...	14'27	12'1
10	Rice hulling ...	4	16	5000	13'4	14'90	16'2	11'13	14'64	12	13'92	...	11'36	9'8
25	Sugar centrifugal and crusher ...	4	16	7500	13'4	14'90	16'2	11'16	14'64	13'5	10'99	...	11'36	9'8
60	Cotton ginning factory	3	20	22500	12'7	13'87	Special rate.	8'19	Special rate.	8'1	9'6*	...	10'69	9'1
60	Oils mills ...	12	20	22500	12'7	13'87	Special rate.	8'19	Special rate.	8'1	8'86	...	10'69	7'8
70	Ice factory ...	6	24	31500	12'16	13'18	Special rate.	7'74	13'76	8'1	9'6†	...	9'6	8'56
125	Rolling mills ...	12	8'5	19922	16'8	19'44	Special rate.	10'98	16'9	8'4	10'3	...	13'47	13'2
200	Strawboard factory ..	12	24	90000	12'16	13'18	Special rate.	6'91	Special rate.	7'2	6'44	7'75	8'22	6'62

*The actual rate calculated is 8'1 pies per unit but the minimum chargeable is 9'6 pies per unit.

†The actual rate calculated is 8'46 pies per unit but the minimum chargeable is 9'6 pies.

N.B.— It is assumed that motors will only be working on an average for 25 days in a month.

APPENDIX E.

Ganges Canal Hydro-Electric Grid.

FORECAST OF LOAD DEVELOPMENT.

Year.	Power station peak load.	Losses.	State canal pumps.	Balance column 2-(3+4) available for the allotment for other loads.	Domestic.	Industrial.	Agricultural.	State tube-wells.	Railway loads.	Miscellaneous.	Total.	Diversity factor.
1	2	3	4	5	6	7	8	9	10	11	12	13
1931-32	3,200	320	1300	1,580	1,220	2,800	300	Nil	500	Nil	4,820	3.0
1932-33	4,200	440	1400	2,360	1,560	4,100	600	100	500	250	7,110	3.0
1933-34	5,300	540	1400	3,360	1,750	5,200	1300	400	700	250	9,600	2.9
1934-35	7,050	850	1900	4,300	2,000	6,700	1700	700	700	300	12,100	2.8
1935-36	8,350	1050	1900	5,400	2,200	8,200	2100	1100	700	300	14,600	2.7
1936-37	9,550	1250	1900	6,400	2,400	9,700	2500	1600	700	300	17,200	2.7
1937-38	10,750	1450	1900	7,400	2,600	11,200	2900	2100	700	400	19,900	2.7
1938-39	12,000	1700	1900	8,400	2,800	12,700	3300	2700	700	400	22,600	2.7
1939-40	13,700	2000	1900	9,800	3,000	14,200	3700	3400	700	400	25,400	2.6
1940-41	15,100	2300	1900	10,900	3,200	15,700	4100	4100	700	500	28,300	2.6
1941-42	16,500	2600	1900	12,000	3,400	17,200	4500	4800	700	500	31,100	2.6
1942-43	17,800	2900	1900	13,000	3,600	18,700	4900	5500	700	500	33,900	2.6
1943-44	19,200	3200	1900	14,100	3,800	20,200	5300	6200	700	500	36,700	2.6
1944-45	21,300	3600	1900	15,800	4,000	21,700	5700	7000	700	500	39,600	2.5
1945-46	22,900	4000	1900	17,000	4,200	23,200	6100	7800	700	500	42,500	2.5
1946-47	24,400	4400	1900	18,100	4,400	24,700	6500	8600	700	500	45,400	2.5
1947-48	26,200	5000	1900	19,300	4,600	26,200	6900	9400	700	500	48,300	2.5
1948-49	28,000	5600	1900	20,500	4,800	27,700	7300	10200	700	500	51,200	2.5

APPENDIX F.

Ganges Canal Hydro-Electric Scheme

THE ULTIMATE DEVELOPMENT.

Statement showing Revenue anticipated.

Year.	Domestic.	Industrial.	Agricultural.	State tube-wells.	Railways.	Miscellaneous.	State canal pumps.	Total.	Revenue per K. W. year.
Col. 1	2	3	4	5	6	7	8	9	10
1931-32	2'40	1'90	'10	Nil	1'10	Nil	1'6	7'10	222
1932-33	2'78	2'99	'31	'10	1'11	1'42	1'61	10'32	246
1933-34	3'24	4'92	'52	'20	1'67	1'42	1'59	13'56	256
1934-35	3'72	6'03	1'09	'35	1'89	1'69	1'90	16'67	236
1935-36	3'96	7'79	1'47	'63	2'00	1'70	2'20	19'75	237
1936-37	4'32	9'70	1'75	'99	2'00	2'00	2'20	22'96	240
1937-38	4'68	11'76	2'03	1'44	2'00	2'00	2'20	26'11	243
1938-39	5'04	13'97	2'31	1'89	2'00	2'00	2'20	29'41	245
1939-40	5'40	15'62	2'59	2'43	2'00	2'00	2'20	32'24	237
1940-41	5'76	17'27	2'87	3'06	2'00	2'20	2'20	35'36	234
1941-42	6'12	18'92	3'15	3'69	2'00	2'20	2'20	38'28	231
1942-43	6'48	20'57	3'43	4'32	2'00	2'20	2'20	41'20	231
1943-44	6'84	22'22	3'71	4'95	2'00	2'20	2'20	44'12	230
1944-45	7'20	23'87	3'99	5'58	2'00	2'20	2'20	47'04	220
1945-46	7'56	25'52	4'27	6'30	2'00	2'20	2'20	50'05	218
1946-47	7'92	27'17	4'55	7'02	2'00	2'20	2'20	53'06	218
1947-48	8'28	28'82	4'83	7'74	2'00	2'20	2'20	56'07	214
1948-49	8'64	30'47	5'11	8'46	2'00	2'20	2'20	59'08	211

NOTE:— Figures in columns 2 to 9 represent lacs of rupees and those in column 10 rupees.

APPENDIX G

Upper Jumna Valley Electricity Supply Co., Ltd.,

(1) Statement of past and Anticipated Development in Meerut, Muzaffarnagar & Saharanpur Districts.

Year	1930	1931	1932	1933	1934	1935	1936	1937
No. of Connections.								
Lights and Fans	315	858	1226	1876	2870	3470	3920	4270
Power	32	77	143	289	423	527	630	730
Total	347	935	1369	2165	3293	3997	4550	5000
Street Lights	929	1228	1386	1968	2148	2250	2275	2300
Connected Load.	K. W.	K. W.	K. W.	K. W.	K. W.	K. W.	K. W.	K. W.
Power	225	600	1125	1950	2900	3615	4205	4985
Lights and Fans	126	343	490	770	1345	1630	1810	1930
Street Lights	42	54	71	88	99	103	103	103
Total	393	997	1686	2808	4344	5348	6118	7018
Units Sold.								
Light and Fans	35852	132234	223245	304239	740000	1039500	1119250	1207000
Power	109292	490765	891303	1501067	2280000	2900000	3260000	3392000
Street Lights	56129	124613	135587	186344	203200	215800	215800	215800
Total	201273	747612	1250135	1991650	3223200	4155300	4595050	4814800

(2) Power Abstract upto 31-12-33.

Flour mills	124	1266.5 H.P.
Workshop	23	243 "
Cotton gins	3	16.5 "
Oil mills	9	141 "
Pumps	73	566 "
Chaff cutters	3	6 "
Cinema	3	25 "
Sugar processing	49	257.5 "
Unclassified	1	40 "
Disintegrator.	1	25 "

(Sd.) J. D. GULLICK,

Resident Engineer,
Meerut.

APPENDIX H.

Note on Sugarcane Production.

1. The economic value of the sugarcane industry to the province and the demand for hydel power which it is expected to create are of considerable importance. The Committee therefore were particularly interested in obtaining information in the various localities as to the possibility of the saturation point of production being reached in the near future, resulting eventually in over production and low prices. The opinions of two Commissioners and a Collector were obtained and the views of local industrialists and landowners ascertained. The Sugar Technologist to the Government of India was also consulted.

2. The general opinion is that saturation point has not yet been reached, but that some form of control of production within the province and by agreement between other provinces should be attempted in order to safeguard the industry. It was generally admitted that an economic need existed for small factories of about 50 tons capacity per day situated away from railway stations, and that such factories should be encouraged by Government. They could compete with the larger factory situated near towns, for they could obtain their cane at a comparatively low price and, moreover, as the cane would in their case always be fresh, a higher average percentage of sugar might be obtained. The grower would also benefit as his expenses would be less due to lower transport costs. In fact the small factory was more likely to become a permanent feature of the Provincial industrial structure than the large one.

3. At present there are 135 factories in India of which 70 are in the United Provinces and 34 in Behar. Of the factories in this province 12 are located in the hydro-electric area with a daily capacity of 4900 tons. The acreage necessary to meet these factory requirements is estimated to be 28,150 while more than 500,000 acres are under cultivation indicating that there is scope for the small factories. A table showing the distribution of sugar factories in the Grid area prepared by the Sugar Technologist to the Government of India is submitted for reference.

4. An interesting feature of these returns is that the estimated acreage under production for 1933-34 is actually less than the actual figures for 1932-33 which would appear to confirm that more factories are needed rather than that saturation point has been reached.

5. In this connection the Sugar Technologist stated that at present India is consuming 900,000 tons of sugar, which is less than formerly. Out of this 250—270 thousand tons is made by the open pan system—which may be gradually replaced by the vacuum process and the rest is made or refined from gur. The imports of sugar for the current year are expected to be 300,000 tons. This amount is likely in future to be gradually reduced by increased production in India, a consideration which confirms the view that saturation point has not yet been reached. The actual problem seems to be competition between provinces, which has been referred to already.

6. The price of sugar at present is the lowest for 15 years and it would be reasonable to assume that prices will tend to rise for some time in spite of competition rather than fall still lower.

7. There is an increasing tendency for the large sugar factories to use hydel power, for lighting and auxiliaries, while it would seem that it would be economical for the small 50 ton factory, using the vacuum process and situated away from transport facilities to use hydel power for crushing and refining in combination with a small low pressure boiler for process steam, utilizing bagasse as fuel.

8. The Chief Engineer estimates that about 7.5 units of electrical energy are required to crush one ton of sugarcane (22 units per 80 maunds).

(ii)

The yield of sugarcane per acre is estimated as follows :--

	Fertilized land.	Unfertilized land.
Canal irrigated	20 tons	15 tons
Dry	13'3 ..	10 ..

Provided the small factory can be partially electrified as already proposed an approximate average consumption of 750,000 units with a corresponding demand of about 300 K.W. could be expected for every 1000 tons crushed per day in a season of 100 days. An additional load might also be derived from the centrifugals.

It would thus appear that the possibilities of this industry as a consumer of hydro-electric power are favourable.

Statement showing distribution of sugar factories and cane acreage in the hydro-electric districts.

DISTRICT.	Total number of factories working during 1933-34.	Total capacity during 1933-34. (Tons cane crushed per day).	Estimated acreage of cane for meeting factory requirements.	Actual cane acreage in district during 1933-34.
Moradabad	1	500	3150	62,336
Bijnor	3	1,050	6600	94,725
Meerut	5	2,400	13200	143,781
Muzaffarnagar	1	400	2200	114,946
Saharanpur	2	550	3000	88,501

NOTE.—There are no sugar factories in the districts of Aligarh and Bulandshahr.

Statement showing acreage under cane during the last six years in the hydro-electric districts.

DISTRICT.	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Saharanpur	47,575	52,974	68,043	73,421	90,735	88,501
Muzaffarnagar	77,800	100,435	111,028	101,669	118,000	114,946
Meerut	129,745	138,017	142,030	122,309	154,320	143,781
Bulandshahr	39,511	43,162	50,805	47,025	59,383	51,872
Aligarh	6,573	7,510	10,910	15,581	22,120	15,653
Moradabad	47,958	48,856	55,420	58,582	63,698	62,336
Bijnor	87,391	81,218	96,292	80,395	91,140	94,725

NOTE.—Figures for 1928-29 to 1932-33 are final, whilst those for 1933-34 are provisional.

APPENDIX J.

Note on State tube well irrigation.

With reference to the forecast of load development for State tube wells in column 9 of the Chief Engineer's schedule II reproduced as Appendix E of this report which shows an estimate of 2700 K. W. in the year 1938-39, we understand that subsequent to the preparation of this schedule a five year plan for State tube well irrigation has been submitted to Government which involves the construction during the years 1934-35 to 1938-39 of some 949 wells. This would represent instead of the figure of 2700 K.W. for 1938-39 estimated in column 9 of the schedule referred to the figure of 5200 K. W.

2. In connection with the Chief Engineer's estimate under this head we have discussed generally with the various witnesses who came before us in the course of our tours the subject of State tube well irrigation. On the technical side we are advised that no difficulty stands in the way of the Chief Engineer's scheme owing to the risk of its depleting the supplies of sub-soil water, that the proposed density of wells in relation to area is technically sound and that the risks of failure from technical causes are negligible. The Agricultural Engineer told us that of about 100 wells installed during his tenure of office of about three years only two had failed and that for very special reasons. In the area covered by the scheme conditions for tube well construction are we understand extremely favourable. Extension of State tube well irrigation was welcomed by the revenue officers as affording increased protection against famine. In the Moradabad District we understand that owing to geological conditions ordinary well irrigation cannot be extended.

3. On the financial side, the only figures of actual expenditure and revenue available to us in this connection relate to the working of the Moradabad District tube wells for 1932-33. This was only the first year of operation, and therefore even in the case of those wells which were constructed in time to operate for the full year, the results cannot be taken as the basis of a reliable estimate for the future. (In the case of ordinary irrigation schemes the test of productivity is applied to the results after the tenth year of operation). We understand however that on results and experience already obtained, the Irrigation Branch has decided not to pursue in future any project on the lines of the Dingarpur Agricultural Canal, which was a scheme of pumping from large wells into small State owned canals and the sale of water therefrom at acre watering rates. With this decision we are in complete agreement. In regard to the tube wells operating on the prepayment meter system of sale by units the poor percentage return (which incidentally was calculated without taking into account the interest charges on capital) shown in the case of all the wells except one was attributable, we believe, to the excessive capital cost of the wells and to the abnormal rainfall during rabi which diminished the demand for tube well water. The project was then moreover in the experimental stage. We have therefore used the results of that year only for general reference in examining the Chief Engineer's estimates of capital cost, working expenses and revenue for a single cusec tube well (which we consider has been demonstrated to be the most suitable type) with one mile of lined channel on the basis of which we understand Government is being asked to provide funds for future tube well construction. We reproduce this estimate at the end of this note. Under present conditions the estimated capital cost per well (Rs. 5,000) is susceptible of considerable reduction. It has worked out at an average figure of slightly below Rs. 4000 on 13 wells recently constructed in the Meerut District. The suggestion has been offered that the cost of the strainer can be reduced by having it made departmentally. This may be considered by the Chief Engineer. A reasonable assumption for the average working hours per annum is, we calculate, 2800. The estimates on which the Chief Engineer is basing the tube well scheme are, we consider, reasonable and the revenue anticipated will, we think, be earned. In the course of our discussions on tour it was suggested that the rates charged could, if such a step proved necessary to ensure the commercial success of the project, be raised

by 25 per cent without imperilling the demand for water. In drawing any comparison with rates charged for canal water, the fact should not be lost sight of that in the prepayment meter system the cultivator only pays for water when he requires it, and he is already, we understand, learning in the tube-well area to use it much more economically than when it is derived from canals. The fact that tube-well water costs more than canal water does not therefore necessarily prejudice the success of the tube-well scheme. Its financial success will however, we believe, be more readily secured if the scheme proceeds in the early stages in *do fasli* areas, with good communications facilitating close supervision and prompt repairs. Above all we would emphasise the necessity on the part of the officers running the scheme for constant consultation with the local officers of the Civil Department generally and with particular reference to propaganda, the selection of sites for wells and measures calculated

- (a) to diminish any hardship that a system involving prepayment might tend to create, and
- (b) to induce to take water those cultivators whose holdings are so small as to make it not worth their while to buy even the amount available for a single token. In regard to the last point there appears room for efforts by the Co-operative Department to organize cultivators into societies so that they may obtain the maximum benefit from the scheme. There appears to us a fair prospect of commercial success for State tube-well irrigation, and while we presume that funds will be made available for it by Government from year to year only after the most careful review of the results obtained from expenditure already incurred, we feel we are not unduly optimistic in accepting the Chief Engineer's estimated load of 2700 K.W. in the 5th year. So far as the hydro-electric project alone is concerned, we note that the price of energy charged to the Irrigation Branch by the Hydel Branch is low and extremely favourable.

4. The question was raised in our deliberations of the comparative merits of irrigation from State owned and private tube-wells. We see no objection to a zamindar's constructing a tube-well to give supply to himself and his tenants—in fact we would encourage his doing so, subject to suitable regulations being imposed by Government as to (1) the maximum rate he could charge for water and (2) the specification of the well he could install.

(iii)

State Tube-well Irrigation.

Financial statement for a single cusec well including cost of one mile of lined gul.

(a) Cost of well.	1. Works	...	Rs. 1300-0-0
	2. Equipment	...	" 3000-0-0
	3. Overhead	..	" 700-0-0
(b) Cost of lining gul.	1. Works	...	" 2000-0-0
	2. Overhad	...	" 600-0-0
	Total cost	...	" 7600-0-0

$$\text{Units consumed per hour} = \frac{36' \times 22000 \times 10 \times 100 \times 0.746}{33000 \times 60 \times 55}$$

$$= 5.4 \text{ or, say, } 5.5 \text{ units.}$$

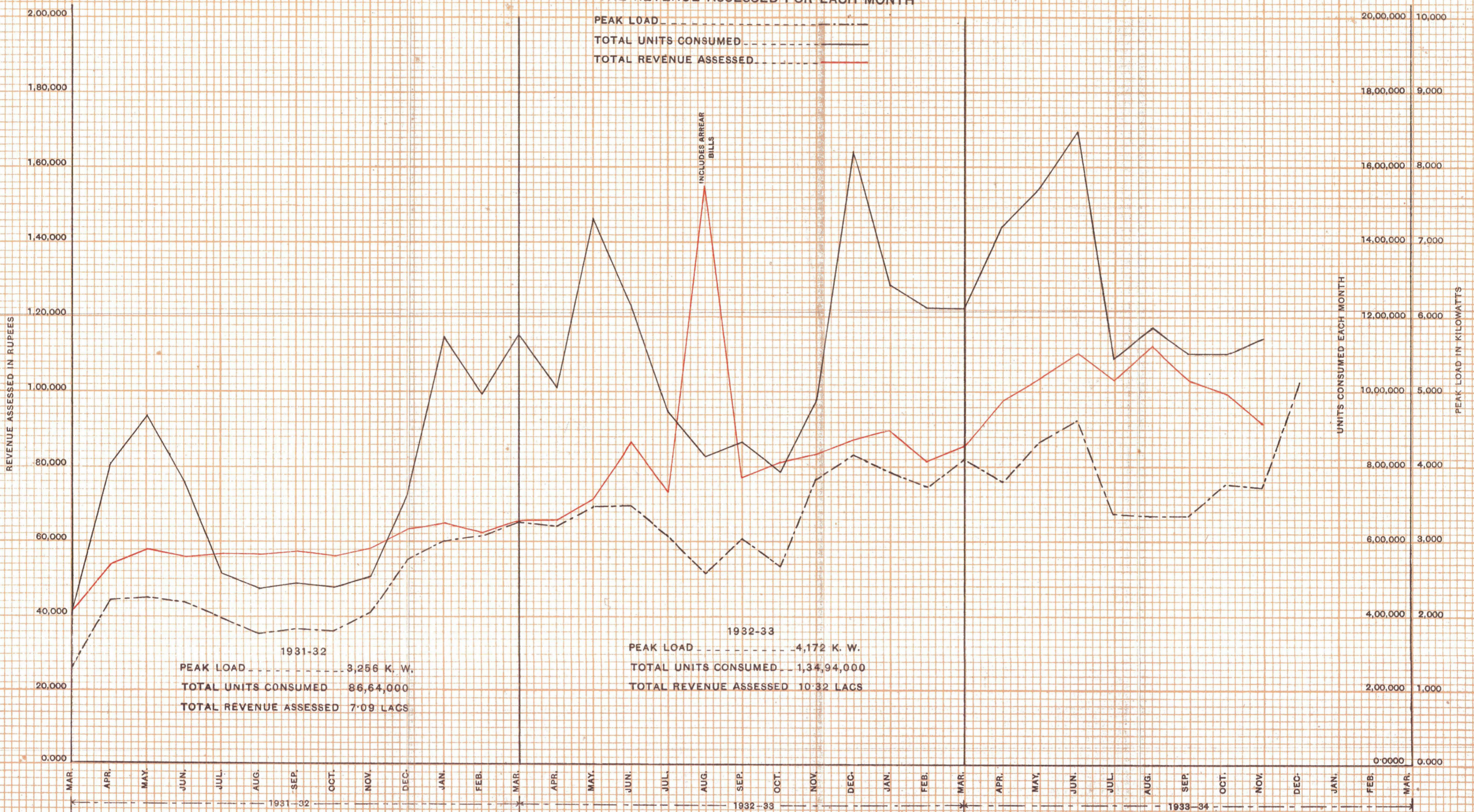
		(1)	(2)
Working hours assumed	...	2,500	3,000
(a) Units consumed per hour	...	5.5	5.5
(b) " " " year	...	13,750	16,500
(c) Gross revenue @ annas 2 per unit	...	1,718	2,062
(d) Annual charges—			
(1) Interest on Rs. 7,600 @ 5%	...	380	380
(2) Depreciation on Rs. 3,000 at 7%	...	210	210
(3) Repairs, oil grease etc.	...	80	80
(4) " to gul	...	80	80
(5) Establishment—			
[i] Share of mistry for 20 wells	... Rs. 2 per mensem.		
[ii] Operator with commission per unit	" 20 "		
[iii] Overhead supervision on 150 wells	" 10 "		
[iv] Leave and pension charges	" 3 "		
	Total per year	... Rs. 35 × 12	
		= 420	420
(6) Cost of energy at 0-0-7 per unit	...	501	601
	Total annual charges	1,671	1,771
(e) Profit (c)—(d)	...	47	291
(f) Equivalent cost per unit	$\frac{(d) \times 16}{(b)}$	1.9 as.	1.7 as

State Tube-well Irrigation.*Abstract of estimate of cost of a single cusec well.*

		Rs.
1. A Preliminary		53
2. B. Land		72
3. K. Building		826
4. L. Earthwork		315
5. O. Miscellaneous		9
6. Q. Equipment		
Switchboard	Rs. 12-0-0	
Notice board	" 4-0-0	
V. notch	" 20-0-0	
7½ H.P. Motor, pump, taper, starter and switch	" 720-0-0	
Ammeter	" 24-0-0	
6" sluice valve	" 90-0-0	
90° Bend with 2 flanges	" 40-0-0	
Foot valve	" 60-0-0	
20 ft. delivery pipe with flanges, @ 3/- per ft.	" 60-0-0	
1 Galvanised sheet expanding funnel with flanges and cover	" 35-0-0	
1 Prepayment meter	" 100-0-0	
200 ft. boring @ 1-12	" 350-0-0	
56 R. ft. of 5" Tej Patent strainer @ 16/- per ft.	" 896-0-0	
128 R. ft. of 6" W. I. pipe @ 2-8	" 320-0-0	
Wiring of pump house, with cables, lamps etc.	" 100-0-0	
Mechanical mistry for fitting	" 10-0-0	
Special T. & P. for fitter and electrician	" 5-0-0	
Contingencies on Rs. 2,846 @ 5%	" 142-0-0	
	Total	Rs. 2,988/-or, say, 3,000
7. Overhead charges on items 1 to 5 Rs. 1,275		
at 28 per cent	... 357	
Overhead charges on item 6 Rs. 3,000		
at 11 per cent	... 330	687
	GRAND TOTAL	4,962
		or say Rs 5,000.

G. C. H. E. GRID.

GRAPHS SHOWING PEAK LOADS, TOTAL UNITS CONSUMED AND THE REVENUE ASSESSED FOR EACH MONTH

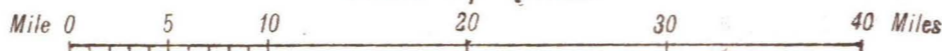


GANGES CANAL HYDRO-ELECTRIC GRID

MAP No. 1.

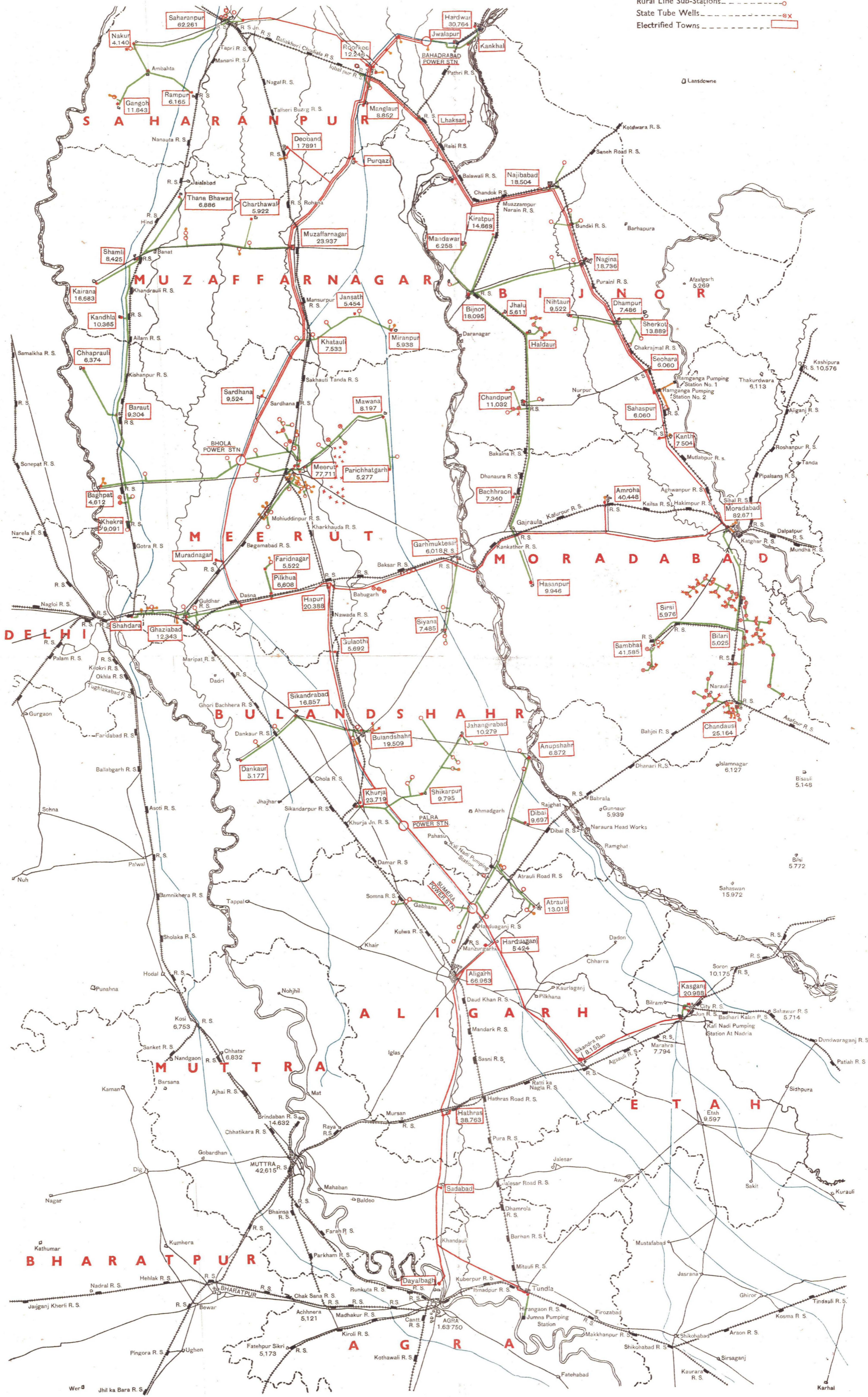
MAP SHOWING WORKS INCLUDED IN THE PRESENT STAGE 1928-34.

Scale of Miles.



REFERENCES.

- Power Stations
- 37,000 Volt Transmission Lines
- 11,000 Volt " Lines
- Other " Lines
- City Sub-Stations
- Rural Line Sub-Stations
- State Tube Wells
- Electrified Towns



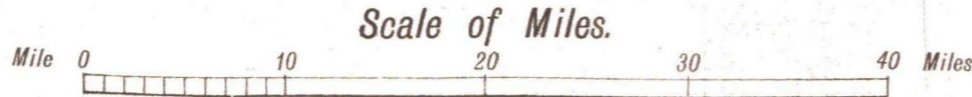
W. L. STAMPE, I.S.E.,
Chief Engineer,
Western Canals,
U. P.

Govt. Photo-Litho. Press, Roorkee

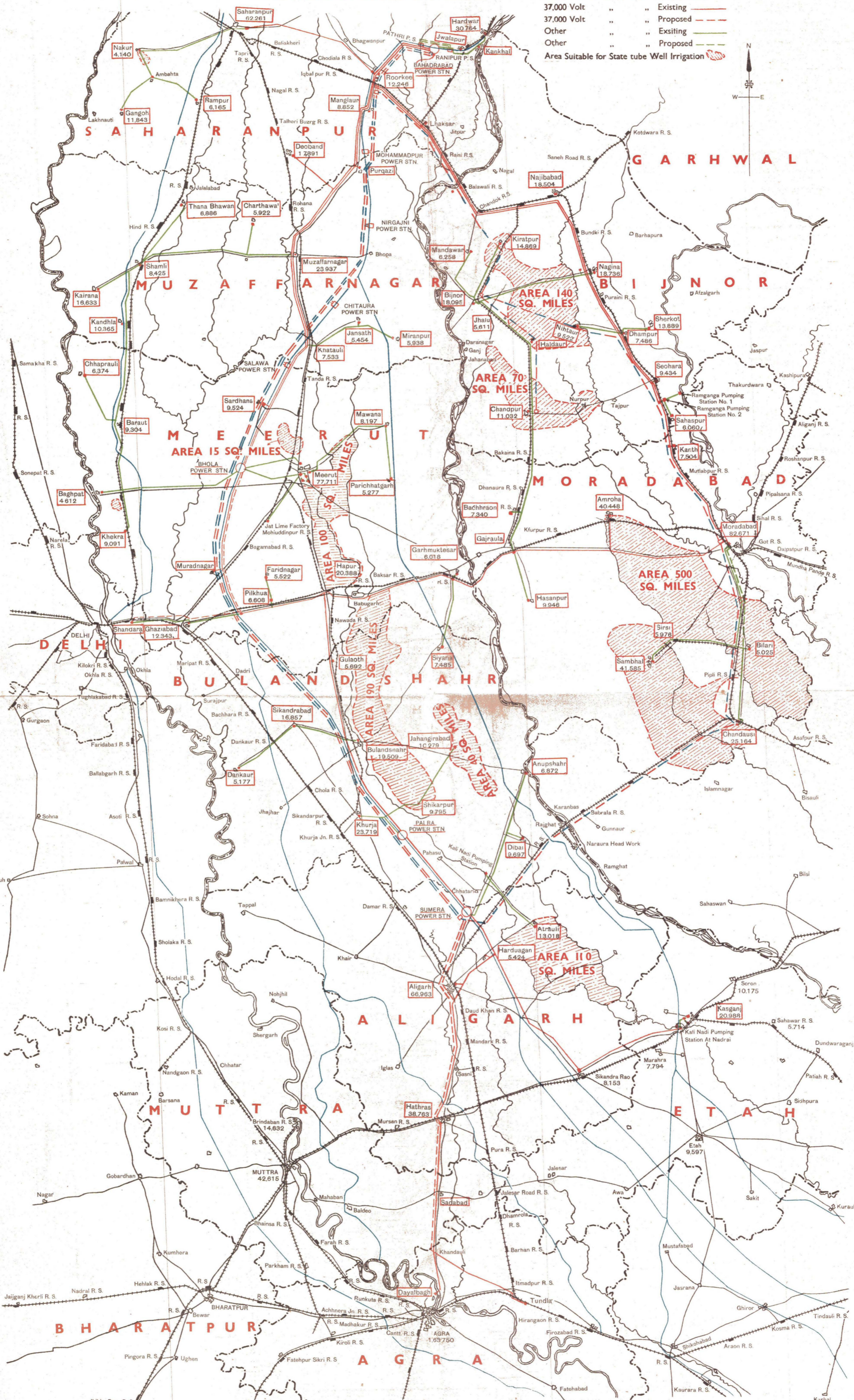
GANGES CANAL HYDRO-ELECTRIC GRID

MAP No.2.

MAP SHOWING THE ULTIMATE DEVELOPMENT.



- REFERENCES.
- Power Stations Constructed ———— ○
 - Power Stations Proposed ———— □
 - 66,000 Volt Transmission Lines Proposed ————
 - 37,000 Volt " " Existing ————
 - 37,000 Volt " " Proposed ————
 - Other " " Existing ————
 - Other " " Proposed ————
 - Area Suitable for State tube Well Irrigation



W. L. STAMPE I.S.E.,
Chief Engineer,
Western Canals,
U. P.

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GANGES CANAL HYDRO-ELECTRIC GRID