

**NEW PROJECTS  
FOR IRRIGATION AND  
POWER IN INDIA**

1950

**CENTRAL BOARD OF IRRIGATION**

**POPULAR SERIES      THIRD EDITION      LEAFLET NO. 3**

## FOREWORD TO THE THIRD EDITION

The first edition of this leaflet was published in January 1947 and the second in April 1948. In addition a Hindi Edition of the 1948 leaflet was also brought out and widely distributed in 1949. All these editions were well received both by the public and the engineers in India and abroad. The river valley projects are intended to harness the immense potential resources of the country for provision of irrigation to millions of acres of land, for production of cheap power for the rapid and intensive industrialisation of the country, for flood control and for furnishing cheap means of transport by water from the sea into the interior of the country. At the moment due to food shortage and desire for industrialization the public is naturally anxious for being posted upto date regarding the progress on these projects, completion of which will fulfil their long-cherished hope of self sufficiency in food, industrial production and general prosperity. This leaflet is, therefore, being reprinted with the object of keeping the public in touch with the activities of the Central and State Governments in the field of river valley schemes. It is hoped that the third edition which contains a brief description of the progress to the middle of 1950 on all river valley projects in India will serve its purpose and will be of interest to the public.

S. L. MALHOTRA

*Secretary*

KENNEDY HOUSE, SIMLA.

*September 15, 1950.*

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## FOREWORD TO THE FIRST EDITION

This leaflet introduces to the reader the names of projects which are, at present, under construction or under investigation in India, for the utilisation of the water wealth of the Nation. Very brief descriptions are also given.

It will be appreciated that during the investigation of projects important changes sometime become necessary in the details. As such the information furnished herein is liable to alter but it will give the reader a general picture of what is being done in the country.

N. D. GULHATI

*Secretary*

KENNEDY HOUSE, SIMLA.

*1st January, 1947.*

# NEW PROJECTS FOR IRRIGATION AND POWER 1950

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## INDIA'S POTENTIAL RESOURCES

India is fortunate in her immense resources in land and water and man-power dependent on these, which are the three essential requisites for the building up of a self-sufficient and self-perpetuating civilisation. It is also remarkable that the waterways in India are widespread and can be utilized for the service of all parts of this vast country. The practice of irrigation in India can be traced to most primitive times and this art has developed with time, resulting in construction in India of some of the most magnificent irrigation works in the world. These have been constructed during the last one hundred years both in the alluvial plains of Northern India and in the South. A brief record of the achievements of irrigation engineers will be found in leaflet No. 1 of these series. India leads the world in irrigation science and technique and irrigates more than 50 million acres of land annually but in spite of this, due to high rate of increase in her population and segregation of the best irrigated areas due to partition of the country, food production has of recent years fallen below requirements. For the last three or four years, food worth *crores*\* of rupees has been imported which is draining heavily on her foreign exchange. There is thus urgent need for the extension of irrigation facilities to new areas to step up food production for the people. On a rough calculation it has been estimated that out of the total quantity of 1,350 million acre feet of water available in the rivers of the country, only about six per cent has been utilised so far, the rest running to waste to the sea and on its way doing every year incalculable damage to life, property and crops through uncontrolled floods.

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\*One crore=10,000,000

India has a total area of 781 million acres of which 370 million acres is culturable and 250 million acres yet remain to be classified. The total area cultivated every year is 236 million acres out of which only 50 million acres are provided with irrigation annually. The irrigated area represents only 13.5 % of the culturable land and 21 % of the land actually under cultivation. Thus large areas in various parts of the country are lying as unculturable waste while existing cultivation in many areas produces but poor and precarious crops, for want of irrigation facilities.

As an addition incentive for developing water resources it may be mentioned that India is trying to keep pace with other advanced countries and is at present at the threshold of an era of industrialisation. She is, therefore, in vital need of cheap power for the setting up of big industries for the manufacture of capital and semi-capital goods, for developing cottage industries, for electrification of her vast net-work of railways and for services on the farm, in the home *etc.*

Power can mainly be generated from coal, oil and water. The quantity of good coal available in India is limited and needs to be conserved for other vital services. Oil resources of the country are scanty and India is already a big importer of mineral oils. The water in our rivers, flowing from high mountains, contains immense potentialities of generating cheap power and if harnessed, will release coal for other national works of an essential nature.

Nature has bestowed us with huge blocks of water power, locked up in the Hima'ayas and various other sites on the rivers in the South. It is estimated that the probable potential water power in India is of the order of 35 to 40 million kW. of which only 0.5 million kW has been developed so far. Possibilities of development of water power are immense and the future has a great promise in store for the people of India.

Further inland navigation was practised in India on a large scale in the past but with the advent of railways has fallen into disuse. The works which were intended for navigation at the time of their construction have seldom been utilised for that purpose. Due to expansion of irrigation almost all the winter supplies have been diverted into canals, thus leaving hardly any appreciable flow to admit of navigation. As stated above the water available in the rivers on the whole is enormous but it will require to be regulated properly to ensure in land navigation throughout the year.

It will be seen from the above that there is an immense scope for the utilisation of the unused water resources of the country for irrigation, power, navigation and other beneficial purposes. As already stated practically all the perennial supplies in the rivers have been utilized through the unique, magnificent and historic irrigation works constructed in India like the Upper Bari Doab, Sirhind, Western Yamuna and Upper and Lower Ganges Canals in the North and Godavari and Krishna Delta Canals in the South. The purpose of this leaflet, however, is to bring to the notice of the reader the new projects in hand both for irrigation and power.

## PROJECTS OF HIGH PRIORITY

Of all the schemes of development, there is no doubt, that projects relating to the development of irrigation and generation of cheap hydro-electric power are going to play the most important part in raising the production per capita and thus the standard of living of the millions of the country. The progressive and optimum utilisation of our immense water resources should, therefore, be our first task and accorded the highest priority. The Governments, Central and State, share this view but due to financial stringency in the country, except for a few important major projects attention is at present being chiefly concentrated on construction of small irrigation works to ensure quick results in order to make the country self-sufficient in food, by the target date of December 31, 1951. Several minor works, which have been given the highest priority include irrigation tube-wells, restoration of old and building new tanks, extension of existing irrigation systems and running of extra supplies during summer, digging of new wells, modernising of agriculture and reclamation of waste lands.

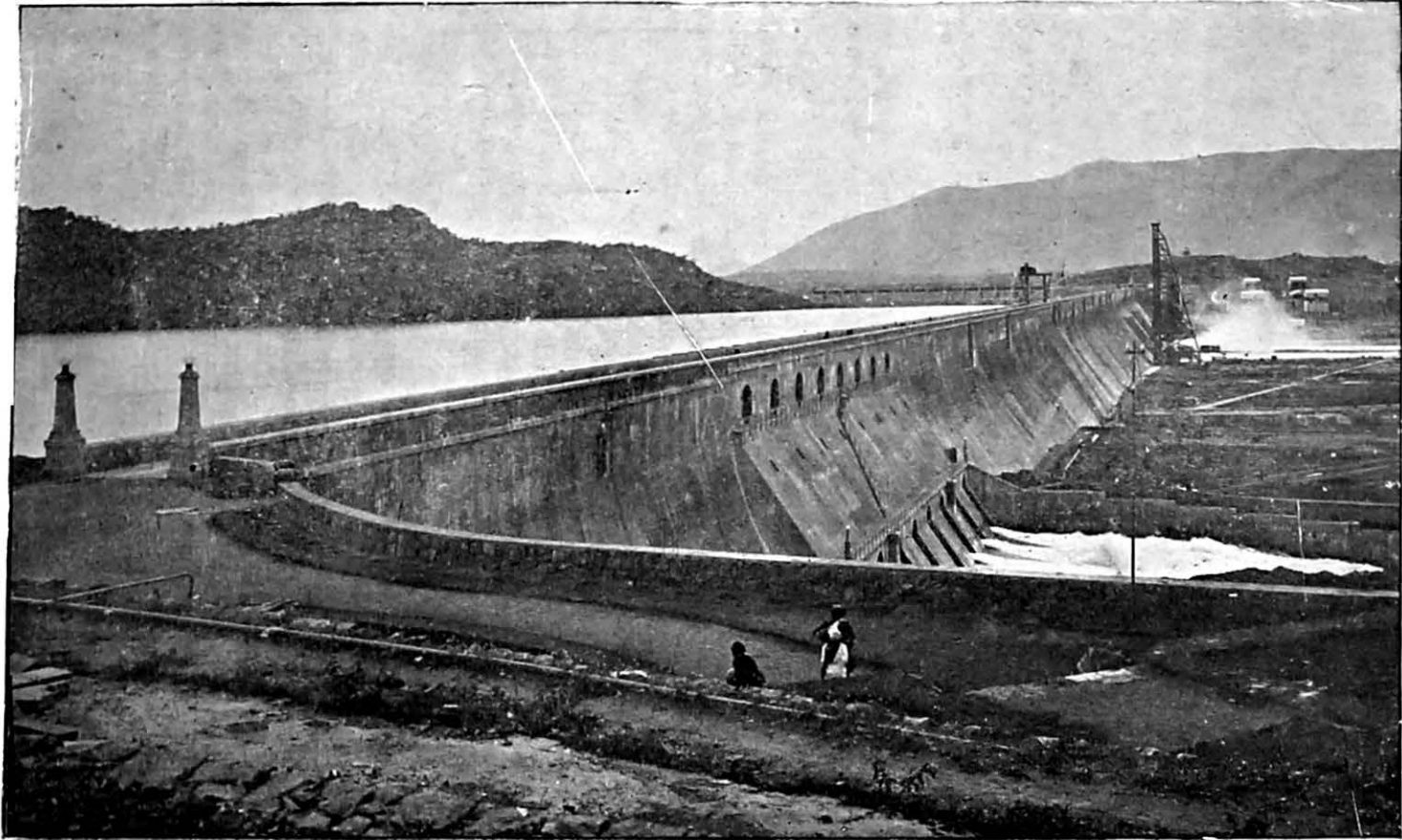
In spite of the above, the large valley schemes, although slowed down continue to receive attention possible under existing finances and some of them are actually under execution.

To ensure progress on projects of immediate importance, a Planning Commission has recently been constituted by the Government of India to co-ordinate development activities of the country and to frame programmes for the development of the country in stages consistent with the available resources in men, material and money. It is hoped that the major river valley projects shall receive the best attention of the Planning Commission, Governments and the people and their execution shall be given the highest priority in keeping with the resources available for their construction. It need hardly be emphasised that even a few projects if executed, side by side with the minor irrigation works, will help to wipe out the entire food deficit of the country.

## THE NATURE OF NEW PROJECTS

The nature of irrigation projects that have been constructed in the past, whether canals, tanks or wells is familiar to all, but most of the new projects are being designed on an extended and ambitious plan. As little water is left unused from the perennial flow in streams, more and more schemes are being based on storage of water available during the rainy season. Multi-purpose projects are being prepared to provide for irrigation, hydro-electric power, flood control, navigation, soil conservation, recreation facilities and fish culture.

Large river works with the big expanse of water, provide excellent sites for recreation facilities. The picture on the next page of the Mettur Dam in Madras which provides a lake, thirty-three miles long and upto four and a half miles broad, reveals an excellent site where one could go for a week end. The



*The Mettur Dam across the Cauvery in Madras—The reservoir formed by the dam is on square miles in extent. There will be many such "Places of pilgrimage" in India in the near future.*

Krishnarajasagar Dam in Mysore is actually visited by a large number of holiday seekers every day. The magnificent Jog Falls in Mysore State have been harnessed by building a dam at Hirabhasager for the development of hydro-power without impairing their natural beauty and are of great attraction to tourists. Many such dams are under contemplation and will be built during the years to come. These sites will provide new "places of pilgrimage" and it is hoped that recreation facilities will be provided there for the benefit of the people.

The projects that are under construction have been described in detail, a brief reference being also given to the projects that have not yet been taken up.

### BHOPAL

The Kaliasote, Ajnal, Sehore Tanks and other minor schemes :—These are minor irrigation projects for 'Grow More Food'. *Kaliasote* comprises a masonry dam with a maximum height of 50 feet and a channel of about four miles long to irrigate 1,800 acres. *Ajnal* consists of an earthen dam, maximum height 50 feet and a channel four miles long to irrigate 4,000 acres. *Sehore tanks* are to improve and increase the capacities of the existing reservoirs by raising the earthen dams and to irrigate an additional area of about 1,500 acres under sugar cane crops. Minor irrigation schemes are proposed to irrigate about 8,000 acres. These schemes are estimated to cost Rs. 47 lakhs.\*

### BIHAR

The Sakri Project comprises the construction of a datum wall across the river Sakri at Pourahi. The canal taking off the headworks will extend irrigation facilities to an area of 50,000 acres. The scheme is estimated to cost Rs. 16,37,000. The project is expected to be completed very shortly.

### BOMBAY

The Meshwa Canal Project comprises a pick-up weir across the Meshwa River at Kaska, Khaira District and a canal on the right bank of the river. The scheme will directly irrigate 10,000 acres of rice crop under its own command and will indirectly benefit an area of 8,000 acres. The estimated cost is Rs. 80 lakhs. The project was started in 1948-49 and is expected to be completed in 1950-51.

The Gangapur Storage Project comprises an earthen dam with a reservoir of 126,500 acres feet capacity on the river Godavari at Gangapur, District Nasik. This will supplement the existing supplies to the Godavari Canals and also provide water supply to Nasik City. It is also proposed to harness falls below the dam, if possible, for generation of power. The work

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\* One lakh = 100,000

on the project is in hand and is expected to be completed by 1953-54. The additional area to be brought under irrigation is 37,500 acres and the increase in food production will be 7,500 tons. The estimated cost of the project is Rs. 334 *lakhs*.

The Wardala Tank comprises the construction of an earthen dam on the Zarmar river at Wardala in Kapadwanj Taluka of the Kaira District. The storage capacity of this reservoir will be 5,370 acre feet. The scheme is expected to cost Rs. 11.5 *lakhs* and will irrigate 3,400 acres. The preliminaries have since been completed. The designs are being finalised. The actual construction will be completed by 1951-52.

The Vir Dam Project.—The scheme is the final phase in the development of the Nira River Valley Project and is supplementary to the existing Bhatgar Reservoir and the Nira Canals. The works involved are (i) construction of a composite dam at Vir in Poona District across the Nira river to store about 2,200 acre feet of water and (ii) remodelling of the Nira Right Bank Canal and Thil Tank at Tisangi. The scheme will cost Rs. 412 *lakhs* and will bring under irrigation an additional area of 99,850 acres. All preliminary surveys have since been completed and the detailed designs are also ready. Work on remodelling the first 50 miles of the Nira right bank canal is in progress. The scheme is expected to be completed by 1956-57.

The Ranand Tank comprises a storage reservoir of 5,700 acre feet capacity on a tributary of the Man river in Satara District. It will irrigate about 4,000 acres of seasonal food crops. The estimated cost is Rs. 21.5 *lakhs*. The work on the scheme was commenced on July 26, 1949 and is expected to be completed by March 31, 1952.

The Patadungri irrigation Tank Project comprises a storage dam, capacity 27,000 acre feet, across the river Khan, Dohand Taluka of the Panch Mahals district. The scheme is estimated to cost Rs. 42 *lakhs* and will irrigate 12,700 acres. The work on the project was commenced in 1949-50 and is expected to be completed by 1952-53.

The Budhial Tank Project estimated to cost Rs. 25.68 *lakhs*, contemplates the completion of an unfinished famine work in the Sholapar District. The capacity of tank will be 23,800 acre feet and the area proposed for irrigation is 11,000 acres of seasonal crops. The project is expected to be completed by 1952-53.

The Radhanagari Hydro Scheme comprises the construction of a dam, 140 feet high, for a storage capacity of 194,000 acre feet across the river Bhogavati, 34 miles southwest of Kolhapur on Kolhapur-Malvan Road. The scheme is meant to supply water for irrigation of 9,000 acres of sugar cane and 10,000 acres of the dry crops and also water supply to Kolhapur City. In addition a low-head hydel station to generate 1,600 kW. continuous power is being constructed on the rear side of the dam. The power made available will cater for the needs of irrigation pumps and also both industrial and lighting load of Kolhapur Town for the present. The scheme is estimated to cost Rs. 207 *lakhs*. The work on building the dam is well advanced and about 60% has been completed. The year of completion of the project is 1952.



The Kakrapar Project has been taken up by the C.W.I.N.C. on behalf of the Government of Bombay and was inaugurated on November 1, 1949. The project is proposed to be developed in two stages. Stage I comprises the construction of a cement concrete dam in the river bed of the Tapi with earthen dam on both banks impounding a gross storage of 1,000,000 acre feet for providing seasonal irrigation to 550,000 acres and perennial irrigation to 50,000 acres. The installed hydro-electric capacity will be 24,000 kW. The cost will be Rs. 12 crores. Work on this stage was started in November 1949 and is expected to be completed by 1952-53. In stage II the height of the dam will be raised for increasing the gross storage capacity to 3.55 million acre feet. There will be two power houses, one at the dam site and the other at the end of a 16-mile power canal with a total installed capacity of 2,00,000 kW. The firm power available at 60% load factor will be 133,000 kW. There will be in addition high level canals commanding a gross area of 100,000 acres. Stage II will cost Rs. 31 crores and is expected to be completed by 1956-57. The scheme will ensure partial flood control of the river.

## HYDERABAD

The Tungabhadra Project—(See under Madras.)

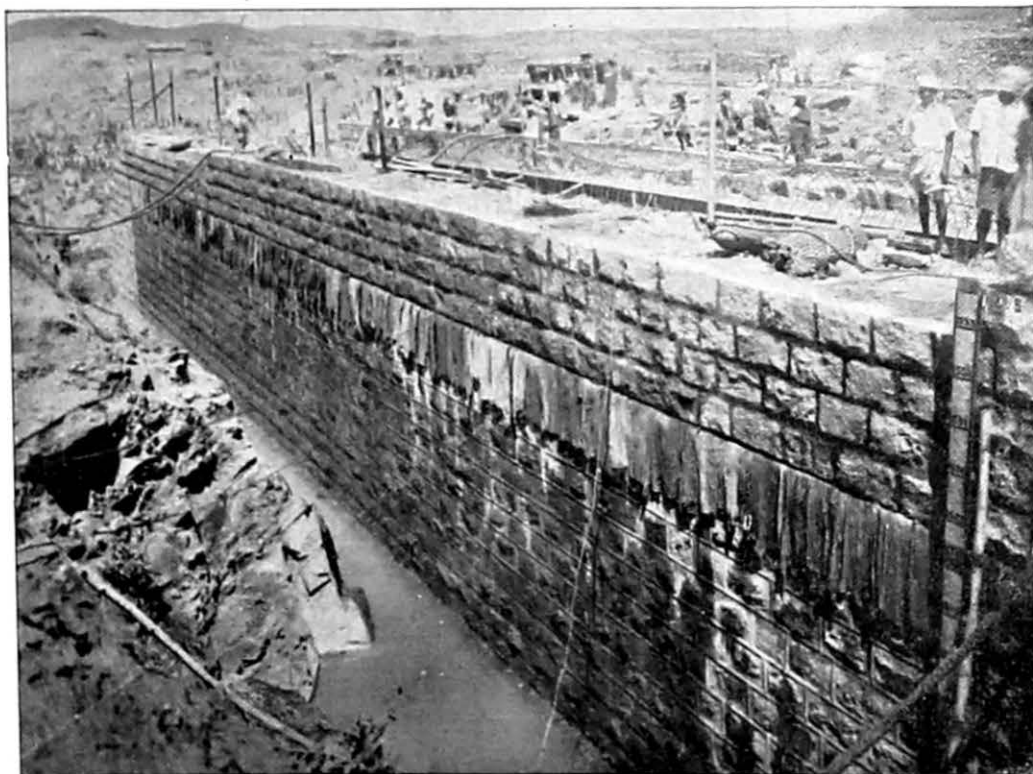
The Nizamsagar Hydro-electric Scheme envisages the utilisation of a drop of 31.5 feet in the existing Nizamsagar canal in the first mile for the generation of hydro-electric power of 15,000 kW. The output of power will vary from 15,000 kW. to 2,000 kW. The scheme is estimated to cost Rs. 140 lakhs and is expected to be completed during 1950.

The Rajolibunda Project is a diversion scheme with an *anicut* across the river Tungabhadra, 80 miles below the site of the Tungabhadra Dam under construction, for an irrigation of 107,000 acres in the Hyderabad territory. The cost of the project is Rs. 1.9 crores and the work is programmed to be completed by 1951.

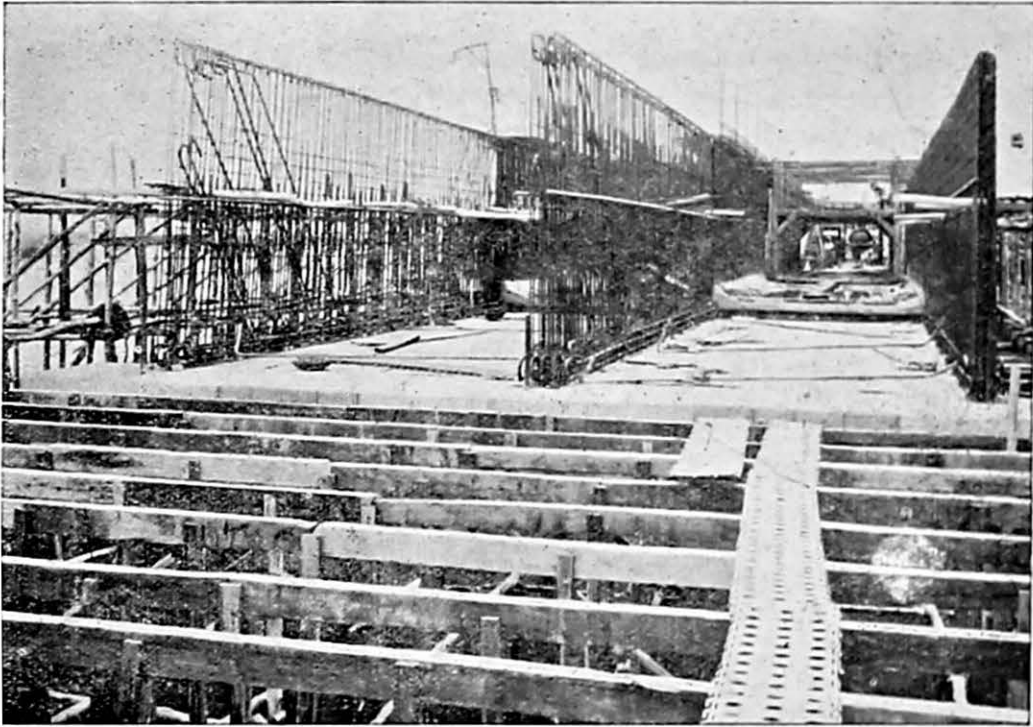
The Godavari Project is a multipurpose scheme and envisages the construction of four dams, two on the main river Godavari and two on the tributaries, the Kaddam and the Manair. The canals will take off from the lower dam on the Godavari on both the north and south banks. The total capacity of the reservoirs formed by the dams will be about 3.0 million acre feet. The total area irrigated will be two million acres. In addition hydro-power to the extent of 175,000 kW. will be generated at the dam and the drops on the canals. The total cost of the scheme including power development and transmission lines is estimated at Rs. 75 crores. As a first step in the implementation of this scheme, a part consisting of the dam on the Kaddam tributary and the canal from it, 90 miles long, has been taken up at a cost of Rs. 8.4 crores. This partial scheme will bring under irrigation 227,000 acres. The work is programmed to be completed by 1955.

## JAMMU AND KASHMIR

The Sindh Valley Hydro-electric Scheme comprises the construction of a headworks at Prang, 22 miles away from Srinagar, across the Sindh Nala, a tributary of the Jhelum. About 375 cusec of water will be carried by a 10-mile long lined canal from the headworks to the generating site at Ganderbal, about 13 miles away from Srinagar. A static head of about 460 feet is available there. It is proposed to have an ultimate installed capacity of about 18,000 kW. with sets of 3,000 kW. each and one set as standby. A reservoir of about 80 acre feet capacity will be made near the forebay which is sufficient on the load factor basis to give 15,000 kW. station capacity. At present only two sets of 3,000 kW. each will be installed. The estimated cost of the scheme is Rs. 150 lakhs. The work was started in 1947-48 and is expected to be completed by 1953-54.



*Tungabhadra project—Showing the front face of the dam on the spillway section. Details of pointing the front face and the grill for the drainage gallery are also seen.*



*Hagari Aqueduct—Reinforcement for first stage beams, etc.—two compartments of 12 feet each.*

#### MADRAS

The Tungabhadra Project work on which has been taken up jointly by Madras and Hyderabad, has as its main feature a masonry dam 160 feet high and 7,942 feet long across the river Tungabhadra, a tributary of the Kistna, near Mallapuram in Bellary District. The main dam, 158 feet high at the deepest foundation, will be of the straight gravity type and will be in rubble in cement or *surkhi* mortar. It will be 6,000 feet long with a spillway in the centre and bulk head section at either end. At the low saddle at the left flank there will be a composite dam for 2,000 feet length. The effective capacity of the reservoir will be 2.6 million acre feet.

On the Madras side the head available at the dam is 60 feet and that at the 15th mile of the canal 110 feet. These heads will be utilised for developing hydro-electric power from the waters drawn from irrigation. About 7,000 kW. of firm power will be developed. 14,000 kW. of seasonal power could also be developed for eight months in a year. The main canal will be 225 miles long and will irrigate a total area of about 300,000 acres in Bellary and Kurnool Districts. The most important work on the canal is an aqueduct across the river Hagari at the 81st mile of the canal. This aqueduct will be 2,400 feet long and will consist of 58 spans of 35 feet each. The cost of

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*Duduma Falls as viewed from the jeep road*

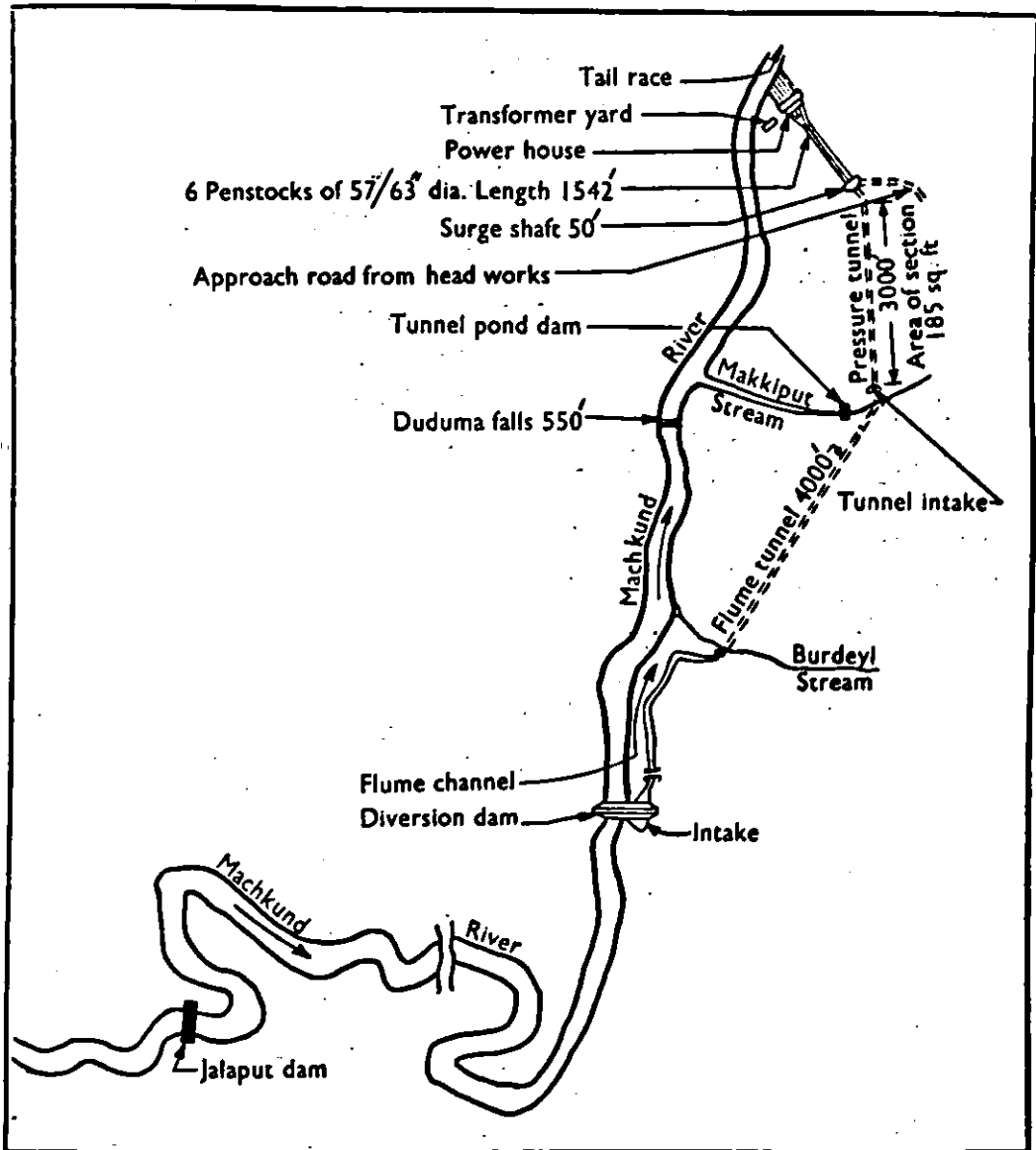
the project to Madras is Rs. 17 crores. It is programmed to be completed by 1953.

The length of canal on Hyderabad side is 140 miles with a carrying capacity of 7,000 cusec at the head, to irrigate 671,000 acres. Hydro-power is proposed to be generated at the dam and at the drops on the canal to the extent of 150,000 kW. The estimated cost on Hyderabad side is Rs. 12.1 crores. The work is well in hand and is programmed to be completed by 1954.

The Lower Bhavani Project comprises the construction of a dam, 160 feet high and 1,520 feet long with earthen flanks, across the river Bhavani, a tributary of the Cauvery. The site is about 20 miles from the Mertupalayam Railway Station. A canal on the right side, 121 miles long, will irrigate about

200,000 acres of cotton, cholam and rice crops in Coimbatore District. The cost of the scheme is Rs. 8.2 crores. A start on the construction was made in 1948 and is scheduled to be completed by 1954.

The Machkund Hydro-electric Project aims at harnessing the Machkund river in the Visakhapatnam District on the border of Madras and Orissa at the Duduma falls where a gross head of 840 feet is available. 100,000 kW. can be developed at this site and the scheme is proposed to be worked out in stages:



*An index plan showing location of Duduma falls and appurtenant works.*

The initial stage comprises the construction of a dam at Jalaput on the Machkund river to store 612,000 acre feet of water, a diversion dam across the river 17 miles below and 1.5 miles above the Duduma Falls, a flume channel 4,135 feet long skirting the hills, a flume tunnel 4,250 feet long, a tunnel pond forebay, a low pressure tunnel 3,000 feet long, a surge tank and three penstock pipes leading to the power house. The power house will have three generating units each of 17,250 kW. capacity and six in the ultimate stage. The power water discharged into the river at the Jalaput dam will be diverted into the flume at the diversion dam. The water from the diversion dam will be taken partly along an open concrete lined flume and partly through a free flow tunnel and will discharge into the Mukkipot Valley. A regulating pond will be formed in the valley by building a small dam 442 feet long and 66.5 feet high above the deepest bed. From the tunnel pond water will be taken through a pressure tunnel. This will be of horse-shoe type and will end in a surge shaft which will be entirely in excavation. From the surge tank penstocks will take off leading to the turbines. The cost of civil works and power house is estimated at Rs. 774 lakhs for the initial stage and Rs. 932 lakhs when two more units are added. The project was started in 1947 and is expected to be completed in 1953.

The Malampuzha Project consists of a masonry overflow dam 60 feet high across the Malampuzha river near Palghat. A canal 20 miles long will irrigate an area of 40,000 acres of second crop and 13,000 acres of third crop in Palghat Taluk in Malabar District. The cost of the project is Rs. 380 lakhs. It was inaugurated on March 27, 1949 and is expected to be completed within five years from the date of commencement.

The Moyar Hydro-electric Project utilises the tail water of the existing Pykara Power Station at the Moyar Slopes, 10 miles lower down, where a head of about 1,280 feet is available. The main features of the scheme are (1) a masonry diversion weir 50 feet high across the Glen Morgan Stream just below the junction of the Pykara Power Station tail race and the stream, (2) a channel about 7,600 feet long to carry the water so diverted to the adjacent Avaraihalla, (3) a regulating reservoir at Maravakandy, four miles lower down by constructing a masonry dam across the Avaraihalla Stream, (4) a flume channel 23,000 feet long to handle 460 cusec from the reservoir to the forebay and headworks at Guruva Gowden Hundi, (5) a 7-foot diameter low pressure pipe line from the forebay to the surge tank at the head of the penstocks on the top edge of the Moyar Gorge and (6) three penstocks, 2,880 feet long in two sections of 45 inches and 42 inches diameter from the surge tank to the power station. The station will have an installed capacity of 36,000 kW. The cost of this scheme is Rs. 381 lakhs. The civil works of the projects are in advanced stages of progress and are likely to be completed before the end of 1951.

The Rallapad Project consists of a reservoir with an earthen dam across the Manneru river with a pick-up *anicut* six miles downstream. There will be a canal on the right side from the reservoir for irrigating about 9,200 acres and a canal on the left flank of the *anicut* to irrigate 2,800 acres. The scheme was sanctioned in 1948 and is expected to be completed by 1952. The estimated cost is Rs. 58 lakhs. It is now proposed to increase the capacity of the reservoir and revised designs are under preparation.

## MADHYA BHARAT

The Chambal Irrigation and Hydel Development Project aims at harnessing the Chambal for irrigation, hydro-electric generation and flood control by construction of three dams and one barrage for the benefit of both the Madhya Bharat and Rajasthan States. A dam, 190 feet high, will be constructed near Chausigarh Fort with a storage capacity of seven million acre feet. Hydro-power to the extent of 28,000 kW. to 38,000 kW. at 100% load factor will be developed and the area to be irrigated will be 40,000 acres. The second dam 100 feet high, near Rawatbhata with a storage capacity of 1.3 million acre feet, will develop 30,000 kW. to 40,000 kW. power at 100% load factor and will provide irrigation facilities to 10,000 acres. The third dam 145 feet high, will be located near Gapernath and will develop 30,000 kW. to 40,000 kW. power at 100% load factor. The barrage will be located near Goanari village and the canals taking off therefrom will irrigate 1,000,000 acres. The total cost of the scheme is Rs. 28 crores. The work on the project was started in October 1948 and is expected to be completed by July 1955.

## MYSORE

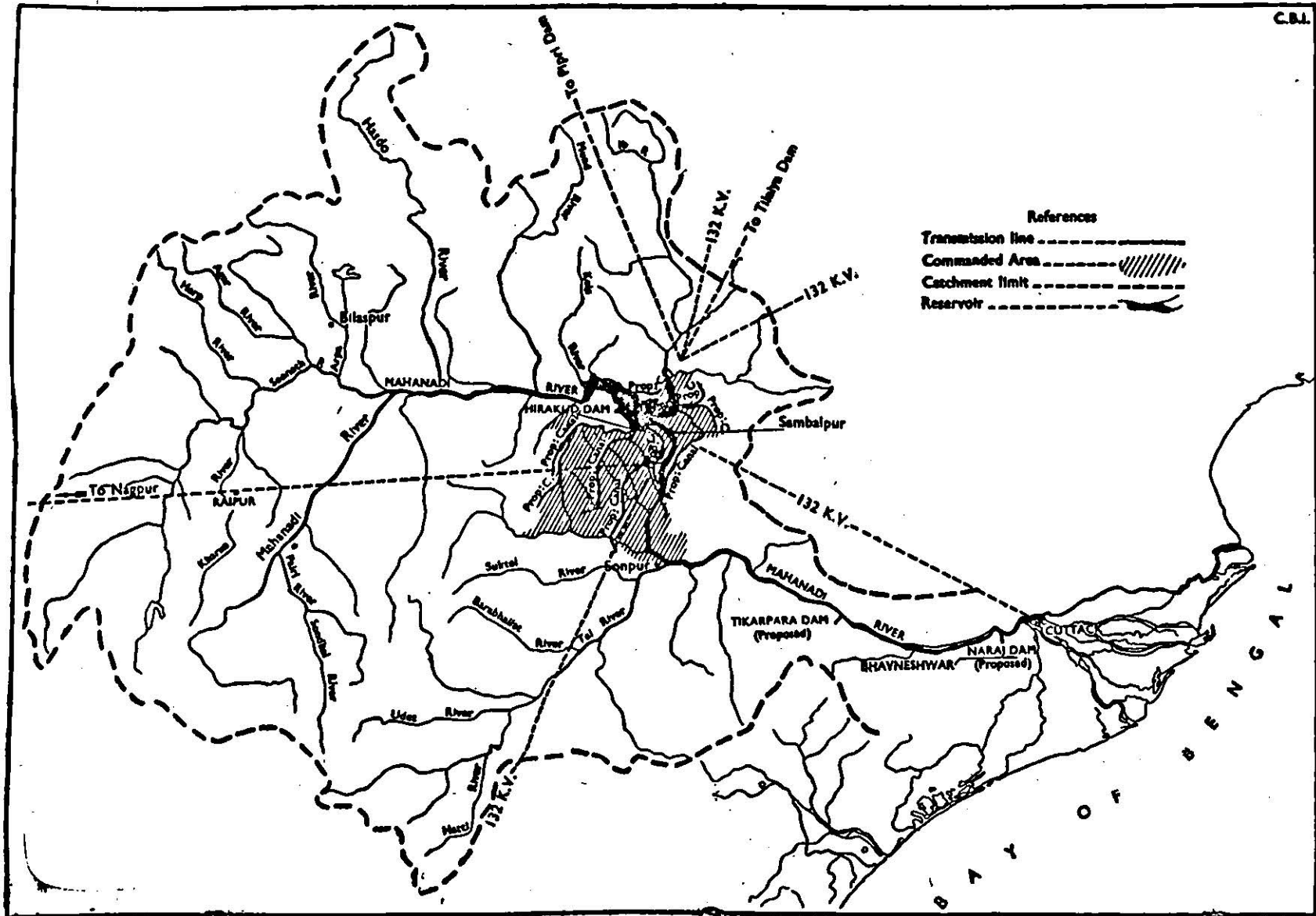
**The Mahatma Gandhi Hydro-electric Works.**—The magnificent Jog Falls on the Sharavati river have been harnessed and the first unit capable of generating 12,000 kW. was switched on in February 1948. Since then three other units each of 12,000 kW. have been erected and put into service. Work on the erection of four further generators each of 18,000 kW. is in progress and these will be ready to go into service in 1951-52. The project under construction, when completed, will have an installed generating capacity of 120,000 kW. The estimated cost of the scheme is Rs. 8.25 crores.

**The Lakkavali Reservoir Scheme** comprises the construction of a dam 185 feet high above river bed across the Bhadra at Lakkavali to impound 1.55 million acre feet of water to irrigate 180,000 acres. It is also proposed to utilise the supplies drawn for irrigation first for power generation before letting them into irrigation. The power thus generated will be 12,680 kW. continuous. The estimated cost of the scheme is Rs. 8.88 crores.

**The Nugu Reservoir Scheme** comprises the construction of a composite dam, 120 feet high, across the river Nugu, a tributary of the Kabini river and a right bank canal to irrigate 20,000 acres. The scheme is estimated to cost Rs. 81 lakhs. The work on it was started in 1947 and is expected to be completed by 1953.

**The Tunga Anicut Works** under construction comprises of a 40 feet high composite overflow dam with two canals taking off one from either bank to irrigate 21,000 acres in Shimoga and Bannali Taluks. The estimated cost of the project is Rs. 198.5 lakhs. The work is proposed to be completed by 1952-53.

There are several other minor schemes under contemplation in the State such as Hamavathi Reservoir Scheme, Mekadatu Scheme. The State has also launched ten years programme costing rupees two crores for the restoration of small derelict village tanks.



- References
- Transmission line -----
  - Commanded Area -----
  - Catchment limit -----
  - Reservoir -----

Index Map of Hirakud Dam Project



## ORISSA

The Unified development of the Mahanadi Valley as designed by the Central Waterpower, Irrigation and Navigation Commission will consist of three units,



*A view of the Rail-Road Bridge across the Mahanadi with Callendar Hamilton Bridge rolled in for a few spans. This bridge has since been completed.*

namely, the Hirakud Dam Project, the Tikkarpara Dam Project and the Naraj Dam Project, each with its own canal systems and hydro-electric power installations. As a first step, the Hirakud Dam Project has been taken in hand. This dam will be nearly three miles in length across the main channel with 17 miles of low dykes on the two sides. The maximum height of the dam above the bedrock will be about 150 feet. The reservoir will have a gross storage capacity of 5.98 million acre feet. Nearly 0.9 million acres of land will be irrigated; of this nearly 0.4 million acres will be irrigated by pumping the water by means of electric power generated by the power houses.

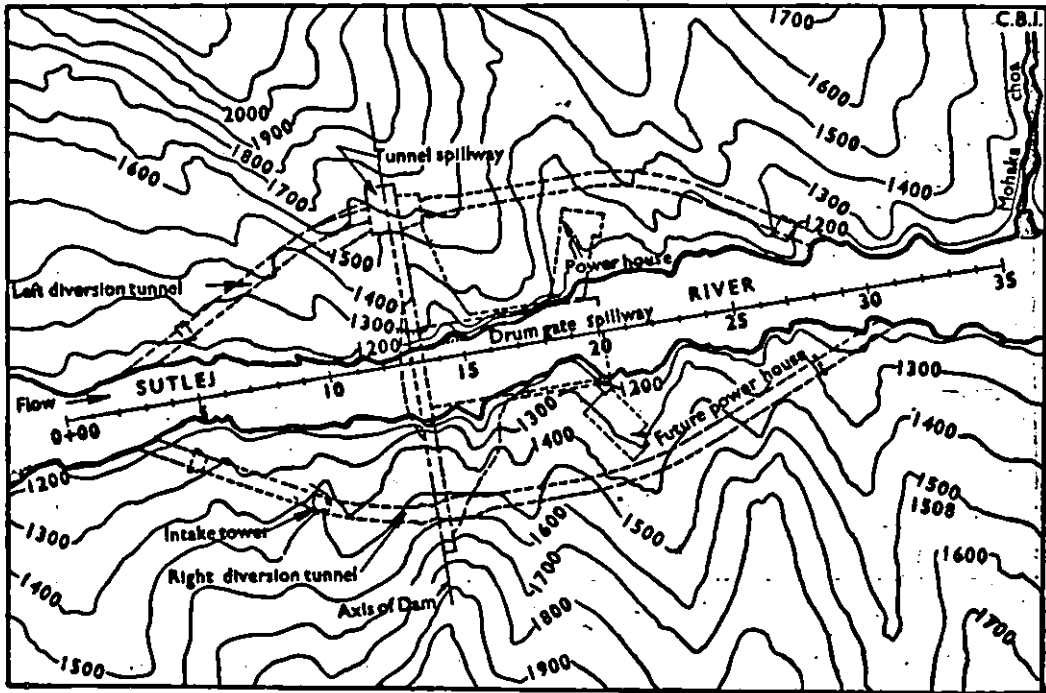
There will be two power houses; one at the dam with an installed capacity of 2,25,000 kW. and the other about 17 miles downstream (at a subsidiary dam) with an installed capacity of 96,000 kW.

With the construction of the Hirakud Dam, it will be possible to afford substantial and adequate measure of flood protection to the delta area at relatively small cost. The regulated releases of water from the Hirakud reservoir will permit appreciable improvement in the navigability of the Mahanadi. Orissa through centuries in the past, has been haunted by spectres of flood and drought. The construction of the Hirakud Dam will substantially relieve the State from the clutches of flood and drought.

The cost of the Hirakud Dam project including main transmission lines and grid substations is Rs. 48 crores.

## PUNJAB

The Bhakra Nangal Project, the completion of which will turn Punjab into a homeland of granary and industrial area and can wipe out most of the food deficit of the country, is now under active construction.

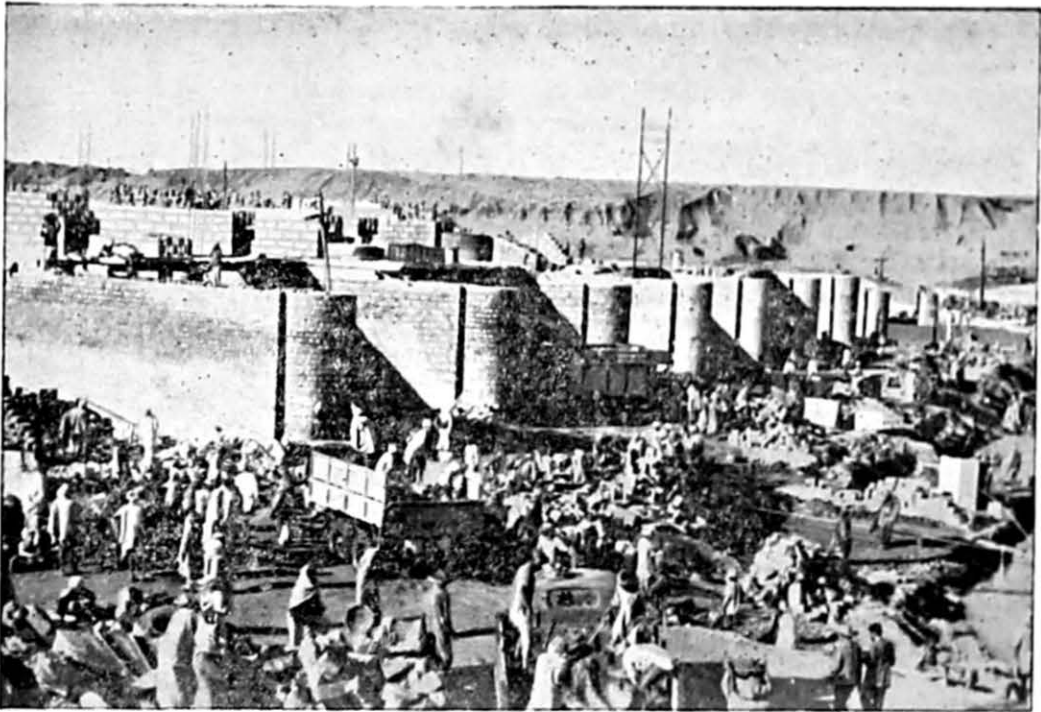


*A general layout at Bhakra Dam Site*

The principal feature of the project is the construction of a 680 feet high dam on the river Sutlej near village Bhakra, about 50 miles upstream of Rupar town, in Ambala District of Punjab; the reservoir formed will have a gross capacity of 7.2 million acre feet out of which 5.625 million acre feet will be available for use. The reservoir will extend to about 50 miles above the dam.

The dam will be of the straight gravity type in concrete. The length at the top will be about 1,650 feet. During construction of the dam, the waters of the Sutlej will be diverted through two 50-foot diameter tunnels, one on each side. The length of two tunnels will be about one mile. Pilot headings of these tunnels have since been completed and their enlargement to full diameter of 50 feet is in progress.

About eight miles downstream of the Bhakra Dam, Nangal Dam is under construction. This dam, 90 feet high, will serve, firstly to divert the requisite supplies from the river Sutlej into the Nangal Hydrel Canal, secondly to provide storage to smoothen the fluctuations is supplied due to load variations at Bhakra Power Plant. The Nangal Canal will take off from the left bank of the



*A view of the Nangal Dam showing piers in progress*

river Sutlej at Nangal Headworks. It will be a lined canal about 40 miles long with a full supply discharge of 12,500 cusec. The Bhakra Main Line will take off from the tail of this channel at Rupar. There will be three power houses on the Nangal Canal. The first two power houses, each utilising a head of 98 feet, are under construction and are situated 12 and 18.6 miles downstream of the Nangal Dam and the third is to be located at Rupar with a fall of about 60 feet into the Sirhind Canal.

The Nangal Dam is nearing completion and it is expected that the erection of the first generating set at Power House I will be completed early in 1952 and the second set will be ready by the middle of 1952. Thus it will be possible to commence commercial supply of electricity from this Power House about the middle of 1952. Power House II is expected to be ready for commercial supply of power by the end of 1952.

The firm power potential of the project works out to 400,000 kW. at 100% load factor. This power will be utilised in the States of the Punjab, PEPSU, Himachal Pradesh, Delhi and Rajasthan.

New Irrigation canals of an aggregate capacity of 15,400 cusec *i.e.*, Bhakra Main Line which takes off from the Nangal canal, Bist Doab Canal which takes off at Rupar and Sidhwan Branch which takes off from the existing Sirhind Canal, are under construction, will command an area of 6.6 million acres in the States of the Punjab, PEPSU and Rajasthan out of which

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1.6 million acres is at present virgin waste land. Annual irrigation expected is 3.6 million acres which will yield 1.13 million tons of food grains and 800,000 bales of cotton. The project is estimated to cost Rs. 132.9 crores. Cost chargeable to irrigation and hydro-electric portions works out to Rs. 57.4 crores and Rs. 75.5 crores respectively. The whole project is programmed to be completed by 1955-56.

The Balban Canal Project contemplates the construction of a new branch to take off from the Western Yamuna Canal near Jagadari for the *kharif*\* irrigation of gross area of 230,000 acres. The estimated cost of the scheme is Rs. 70 lakhs and is proposed to be completed by 1952.

The Improvement and Extension of Irrigation of Kangra Valley Scheme contemplates the taking over by the Government the control of *Kulhas* (small streams) from individuals and private agencies which are at present very poorly managed. Their maintenance by the Government, economical distribution and use of water supply for extension of irrigation and assured supply are sure to improve the general economic condition of the valley. The gross commanded area is 225,000 acres out of which 90,000 acres will be virgin land. The scheme is estimated to cost Rs. 60 lakhs and is expected to be completed by 1953-54.

The Extension of Irrigation in Kulu Valley Scheme estimated to cost Rs. 8 lakhs, envisages the taking over by the Government the control of *Kulhas* which are at present owned by individuals and are poorly managed. The gross culturable commanded area affected by the scheme is 22,000 acres out of which 10,000 acres are virgin lands. The scheme is proposed to be completed by 1951-52.

### RAJASTHAN

The Jawai River Irrigation and Hydroelectric Project, under construction, has a potential of 4,000 kW. hydel power and irrigation of 110,000 acres. The scheme is programmed to be completed by 1953.

The Morel Reservoir Project comprises the construction of a dam four miles upstream of Lalsote-Sawai Madhopur Road across the river Morel. The area irrigated will be 13,750 acres. The scheme is estimated to cost Rs. 20 lakhs and will be completed in 1950.

### SAURASHTRA UNION

The Brahmani Irrigation Scheme comprises the construction of a dam on the river Brahmani just below its junction with river Balal near village Palson. The main dam is earthen and 8,400 feet long. The area under command will be 75,000 acres out of which 12,000 acres will be under *kharif* and 50,000 under *Rabi*† crop will be irrigated. The total cost is estimated at Rs. 7.24 crores. The construction on the project was started in 1949 and is programmed to be completed by 1953.

The Bhimdal Irrigation Scheme contemplates the construction of a storage reservoir near Bhimdal in Batad Taluka. The dam work was started about 25

\* Summer Crop.

† Winter Crop.

years back but was dropped due to some difficulty in acquiring land after spending about Rs. 2·5 *lakhs*. The scheme has now been reinvestigated for taking maximum advantage out of it. The estimated cost is Rs. 17·77 *lakhs*. The investigations have since been completed and the project is to be completed by 1952. The area proposed to be irrigated is 4,000 acres.

**The Machhu Irrigation Scheme** comprises the construction of a dam across the river Machhu just below the junction of river Machhu and Benio—22 miles north east of Rajkot. The main dam will be masonry and will have a storage capacity of about 60,000 acre feet. The area under command is 45,000 acres out of which 22,000 acres will be irrigated under mixed crops. The total cost of the scheme is Rs. 68·04 *lakhs*. The work on this project is under progress and is expected to be completed by 1952.

**The Malan Irrigation Project** envisages the construction of two earthen dams, one across the river Malan and the other on the River Rojke, a tributary of the Malan. The total land under irrigation will be 10,970 acres. The estimated cost of the project is Rs. 53·27 *lakhs*. Work on this project was started in 1950 and is scheduled to be completed by June 1952.

**The Moj Irrigation Scheme** envisages the construction of a masonry dam across the river Moj, eight miles upstream of Unleta. The area under command will be 30,000 acres out of which 15,000 acres will be irrigated. The cost will be Rs. 57·87 *lakhs*. The work is proposed to be completed by 1953.

**The Rangola Irrigation Scheme** contemplates the construction of an earthen dam on the river Rangola, one mile upstream of village Rangola, 34 miles from Bhavnagar. The area under command is 41,000 acres, out of which 10,000 acres will be irrigated under mixed crops. The work is scheduled to be completed in 1950.

**The Sashoi Irrigation Scheme** envisages the construction of a dam 49 feet high to irrigate 56,000 acres of land. The estimated cost is Rs. 58·6 *lakhs*. The project was started in 1945 and is expected to be completed in 1952.

#### UNION OF TRAVANCORE AND COCHIN

**The Chalakudy Scheme** contemplates the diversion of the waters of the Chalakudi river at present running to waste into the sea, for the purpose of irrigation by constructing a weir at Thumburmuzhi about 10 miles below Adirappilli falls, with two canals on the left and right banks. The total area to be benefited by the scheme is about 50,000 acres with an additional yield of 13,000 tons in a year. The work on the weir and canals is in progress and is programmed to be completed by the end of 1951. The estimated cost of the scheme is Rs. 120 *lakhs*.

**The Peechi Irrigation Scheme** is designed to conserve the waters of the Manali river by the construction of a masonry dam and use them for irrigation purposes by means of two canals. The area to be benefited is 47,800 acres of paddy lands with an expected additional yield of 16,000 tons annually. The scheme also provides for the supply of drinking water to the neighbouring town of Trichur where there is scarcity of drinking water. The work on this scheme

was started in the year 1948 and the dam and the canals are now in good progress. The entire scheme is scheduled to be completed by the end of 1952. The estimated cost of the scheme is Rs. 150 *lakhs*.

The **Kodyar Project Extension** comprises the construction of a dam across the Paralayar and the construction of a diversion weir at Thripparappu across the Kodyar for supplementing irrigation in the commanded area of the Kodyar Project in South Travancore. When completed, about 11,000 acres of land will be irrigated besides assuring the unfailing supply to several acres of existing paddy lands in Kalkulan and Vilavancode taluks. The scheme was started four years ago and all auxiliary works have since been completed. Work on the dam proper has been taken up in right earnest and is expected to be completed by the end of 1951. The estimated cost of the scheme is Rs. 67.42 *lakhs*.

The **Pallivasal Hydro-Electric Stage II Project** comprises the construction of Madupaldy dam in the upper reaches of the Mudirdpuzha river for impounding 45,900 acre feet of water to maintain a continuous discharge of 250 cusecs in the river for the most part of the year. Only on its completion the Pallivasal Power House will give out its full firm output of 32,500 kW. The dam is expected to be completed by 1953.

The **Sengulam Hydro-electric Project** envisages the utilisation of the tail water discharged from the Pallivasal Power station over a head of 1,200 feet.

The project is under execution and is estimated to cost Rs. 269 *lakhs*. The water discharged from the Pallivasal generating station will be taken through the channel about 1,400 feet long to a storage pond from which it will be pumped over a head of 50 feet into concrete lined tunnel 7,500 feet long. This tunnel will emerge into a balancing reservoir created by constructing a gravity dam about 70 feet high. The water from the balancing reservoir will be taken to another tunnel 5,500 feet long through a low pressure pipe line and two penstocks to feed four pelton driven generators each rated at 12,000 kW. housed in a power station in the bank of a Mudirapuzha river at Vallathuval. The combined output of the Pallivasal and Sengulam generating stations will be about 73,500 kW. at 70 per cent. load factor. The various hydraulic works are yet under way and nearly 60 per cent. of the tunnel work has been completed. The first unit in the Sengulam power Station is anticipated to be put on commercial load by the end of 1951 or beginning 1952.

The **Porinkaluthu Hydro Electric Scheme** is proposed to be developed in five stages. The work on the first stage is in progress and when completed in 1954 will develop 16,000 kW. at 50 per cent. load factor. It consists of building of a dam across the river above Porinkaluthu falls to obtain a storage of 27,840 acre feet. The water will be taken from this reservoir through a tunnel approximately 4,000 feet long to a valve house and thence through three pipe lines to feed three Francis turbines driving alternators each rated at 8,000 kW through a gross head of 595 feet. The first stage works are estimated to cost 234 *lakhs*. The construction of the dam tunnel, roads and buildings are in progress.

## UTTAR PRADESH

The Pipari Dam Project is meant to supply water for irrigation in the Lalitpur Tehsil in Jhansi District and augment supplies in the Betwa canals for the irrigation of new areas in Jalaun District. The work is in progress and is expected to be completed by 1951. The cost of the scheme is Rs. 186 lakhs and the area to be irrigated is 116,700 acres.

The Sarda Canal Hydro-electric Scheme (Khatima Power House) is one of the major schemes, the Uttar Pradesh Government have in hand at present. It is proposed to combine into a single drop a number of existing drops on the existing Sarda Canal between its mile 7 and mile 20 and to instal a power station near Khatima about nine miles from Banbassa, the Head-works of the Sarda Canal. The power house will generate 41,400 kW. out of which 23,000 kW. will be firm power. The cost of construction of the power station including plant, about 12 miles long tail race channel and allied works, is estimated to be Rs. 7 crores approximately. This project will supply electric power to the Kumaon, Rohilkhand and Oudh divisions for domestic, agricultural and Industrial purposes. It will also augment the power supply of the existing Ganga Hydrel Grid.

The Pathri Power Station Project will add an installed capacity of 19,500 kW. out of which 10,000 kW. will be firm power, on the Ganga Hydro-electric Grid by the construction of a power house on a by-pass power-channel at Bahadrabad on the Main Ganga Canal. The project is under construction and is expected to cost approximately Rs. 1.8 crores.

The Sprar Dam and Canal Project provides for the construction of an earthen dam 55 feet high and 11,150 feet long to store about 64,000 acre feet of water. This will provide water for 72 miles of new canals in Lakheri-Dhasan Doab and eight miles of extension in the Siaori system on both banks of the Jhansi Division. Supplies in Jhansi Division will also be supplemented to some extent by this scheme. The work was commenced in March, 1948 entirely by manual labour and is expected to be completed by 1951.

The Majhgawan and Trans-Baghain Canal project aims at increasing supplies in the Ken Canal system for irrigating a new area of 95,972 acres in the Banda district. The carrying capacity of Ken Canal will be increased from 1,100 cusecs to 1,850 cusecs. The dam will be constructed on the Baparia Nadi, a tributary of the Ken river, opposite mile 7 of the Ken Canal. The scheme is estimated to cost Rs. 73 lakhs and is expected to be completed by 1953.

The Partapgarh Branch Project envisages the construction of a branch taking off from the Sarda Canal for providing irrigation facilities in the area of Sai-Bakklahi Doab. The cost of the scheme is 53.98 lakhs. It will irrigate an additional area of 68,164 acres and will produce 6,200 tons of food annually. The construction of the branch is expected to be completed by 1951.

The **Rabti Canal Project** comprises the construction of a pumped canal with a head discharge of 532 cusec from the Rabti river for irrigating an area of about 81,000 acres in the Basti and Gorakhpur districts. The scheme is estimated to cost 58 *lakhs* and will take three years for completion.

The **Sarda Canal extension by 1,062 miles**.—The excavation of the additional length of the canal will provide irrigation to additional area of about 300,000 acres in the districts of Hardoi, Unnao, Rai Bareilly, Partabgarh, Sultanpur and Allahabad. The scheme is estimated to cost Rs. 155 *lakhs*. It is under construction and is expected to be completed by the end of 1952.

The **Sarda Canal Extension in 5th Circle** consists of earth work and pacca work on channels to provide irrigation facilities to 197,650 acres of land in the Trans-Kalyani area. The water will be pumped by means of Roscoe Moss Wells provided for irrigation in the tract and will take five years for completion.

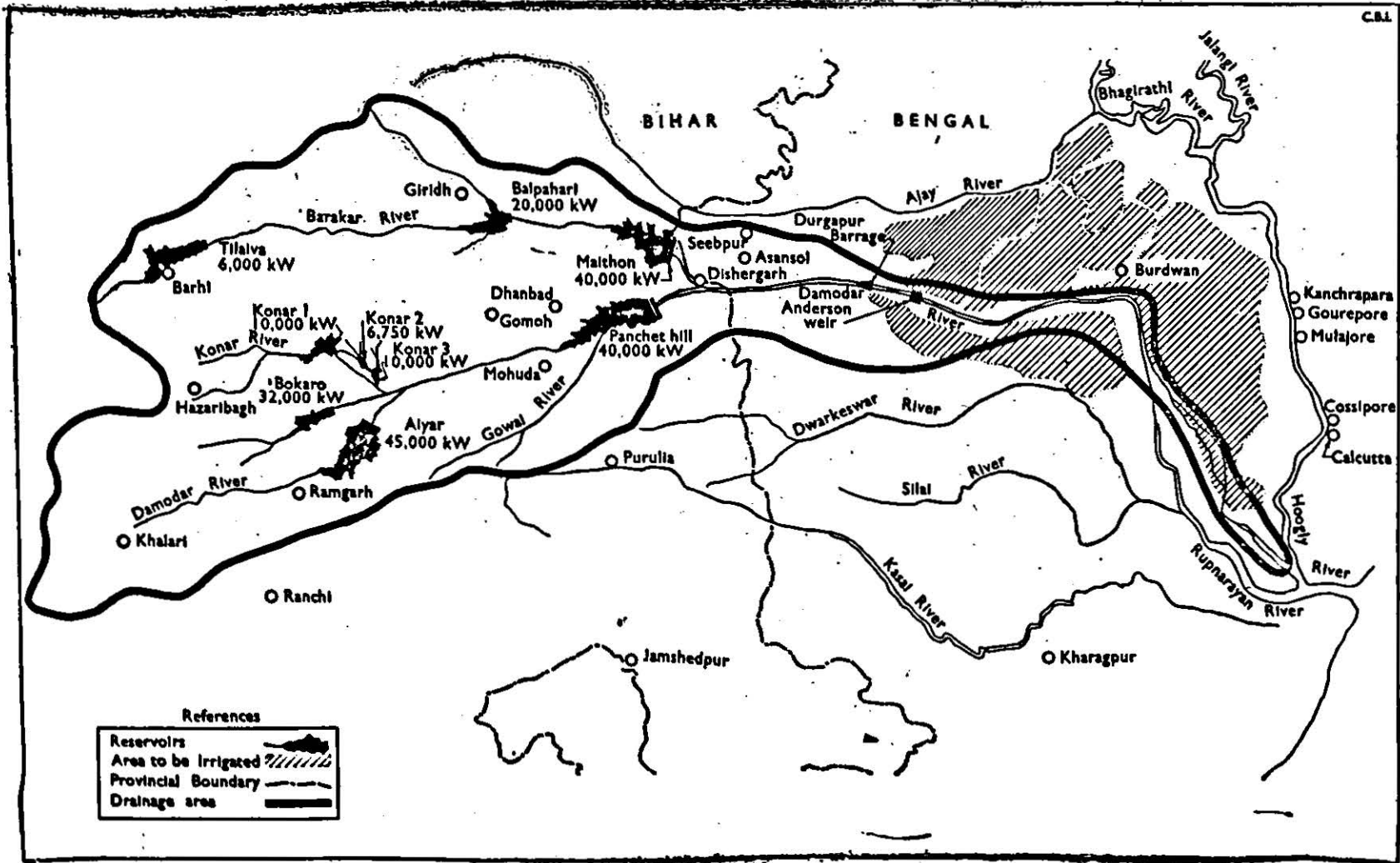
In addition there are other minor and tube well schemes in the Uttar Pradesh, which will irrigate thousands of acres of land.

## WEST BENGAL

The **Damodar Valley Project** which is one of the most important multipurpose scheme and is to benefit the provinces of Bihar and West Bengal, has its main features the construction of (a) Multipurpose storage dams with hydro-electric plants, (b) two additional hydro-electric plants at Kanar No. II and Bormo respectively, (c) the Steam power plant of 20,000 kW. capacity, (d) An irrigation project with net work of irrigation canals and distribution measuring 1,553 miles, (e) 90 miles long navigation canal, and (f) Power transmission grid. The ultimate benefits that will accrue from this scheme include (a) effective flood control of the Damodar Valley, (b) perennial irrigation of 967,000 acres including 195,000 acres now irrigated in the *kharif* season, resulting in additional yield of rice and *rabi* crop amounting to Rs. 18·65 *crores* a year, (c) generating of 240,000 kW. electric power, which will enable the growth of industrial concerns, electrification of railways *etc.*, and (d) the cheap transport facilities through the navigation canal. The estimated cost of the scheme is Rs. 67·90 *crores*. The construction on some of the dams was started in 1948 and 1949 and the entire project is programmed to be completed by 1954-55. The development of the Damodar Valley was planned on T. V. A. lines and the Damodar Valley Corporation, set up by the Central Government by an Act, is incharge of the Project.

The **Mayurakshi Reservoir Project** comprises the construction of a low masonry dam of 117 feet high to store 0·5 million acre feet of water, a weir at Tilpara and a canal system extending over 1,240 square miles on both sides of the river Mayurakshi. The scheme will bring under irrigation an area of 595,000 for *kharif* and 100,000 for *rabi* crops. In addition 4,000 kW. hydro power will also be generated. The estimated cost of the scheme is Rs. 15·5 *crores*. The project is under construction and is programmed to be completed by 1954.





Index plan showing tentative plan of development of the river Damodar.

### SCHEME NOT YET BEGUN

In addition to the schemes in progress there are a number of other projects which are in various stages of investigation, a few having already been investigated in detail but construction of which has been postponed for want of funds. There are in all 122 such schemes, which will cost over Rs. 1,300 *crores*. The description of some of the important ones is given below :

**The Kosi Project** envisages the construction of a dam of an unprecedented height of about 785 feet above rock foundations on the Kosi river, a mile upstream of Barakhshetra temple in Nepal, for flood control, power, irrigation, navigation, soil conservation, silt control, fish culture and recreation *etc.* The barrage will be constructed across the Kosi at Chatra in Nepal and the canals one on either bank will take off to irrigate 3·845 million acres, out of which 0·52 million acres will be in Nepal and 3·325 million acres in Bihar. The power station to be installed in the body of the dam will have an installed capacity of 1·8 million kW. The project has been planned for construction in seven stages. The total scheme is to cost Rs. 177 *crores*. The work on stage I is expected to be started shortly.

**The Gandak Valley Project** (Bihar), envisages the construction of a barrage across the Gandak River at Tribeni Ghat just below the offtake of the existing Tribeni canal and two new canals one on either bank of the river. The area to be brought under irrigation is 2·5 million acres in Bihar, 0·75 million acres in Uttar Pradesh and 0·1 million acres in Nepal. The scheme is estimated to cost Rs. 25 *crores*.

**The Ghatprabha Valley Project** (Bombay), comprises the construction of two storage dams, one on the Ghatprabha river and the second on the Hiranyakeshi, a tributary of the Ghatprabha river. The whole scheme is expected to cost Rs. 30 *crores* and when completed, will irrigate about 600,000 acres. The project is intended to be developed in two stages.

**The Koyna Hydro-electric Project** (Bombay), contemplates the construction of a dam across the Koyna River at Jalkwadi. The scheme is ultimately capable of generating 580,000 kW. of firm power at about 75 per cent. load factor. The scheme is estimated to cost Rs. 65 *crores*.

**The Kalinadi Hydro-electric Scheme** (Bombay), envisages the development of the Kalinadi basin for hydro electric power in four stages. It is estimated that total 325,000 kW. continuous power can be generated. The scheme is estimated to cost Rs. 1,212 *lakhs* and will take seven years to complete after commencement.

**The Broach Irrigation Project** (Bombay), consists of a dam 160 feet high approximately 48 miles North East of Broach on the Narbada river. The canal systems on both banks will command an area of 1·8 million acres. The scheme is estimated to cost Rs. 10 *crores* and will take seven years for completion.

The Kistna Pennar Project is by far the most important scheme in the State of Madras. The project consists of the construction of two reservoirs, one in Kurnool district on the Kistna river near Siddeswaram and other on the Pennar river on Someswaram. The water of the Kistna will be led into the Pennar by a large canal cut about 100 feet deep through the ridge separating the two rivers. Between the Kistna and the Pennar, large areas would be brought under irrigation in Kurnool and Cuddapah districts. The total area to be irrigated will be 3·2 million acres. Large blocks of firm and seasonal power will also be developed. The estimated cost of the project is Rs. 120 *crores* excluding the cost of works required for power generation.

The Ramapadasagar Project (Madras) like the Kistna Pennar is a super project costing about Rs. 129 *crores*. It comprises the construction of a concrete dam, 430 feet high with the lowest foundation level 190 feet below the river bed. The project will irrigate 2·7 million acres of 1st and 2nd crop and will improve the existing supply of another 2·11 million acres of land. It will develop 150,000 kW. of firm power and provide in addition, navigation facilities from the port of Vazigapatam to the hinterland of the lake. The annual food production is expected to be 1·1 million tons. The project will take 10 years for completion.

The Wain-Ganga Reservoir Project (Madhya Pradesh) contemplates the construction of a dam 154 feet high across the river Wain Ganga, eight miles to the south of the Warsaw. This multipurpose project will irrigate one million acres and will generate 620,000 kW. hydro power and will provide navigation facilities for 320 miles along the river. The estimated cost of the Project is about 50 *crores*.

The Nayar Dam Project (Uttar Pradesh), involves the construction of a 600 feet high dam to store 1·06 million acre feet of water on the Nayar River, tributary of Ganga. The supplies will be utilised for supplementing the existing discharge of the Upper Ganga Canal and for generating 181,700 kW. effective peak power. An after bay dam at Byasghat seven miles downstream of the main dam, would balance the fluctuating supplies and pass a constant weekly discharge for irrigation purposes. Detailed investigations have been completed but the construction of the project has been postponed to some future date due to financial stringency. The scheme is expected to cost about Rs. 27 *crores* and will take seven years to complete from the date of commencement of construction.

The Pipri Dam and Power Station Project (Uttar Pradesh).—It is proposed to impound nine million acre feet of water by a 280 feet high dam across the river Rihand, a tributary of Sone, near village Pipri. The power house will have an installed capacity of 240,000 kW. and it will also bring under irrigation about four million acres of land. The estimated cost of the scheme including transmission and transformation is about Rs. 31·2 *crores*. Preliminary investigations have been completed and contract drawings specifications prepared. However, due to financial stringency, work on this scheme has been considerably closed down.

The Yamuna Hydro-electric Scheme (Uttar Pradesh) as proposed will be fully developed in two stages and will utilise, for generation of power, the total drop available in river Tons from the site of proposed Kishan Dam (14 miles upstream from its confluence with the river Yamuna) to Paonta on the Yamuna river, in the district of Dehra Dun. First Stage, involving the construction of a barrage and a 8.7 miles long concrete lined power channel providing two drops of 50 and 100 feet each is under construction. This stage will have an installed capacity of 51,000 kW. at an estimated cost of about Rs. 5 crores. The second stage will have an installed capacity of 150,000 kW at an estimated cost of Rs. 8.8 crores.

The Ganga Barrage Scheme (West Bengal) is a multipurpose Project and comprises the construction of a barrage across the Ganga, which will provide improvement of navigation, irrigation, flushing and drainage etc. and in the tract lying on both sides of the Bhagirathi and in addition will serve as a main link between West Bengal and Assam. The investigations on this project are in hand and are expected to be completed by February 1952. The site for the barrage has been selected at Faracca.

### CONCLUSION

In addition to the important works that are under construction or under investigation, which have been enlisted in the preceding paragraphs, there are large number of minor works of similar nature, the details of which may not be of much interest to the reader.

The total estimated cost of the projects under construction or which have not yet been started is about Rs. 1,900 crores, spread over a number of years. All these works, if and when completed, will add over 42 million acres to India's existing 50 million acres irrigated areas, and add about 11.0 million kW. of hydro-electric energy to the existing paltry half-million.

At present eight multi-purpose schemes, one major irrigation scheme, three power schemes each costing over Rs. 10 crores and 24 schemes each costing between Rs. two crores and ten crores and 99 schemes each costing less than two crores, are under actual construction. The total estimated cost of the 12 major schemes is Rs. 438 crores. It is expected that the completion of these projects will progressively add to the irrigation, food and hydro power as under :

Year	Irrigation (1,000 acres)	Additional food million tons (based on present standard of agriculture)	Power (1,000 kW)
1951-52	647	0.2	..
1952-53	1,114	0.4	351
1953-54	1,997	0.7	554
1954-55	4,315	1.4	596
1955-56	5,499	1.8	636
1956-57	6,685	2.2	708
1957-58	7,502	2.5	791
1958-59	8,527	2.8	817
1959-60	9,190	3.1	910
Ultimately	12,949	4.3	1,996

**COMPREHEND THE TERMS**

**ONE CUSEC** represents a volume of water equivalent to the flow of one cubic foot of water per second. Flowing continuously for 24 hours, it will cover five acres to a depth of about five inches—normally considered as a good watering for irrigation purposes. If used for a town water supply, one cusec can supply 30 gallons per head per day to a population of 18,000 souls.

**AN ACRE FOOT** denotes a volume of water sufficient to cover an area to a depth of one foot. Two acre-feet are equivalent to one cusec flowing for 24 hours. A million acre feet of water is equal to 43,566,000,000 cubic feet and is sufficient to cover an area of ten square miles to a depth of 156 feet. This represents a storage sufficient to feed a canal of 185 cusecs capacity for the flow season in a year (normally 270 days).

Water, at the rate of one cusec, through a height of 150 feet can generate a 10 **KILOWATTS** or units of electric power sufficient to drive a 12 h.p. car at a speed of 40 miles per hour on a reasonably good road, and roughly equal to the power output of a hundred men. One kilowatt or unit of electric power is sufficient to light 25 average sized electric bulbs. Not more than one thousand such units are required to drive a passenger train at a speed of 50 miles per hour. One kilowatt of power generated continuously for a year can irrigate annually 50 acres of land by pumping water from a depth of about 20 feet. Every kilowatt of hydro-electric power, if operated continuously, represents a saving of 5 tons of coal per year.