GOVERNMENT OF INDIA

PLANNING COMMISSION

REPORT

OF

THE TECHNICAL COMMITTEE TO EXAMINE

UKAI PROJECT

JANUARY, 1958.

REPORT

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UKAI PROJECT

January, 1958.

LETTER OF TRANSMITTAL.

No.WB-383/5000

Dated 31-1-1958.

To

The Secretary,
Planning Commission,
Udyog Bhawan,
New Delhi.

Sir,

I have great pleasure in forwarding to you the report of the Technical Committee that was appointed to examine the Ukai Project in Bombay State. This report is an unanimous one. It has been made after consideration of the pertinent information and in particular the various reviews and scrutiny made by the Central Water and Power Commission and the Planning Commission. It has been the result of an objective analysis un-influenced by any extraneous considerations and after studying certain special problems relating to submersion of lands and the future upper Tapi basin development. The findings and recommendations have been set forth in detail in pages 10 to 24. In brief, they are

i. An allocation of 6.0 m.a.ft. for the basin above Ukai and 3.18 m.a.ft. for the area below it including the Narmada area in a design year of 9.18 m.a.ft. availability;

ii. The most economical size of the dam is for the full reservoir level of 345; and

iii. Estimates of cost as worked out by the Committee stand at Rs. 61.57 crores for development of an average of 120,000 K.W. of power annually and complete irrigation of the areas envisaged in the 1956 report on Ukai Project.

The report expresses no conclusions applicable to matters dealing either with the modus operandi or the technical personnel necessary for the execution of work or on the period of actual execution, as these are beyond the scope of the Committee's assignment.

Yours faithfully,

M.S. Iyengar

(M. S. Thirumale Iyengar)
Chief Engineer, Hirakud
&
Chairman, Ukai Technical Committee.

C O N T E N T S

Introductory.

1. The Ukai Technical Committee was set up by the Planning Commission under its letter No.NR.2(12)/57 dated the 5th October 1957 (Appendix A) to examine the Ukai Project in Bombay State included in the Second Five Year Plan.

2. The members of the Committee are -

(i) Shri M.S.Thirumale Iyengar, I.S.E., Chief Engineer, Hirakud Dam Project, Ministry of Irrigation and Power, Govt. of India.

Chairman and Convenor.

(ii) Shri N. N. Iyengar, Member of the Advisory Committee on Irrigation and Power Projects, Planning Commission.

Member.

(iii) Shri M. Narasimhaiya, Member, Irrigation and Power Team, Committee on Plan Projects, Planning Commission.

Member.

(iv) Shri M.L. Champhekar, I.S.E., Chief Engineer (Retired), Engineer Administrator, Naval Dock Expansion Scheme, Bombay.

Member.

(v) Shri U. N. Mahida, I.S.E., Chief Engineer, Irrigation Department, Bombay (now Chairman, Bombay State Electricity Board)

Member.

Shri V. B. Manerikar, Superintending Engineer, Irrigation Department, Bombay.

Secretary.

3. The terms of reference of the Committee are -

(i) To consider and assess the relative requirements and allocation of waters for the different areas in the Tapi Basin and examine the proposals for the Ukai Project from this and other points of view.

(ii) To advise on the optimum size of the Ukai Project and other relevant factors.

(iii) To examine the estimates of costs and benefits including financial returns. and

4. The first meeting of the Committee was held at Bombay on the 30th November 1957. At this meeting the issues were broadly discussed and it was decided to examine and arrive first at the quantum of waters to be reserved for the development of the upper regions and on which the other issues depend. The Committee therefore decided that -

(i) Copies of the studies made by Sarvashri Dhanak, Datey and Andhare with regard to the development of the Tapi Upper Basin be obtained and supplied to the Members immediately for study.

(ii) Topo sheets of the Tapi Basin be obtained and furnished to Shri Champhekar for study.

(iii) Data be obtained from Madras and Mysore for certain typical minor basin developments that have been developed in those States.

(iv) The Committee to get a general idea, make a tour of the Kakrapara area as well as some representative regions in the upper basin of the Tapi river.

5. The Committee toured in the Tapi Valley from the 3rd to the 5th January 1958. The Kakrapara, Ukai and Tokerwa dam sites, and some regions of the Purna, Girna and Upper Tapi Valleys were visited. After the tour a meeting of the Committee was held at Khamgaon on the 5th January 1958 when the first term of reference was examined in great detail in the light of all data on hand viz., correspondence between C.W.& P.C. and Planning Commission, statistical data of cultivable and cropped areas in the basin, studies of Sarvashri Dhanak, Datey and Andhare, Bombay P.W.D. note supplied by Shri Champhekar, and descriptive memoirs of development in two minor basins in Madras State (Salem and North Arcot). As a result of this and discussions it was decided that for the full allocation of 2.8 m.a.ft. for the Tapi at the Ukai Dam site, for the irrigation as proposed in the Ukai project, the allocation for the Upper Tapi basin i.e., above Ukai should be 6 m.a.ft. It has been contended that the Kakrapara right bank canal utilisation that covers a part of the Narbada basin, was not entitled to the Tapi waters and that area must eventually be supplied by the Narbada waters when the requirements of the upper Tapi region exceed the 6 M.A.ft. That being understood, the design year of 9.18 m.a.ft. which is a 75% year, was considered as the interim basis for determining the optimum size of Ukai reservoir. The

The basis for determining the 6 m.a.ft. has been more fully explained under the Chapter on 'The findings and recommendations'.

The Committee met at Bombay on 25th January 1958 and finalised their report.

The Committee wishes to place on record its appreciation of the work done by the Secretary Shri V.B.Manerikar, Superintending Engineer assisted by Shri C.C.Patel, Executive Engineer and Shri K. S. S. Murthy, Executive Engineer and P. A. to C.E., Hirakud.

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The Ukai Project.

1. The Ukai Multi-purpose project was prepared by the C.W.& P.C. in 1955. It provided for an annual irrigation of 3,91,650 acres and firm power generation of 1,10,000 K.W. with 60% load factor, and partial flood control. The estimated cost of the project was Rs.60.73 crores. The project was revised by the C.W.& P.C. in 1956 and the F.R.L. was raised from 345 to 351, conferring generally the same benefits as before with an increase of Rs.3 crores in the project cost. The raising of the F.R.L. was considered possible because of the allocation of only 2.22 m.a.ft. in good years and 1.67 m.a.ft. in lean years for upstream utilisation which permitted of large carry overs. It was however found by the C.W. & P.C. that the cost of power per K.W. at the F.R.Ls 345 and 351 worked out almost the same. So further raising of the F.R.L. for mere carry overs was not considered advisable in view of the considerably increased cost of submergence that would be involved thereby and also the likelihood of the Railway line being affected to a greater degree. The C.W. & P.C. considered the storage at R.L.351 to be the optimum.

The comparative principal features of the 1955 and the 1956 revised projects are in appendix B.

2. The N. R. Division of the Planning Commission reviewed the project and made the following observation:

(i) The economics of power generation should be

reworked after allocating the cost of the dam between irrigation and power and examining what power can then be developed economically. The Planning Commission thought that the cost of power generation in the higher slab from F.R.L. 345 to F.R.L. 351 would be more.

(ii) The alternative site at Tokerwa should be examined in more detail as it was likely to turn out more economical especially for a smaller storage of 2.5 to 3.5 m.a.ft.

(iii) The reservation of 0.95 M.A.Ft. for upstream utilisation in Madhya Pradesh and 1.27 M.A.ft. in East and West Khandesh districts seemed inadequate and required to be increased.

3. The above comments were then replied to in detail by the C.W.& P.C. who made out that -

(i) The basis for design for power was a high degree of reliability of 97 per cent which necessarily involved substantial carry over to run through a cycle of good and bad years. That the minimum live storage required for irrigation alone was 2 M.A.Ft. and that the possible power generation with live storages ranging from 2.85 m.a.ft to 6.70 m.a.ft. was also indicated as ranging from 25,000 K.W. to 1,10,000 K.W. The cost of power at various slabs on the basis of proportional as also lump-sum allocation of cost to irrigation was worked out and it was indicated that it was economical to have a live storage of 6.7 m.a.ft. for firm generation of 1,10,000 K.W. with 60% L. F.

(ii) The Tokarwa site was costlier than the Ukai site by Rs.1.2 crores and besides involved substantially larger submergence of culturable land and greater displacement of population including the submergence of the taluka town of Taloda.

The reduction of storage was out of question in view of (i) above.

(iii) The question of upstream utilisation had been reviewed and it was considered that no revision of the figure of 2.22 M.A.Ft. was necessary.

4. The Planning Commission was not satisfied with this and made further observations on the replies given by C.W.& P.C. as follows :-

(i) The project should be designed on the basis of 85% reliability as eventually the Ukai Power Station would be in grid with other power stations in North Bombay area.

(ii) The 85 per cent reliable power available should be reworked out after increasing allowances for upstream utilisation.

(iii) The cost of extra power generation of 60,000 K.W. with carry over of 3.7 M.A.ft. should be recalculated after making allowances for interest charges during period of development of demand.

(iv) The rates of concrete and earthwork should be firmly estimated after making detailed analysis. The cost of the extra power generation of 60,000 K.W. comes to 0.75 annas per K.W.H. which is not economically attractive.

(v) The basis adopted by the Planning Commission was 85% reliability for power and 76% reliability for irrigation.

(vi) The land acquisition and other estimates need revision in the upward direction.

(vii) The cost allocated to irrigation should be based on 1.4 M.A.Ft. live storage for 76% reliability.

(viii) The unit cost of thermal generation should be taken as 0.5 annas per K.W.H. instead of 0.7 to 0.8.

(ix) Tokarwa site should be reconsidered with reduced storage.

(x) Allowance for upstream utilisation should be increased.

(xi) In view of the slow development on irrigation on Kakrapara canal system irrigation development on Ukai storage is not urgent and alternative schemes to Ukai dam may be considered e.g., Tokarwa and Hatnur storages. Since Ukai project would not be feasible on the score of power alone but as the demand for power appears more urgent in this tract than irrigation it may be worth-while considering cheaper hydro-electric schemes like Punasa on Narmada.

5. Later the C.W.& P.C. sent letters to the Planning Commission indicating that

(i) The minimum live storage for irrigation was 2.0 M.A.ft. as reliability of not less than 90% was essential for irrigation involving perennial cultivation.

(ii) The rates of earthwork and concrete had been analysed and no revision of the cost estimate was considered necessary.

6. At the sixth meeting of the Advisory Committee on Irrigation and Power Projects the points at issue were discussed and as there was no agreement between the Planning Commission and the C.W.& P.C. on several points bearing on the project the Ukai Technical Committee was set up to go into the question and examine the outstanding matters and to submit its recommendations in the shortest possible time.

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Findings and Recommendations.

1. Relative requirements and allocation of water for different areas.

Appendix C gives information regarding the gross areas, culturable areas, and cropped areas in the Tapi basin both district and region-wise. It is seen from this that out of the total cropped area of 90,75,197 acres, an area of 84,27,853 acres lies in the basin upstream of Ukai and is comprised of 35,99,721 acres in old Madhya Pradesh, 44,086 acres in old Madhya Bharat State, 45,72,249 acres in old Bombay State and 2,11,797 acres in Aurangabad District (old Hyderabad State). The percentage of cropped area to culturable area is quite high in the region ranging from 77 per cent to 95 per cent. Dhanak's report assumes out of this area, only an area of 10 lakh acres as likely to be brought under irrigation. The latest review by the Bombay Secretariat made available by Sri Champhekar gives this area as 13 lakh acres. But both these reports are based on a study of maps. A combined study also of maps made by Vasudev and Hari Singh puts the figure as some where near 20 lakhs of acres. The total potential for intensive irrigation development in the old Madhya Pradesh area of about 36 lakhs acres, has been estimated by the C.W.& P.C. as 7.46 lakhs. On the same basis the area of about 48 lakhs acres in the old Bombay State, old Madhya Bharat and Aurangabad (old Hyderabad State) is likely to give over 9 lakhs acres for intensive irrigation development. On this analysis the total extent of cropped area in the entire upper basin that will be available in due course for intensive development,

perennial and otherwise is likely to be about 16 lakhs of acres. The actual tour undertaken by the Committee covering representative regions in the upper basins of the Tapi river generally confirms the feasibility and also the possibility of developing that much area by irrigation eventually remembering the fact that any niggardly computation now would jeopardise the upper basin interests for all time to come.

2. Next, a study was made of the descriptive memoirs and maps for two minor basins (Sannath Kumara-nadhi and Amboordroog) in the Madras State and three minor basins of Mysore State, which approximate to the various minor basins in the Upper Tapi catchment in point of rain-fall etc. These memoirs give a history of the progressive development of the basins with a number of tanks or reservoirs and small diversion works.

Basin.	Average rainfall.	Total No. of minor works.	Area irrigated (acres).	Water utilised (M.Cft.)
A. MADRAS BASINS:				
1. Sannath Kumar Nadhi minor basin.	33.14"	454	6188.33	1132.93
2. Amboodroog minor basin	32.27"	426	8480.00	1579.97
		Total:	14668.33	2713.0
	Water utilisation -		0.185 m.cft. per acre i.e., 5.5 acres per M.Cft.	

Basin.	Average rainfall.	Total No. of minor works.	Area irrigated (acres)	Water utilised (M.Cft.)
B. MYSORE BASINS.				
1. North Pennar Basin - Minor Series.	26"	1408	32977	7863.80
2. North Pennar Basin - Lower Series.	21"	186	11924	2433.00
3. North Pennar Basin - Upper Series.	26"	355	28872	5559.38
		Total:	73,773	15856.18

Water utilisation = 0.215 M.Cft. per acre
i.e., 4.7 acres per M.Cft.

These indicate that the average water utilisation now in Madras is 0.185 M.C.Ft. per acre which works to 5.5 acres per M.C.Ft. and in Mysore to 0.215 M.C.ft. per acre which works out to 4.7 acres per M.C.ft. with the aid of small storage reservoirs and diversion works. In all these minor basins, intensive development is taking place part of the area being cultivated with perennial crops and part by paddy and other seasonal crops. There is every possibility and feasibility of developing the upper Tapi basin largely in this manner with a number of minor irrigation works, in addition to major and medium sized projects on the major streams. With the advanced methods of agricultural practices coupled with economical use of water, actually observed in the Cauvery some of the minor basins with annual rainfall approximating to 30 inches to 35 inches have worked to more than 5 acres per M.C.Ft. In view of all this it would be reasonable to make an allowance of 6 acres per m.c.ft. for the eventual intensive development

by irrigation for the area of 16 lakhs of acres above Ukai. This means a reservation of 6 M.A.Ft. of annual utilisation.

3. The irrigation requirements on the Ukai Project are 0.614 m.a.ft. for the Ukai Left Bank Canal and 2.608 m.a.f for the Ukai Right Bank canal and the Kakrapara canals, making 3.22 m.a.ft. in all. This includes the requirements of that part of the Narbada basin not strictly entitled to the Tapi waters and which eventually may have to be made good by Narbada. An annual run-off of 9.18 m.a.ft. is available at Ukai in a 75 per cent year. Taking this to be the design year the allocation of waters would be 6.00 m.a.ft. for areas above Ukai and 3.18 m.a.ft. for areas below Ukai, including the Narmada area. This may be allowed to stand as the C.W.& P.C. opines it is uneconomical to make a Narmada Canal for it. This question has however not been gone into by the Committee searchingly as examination of the Narmada Projects was not in the assignment of the Committee.

The Committee however would like to make one observation on a policy matter as worthy of adoption. This relates to lean years of less than 9.18 m.a.ft. annual availability. In such years the distribution shall be Pro-rata to the extent of the developed areas at the time.

2. Optimum size of the Ukai Project and other relevant factors.

With reserving 2.2 m.a.ft. only, as had been done in Ukai Project, for all irrigation usages above Ukai, there were available for power development at Ukai, major portions of the runoffs in the catchment. C.W.& P.C. have made economic studies of different reservoir levels for firm power development with carry-overs from good runoff years and had found that about 110 M.W. at 60% L.F. could be developed firmly at Ukai with a reservoir level of 351.

The Committee's studies now show that upper regions can utilise more water for irrigation. They will be able to use eventually 6 m.a.ft. There will therefore be correspondingly less runoffs that can be stored at Ukai for power generation. The firm power development at 60% L.F. will be less than 110 M.W.

According to discussions of the Committee on 5-1-1958 at Khamgaon the waters apportioned for different uses in a design (over 75% of the time) year were as follows:

Total runoff at Ukai	= 9.18 m.a.ft.
Allocation for upper irrigations.	= 6.00 "
Balance for use at Ukai & below.	= 3.18 "
Out of this Ukai Left bank canal will use	= 0.6 "
Balance for use below Ukai including the Narbada basin area	= 2.58 "

Out of 6.0 m.a.ft. allocated for irrigations upstream of Ukai, 20% was to be reckoned as available at Ukai by regeneration. This quantity can be stored or used as available for firm power generation.

Total firm power water available at Ukai in a design year would be :

1.2 m.a.ft. by regeneration available uniformly.

2.58 m.a.ft. available in irrigation seasons.

For power generation we may assume that any of 2.58 m.a.ft. will not be available during the rainy months when water is to be stored in Ukai reservoir. Power water for three rainy months i.e. $\frac{2.58}{3}$ = 0.860 m.a.ft. should be drawn from Ukai reservoir which should store some good year runoffs, for this purpose. 0.4 m.a.ft. which will ultimately be obtained from Narbada and not available as irrigation discharges at Ukai will have to be obtained from storage of good years at Ukai Dam. There will therefore need to be drawn from good years storages at Ukai about 1.13 M.A.ft. for maintaining firm power develcpment at the design level.

Firm power capacity (60% L.F.) possible at Ukai can now be determined on the basis of uniform (throughout the year) availability of the following waters for 75% of the time (years).

	Runoffs used for irrigation m.a.ft.	Runoffs utilised for power generation m.a.ft. at Ukai.	
Ukai left bank canal.	0.60	-	
For canals below Ukai.	2.58	2.580	Irrigation discharge.
For Upper Irrigation.	6.00	1.200	Regeneration eventually; from direct run-offs initially.
		0.860	From Tapti in good years as carryover, for use in the non-irrigation seasons.
	9.18	4.640	

Let this firm power be "X" M.W. The minimum capacity Ukai reservoir would be designed for, should hold sufficient storage capacity to receive monsoon runoffs of a design year and discharge irrigation and power waters, through the year, as required. Total minimum reservoir storage capacity is determined by space provisions for silting and evaporation losses.

The Minimum Storage capacity should also allow for storing enough extra water out of the good years in 75% of time so that the extra 0.860 m.a.ft. is available for power generation during rainy months, every year of the 75% time.

The above minimum storage will provide during 75% of the time full designed irrigations from Ukai dam and below Ukai dam and also "X" MW power production at 60% L.F. In the balance 25% of the time, the power side energy productions will be less than the equivalent of "X" MW at 60% L.F. The deficiency will depend on the variation of runoff in the year from the designed runoff.

As Ukai power station will definitely be operating in an interconnected power transmission system, the requirements that the same extent of power should be generated at Ukai year after year need no longer determine the designs of storage in the Ukai reservoir and installed capacity in the Power House. Provisions must be made for capacity installations gradually upto a maximum extent; the plant can be initially operated at high load factors as long as irrigation is not fully developed and surplus runoffs are available. With development of irrigation the runoffs will be lowered; the power station operation may be modified to maintain peak power production upto

the installed capacity and obtaining the energy deficiencies, if experienced, from the inter-connected transmission system by purchasing thermal or hydro-power from other power stations.

However in order to utilise as much as possible and minimize waste of excess waters available in good years, economic studies have been made to what extent the minimum reservoir level may be raised to produce more energy and avoid purchasing thermal energy in lean years.

Appendix D gives the calculations. In a 75 per cent year with an annual run-off of 9.18 M.A.Ft. the power generation is 90,000 K.W. at 60% L.F. or a 44,000 K.W at 60% L.F. in 95% years. The live storage required for this is 3.35 M.A.Ft. with an F.R.L. of 327. With a live storage of 5.75 M.A.Ft. with an F.R.L. of 345 it would be possible to generate 1,30,000 K.W. at 60% L.F. in 75% years, or 90,000 K.W. at 60% L.F. in 95% years. The average cost of generation at F.R.L. 345 works to 0.324 anna per K.W.H. which compares very favourably with the cost of thermal generation in this area. Raising the height of the dam beyond R.L.345 will not permit of any appreciable increase in utilisation of water in a 75% year. Therefore the most economical size of the dam is for the F.R.L. 345, which is recommended for adoption. The calculations also indicate that the minimum power in a 100% year with F.R.L. 345.00 will be 50.000 K.W. at 60% L.F. This minimum power in the driest year will enable the 1,30,000 K.W. Ukai Power Station to work as a peaking station in such years when it operates in an interconnected network with large sized thermal stations.

The deficiency of energy for 60% load factor operation can be made good by operating other power stations in the system at higher than the system load factors, wherever there is scope for such operation. Such resources in the region are (a) one or more thermal power stations in the interconnected grids of the region, (b) neighbouring hydro power stations in the initial stages of their load developments as the 2nd stage of Koyna Project probably (c) the very large power resources of the neighbouring Narbada Valley and (d) any nuclear power station that may be established in the region, such stations have to operate as base load stations with high load factors to keep down average energy costs.

130 M.W. capacity may be obtained by the installation of four (one spare) 45 M.W. generating units. A study of the drawings of power sluices in the C.W.& P.C. Designs for Ukai Dam for 345 F.R.L. indicates two more 45 M.W. generating units can be installed as may be necessary later on to permit Ukai Power Station to function mainly as a peaking station in the interconnected Power System of the region.

Tokerwa Site.

The Committee made an inspection of the site at Tokerwa on 3rd January, 1958.

It is reported that the Bed level of the River is R.L.157.00 as against the R.L. 180.00 adopted by the Central Water & Power Commission in the comparative study of Ukai Vs. Tokerwa. This would mean an increase of 13 ft. in the height of the Tokerwa Dam over Ukai as against the earlier 10 ft. lower height. This error of 23 ft. will substantially alter the comparative costs of dam. Considering the difficult accessibility, higher cost of land acquisition, higher unit rate of concrete and longer length of canals the Committee is not impressed of the site being in any wise of advantage over the Ukai site.

3. Estimates of cost and benefits including financial returns.

The estimates of cost have been reviewed and recast for a reservoir with R.L.345 at Ukai. Appendix E indicates :

(i) the estimates of costs as framed by C.W.& P.C. in their 1955 report which is for 345FRL.

(ii) revisions already proposed by C.W. & P.C. in their 1956 report and in the note to the 6th meeting of the Advisory Committee on Irrigation and Power Projects; and

(iii) increases now suggested.

The estimate of 1955 and the increases proposed by C.W.& P.C. have been reviewed in general, and are found in order except for the following modifications:-

(1) LAND

The rates proposed for land acquisition at Rs.125/- per acre for un-cultivated land and Rs.175/- per acre for cultivated land appear to be an under-estimate though it is stated that they are higher than the rates intimated by Revenue Officials. Experience on other projects, notably Hirakud, indicates that the cost of land has increased considerably although estimates were initially based on information furnished by the Revenue authorities. This is due to :-

(i) the acquisition of uneconomic holdings where such result after acquisition of affected lands;

(ii) evacuation charges;

(iii) increase in resettlement expenses and

(iv) increase in compensation awarded invariably by Courts for certain classes of land in particular circumstances.

The average rate of compensation in Hirakud has worked out so far to Rs.340/- per acre. Payments in many cases are still to be finalised. Cases have gone to arbitration and to courts asking for higher compensation. Keeping in view the Hirakud experience the committee would recommend a revision of the rates to Rs.200/- for uncultivated land and Rs.450/- for cultivated land which would give a weighted average of Rs.350/- per acre, very nearly the same as is likely to be obtained in Hirakud eventually.

The areas reported in the 1955 report have since been revised by the C.W.& P.C. on the basis of further information. The figures for uncultivated and cultivated land coming under submergence are now taken as 27,000 acres and 40,000 acres.

A sum of Rs.70 lakhs has been provided for rehabilitation in the 1956 estimates against 20.625 of the 1955 report. Allowing for the reduction in the area submerged and reduction in the number of families affected a sum of Rs.60 lakhs is now suggested for this purpose.

Provision of Rs.10 lakhs for evacuation (Transport) of displcaed families based on Hirakud experience is necessary.

As advised by the Bombay Government the provision made for the areas under forest and value of timber, bamboo etc., may be deleted.

A revised statement of all items under 'B' land is given in "Appendix E". The net increase in this sub-head works out to Rs.22.5 lakhs.

(2) C - Works.

The analysis furnished by C.W.& P.C. for earthwork has been examined. Their rate of Rs.82/- per 1000 cubic feet is generally in order.

As regards the rate for concrete, the recent increase in the cement price necessitates a revision. The cement price has gone up by Rs.15/- per ton. The analysis furnished by C.W.& P.C. takes account of a credit of Rs.15/- per ton on account of bulk supply of cement. This credit may not materialise in practice, for the entire quantity of cement to be used in concrete and masonry. It is therefore recommended that no credit should be allowed for this in the analysis. Taking these two factors into account a revised analysis has been prepared (vide Appendix E). The rate has to be revised to Rs.215/- per 100 cft. as against Rs.200/- in the 1956 report.

Provision for illumination of Dam, galleries etc., has been transferred from Unit III to Unit I.

(3) K - BUILDINGS.

In their note to the Advisory Committee the C.W.& P.C. have suggested an increased provision of Rs.15/- lakhs. This may be allowed to stand.

(4) O - MISCELLANEOUS.

A few minor items as indicated in "Appendix E" are suggested to be included in this sub-head.

(5) R - COMMUNICATION:

A provision of Rs.10 lakhs suggested for diversion of roads coming under Reservoir in the 1956 report may be allowed to stand. In addition a sum of Rs.1 lakh may be provided for setting up wireless stations etc.

(6) SPECIAL T & P.

The increased provisions suggested by C.W.& P.C. in their report of 1956 and their note to the Advisory Committee, may be allowed.

UNIT II CANALS:

On account of increase in price of cement and steel, an additional provision of Rs.11 lakhs under this unit has been suggested.

UNIT III HYDRO-ELECTRIC WORKS:

An additional provision of Rs.5 lakhs on account of increase in cost of steel and cement is suggested. In case of Power Plant the rate has been revised in consultation with C.W.& P.C. vide (Appendix E) based on the prices tendered for power plants at Chambal and other projects. These prices are in accordance with the prevalent market rates which are lower than the rates at the time of framing the original estimate.

The net result of all these changes will be a revision of the 1955 estimate from Rs.60.73 crores to Rs.62.57 crores or an increase of Rs.1.84 crores. This does not take into account credit for the salvage value of Special T & P. Based on the experience in the disposal of surplus equipment and the resale value obtained in Hirakud it would be reasonable and safe to allow a credit of Rs.1 crore. If this is done the net increase in the estimate of cost would be only Rs.84 lakhs making the final estimate at Rs.61.57 crores.

The above estimate of cost is for an F.R.L. of 345. For the F.R.L. of 351 of the 1956 note, the increased cost on similar considerations would come to Rs.64.50 crores.

In the 1956 financial forecast the cost of the dam was allocated in equal shares between irrigation and power. Cost of a dam to provide irrigation requirements alone is estimated at Rs.22 crores. Present estimate of the dam with F.R.L. 345 is Rs.36.23 crores. The requirements of irrigation are met in full. It is, therefore, justified to allocate a sum of Rs.22 crores to irrigation and the balance of Rs.14.23 crores to power. This allocation has been taken into account in working out power production cost figures.

The comparative cost in the Ukai Project Report and the revised estimates are tabulated below:-

Rupees in lakhs.

	1956 Report (F.R.L.351 Original Estimate.	1956 Report (F.R.L.351) Revised Estimate.*	Present proposals (F.R.L.345)
Unit I, Dam and Appurtenant Works.	3473.63	3931.21	3637.66
Unit II Main Canal and Branches.	1160.55	1172.64	1172.64
Unit III H. E. Installation.	1529.82	1346.47	1346.47
Total :	6164.00	6450.32	6156.77

* On the basis adopted for revision of the 1955 Estimate with F.R.L. 345.

Irrigation benefits being the same as originally the revenue from it remains unaltered. As regards power, the revenue was assessed on the basis of 110,000 K.W. at 60% Load Factor in a 95% year. More revenue would ofcourse have accrued in view of the fact that the power available in a 75% year was about 160,000 K.W. according to old proposals, but this was not taken into account for working out those financial returns.

The power, that would be available according to the revised proposals now suggested is, 1,30,000 K.W. in 75% years, 100,000 K.W. in 20% years and 50,000 K.W. in 5% years, or an average of 120,000 K.W. annually. Because of this, the revenue from power would be about the same as the original anticipations. The total capital outlay also remains the same. The overall percentage return from this multi-purpose project will, therefore, remain nearly the same as forecast in the 1956 note. So the preparations of detailed financial statements have not been attempted by the Committee.

Sd. M.S.T. Iyengar
25.1.58.
Chairman.

Sd. M. L. Champhekar
25.1.58
Member.

Sd. U. N. Mahida
25.1.58
Member.

Sd. M. Narasimhaiya
25.1.58
Member.

Sd. N. N. Iyengar
25.1.58
Member.

APPENDIX A.

No.NR-2 (12)/57
Government of India,
Planning Commission.

UDYOG BHAWAN
NEW DELHI, the 5th October 1957.

From

The Secretary,
Planning Commission.

To

1. Shri M.S.Thirumale Iyengar, ISE,
Chief Engineer, Hirakud Dam Project,
Ministry of Irrigation & Power,
Government of India, Hirakud Colony -
Chairman and Convener.

2. Shri N. N. Iyengar - Member of the
Advisory Committee on Irrigation and
Power Projects, Planning Commission,
(D-14, National High School Road,
Visveswarapuram, Bangalore) - Member.

3. Shri M. Narasimhaiya,
Chief Engineer (Retired),
Member, Irrigation and Power Team,
Committee on Plan Projects,
Planning Commission - Member.

4. Shri M. L. Champhekar, Chief Engineer
(Retired), Engineer Administrator,
Naval Dock Expansion Scheme, Bombay.

5. Shri U.N.Mahida, Chief Engineer,
Irrigation Department, Bombay - Member.

6. Shri Manerikar, Superintending Engineer,
Irrigation Department, Bombay - Secretary.

Sir,

The Planning Commission have set up a Technical Committee to examine the Ukai Project in Bombay State included in the second Five Year Plan.

2. The members of the Committee will be :-

(i) Shri M.S.Thirumale Iyengar, ISE.,
Chief Engineer, Hirakud Dam Project,
Ministry of Irrigation and Power,
Government of India, Hirakud Colony,
Sambalpur District (Orissa) -
Chairman and Convenor.

(ii) Shri N. N. Iyengar, Member of the
Advisory Committee on Irrigation and
Power Projects, Planning Commission,
(D-14 National High School Road,
Visveswarapuram, Bangalore) - Member.

/p.t.o./

(iii) Shri M. Narasimhaiya, Member, Irrigation and Power Team, Committee on Plan Projects, Planning Commission - Member.

(iv) Shri M.L.Champhekar, Chief Engineer, (Retired), Engineer Administrator, Naval Dock Expansion Scheme, Bombay.

(v) Shri U. N. Mahida, Chief Engineer, Irrigation Department, Bombay - Member.

Shri Manerikar, Superintending Engineer, Irrigation Department, Bombay, will work as Secretary to the Committee in addition to his duties.

3. The terms of reference of the Committee will be :-

(i) To consider and assess the relative requirements and allocation of waters for the different areas in the Tapi basin and examine the proposals for the Ukai Project from this and other points of view.

(ii) To examine the estimates of costs and benefits including financial returns and

(iii) To advise on the optimum size of the Ukai Project and other relevant factors.

4. The Chairman, Members and Secretary of the Committee will draw their pay and allowances (Travelling Allowances/ Daily Allowances) etc. from their parent offices. The travelling and daily allowances of Shri N.N.Iyengar for attending the meetings of the Committee as well as for any touring to be done in connection therewith, will be drawn by him in his capacity as Member of the Advisory Committee on Irrigation and Power Projects.

5. The Committee will complete and submit its report by end of December, 1957.

Yours faithfully,

Sd. Yadava Mohan
for Secretary, Planning Commission.

Copy to:-

1. Ministry of Irrigation & Power, Government of India, New Delhi.
2. Ministry of Defence, Government of India, New Delhi.
3. Secretary, Committee on Plan Projects.
4. Secretary, Public Works Department, Govt. of Bombay, Bombay.
5. Administration Branch, Planning Commission.
6. The A.G.C.R., New Delhi.
7. The Treasury Officer, New Delhi.

Copy also forwarded for information to :-

1. Chairman, Central Water & Power Commission.
2. Shri K. R. Khushalani) Additional Secretaries,
3. Shri V. R. Raghavan) Advisory Committee on Irrigation and Power Projects, C.W.& P.C., New Delhi.

Sd/- Yadava Mohan,
for Secretary, Planning Commission.

APPENDIX 'B'

TABLE NO. I.
UKAI DAM P R O J E C T.

Comparative salient features of the 1955 and revised proposal.

Locations.

1.	State.	- Bombay.
2.	District.	- Surat.
3.	Tehsil.	- Songhad.
4.	River.	- Tapi.
5.	Site of Dam.	- On the river Tapi about 62 miles upstream of Surat and 84 miles upstream from the mouth of the river.

		1955 Project.	Revised Project. 1956.
Hydrology.			
1.	(a) Mean Monsoon run off	-	11.49 m.a.ft.
	(b) Mean annual run off	13.26 m.a.ft.	12.42 m.a.ft.
2.	Design flood.	13.35 lakh cus.	14.46 lakh cus.
3.	Max. regulated outflow from the reservoir.	12,00,000 cusecs.	11,90,000 cusecs.
Reservoir.			
1.	Storage capacity.	6.20 m.a.ft.	7.85 m.a.ft.
2.	Dead storage below RL. 270	0.95 m.a.ft.	1.15 m.a.ft.
3.	Live storage.	5.25 m.a.ft.	6.70 m.a.ft.
4.	Normal storage level.	FRL 345	FRL 351.
5.	Area submerged.	1,27,000 Acres.	1,60,000 Acres.
Dam.			
1.	Top of Dam.	EL. 357	EL. 363
2.	Length of Dam Total.	16,014 ft.	16,140 ft.
(a)	Concrete Section.	2,954 ft.	2,954 ft.
(b)	Earth Section.	13,060 ft.	13,186 ft.
3.	Max. height:-		
	Main Dam.	236' above foundation.	242' above foundation.
	Concrete Section.	219' above river bed.	225' above river bed.
	Main Dam- Earth Section	217' from the bed of river.	223' from the bed of the river.
	Saddle- Concrete Section	147' above foundation.	153' above foundation.
	Saddle Earth Section.	119' above bed 107'	123' above bed 113'
Spillway.			
1.	Cresh level of spillway	EL 310	EL 316
2.	Top of Cresh gates.	EL 345	EL 351
3.	Length of spillway:		
	Main Saddle.	1131 ft. 471 ft.	1131 ft. 471 ft.
Cost			
	Total.	Rs. 6972.95	Rs. 6164.00 lakhs.
Unit I	Dam & Appurtenant works.	Rs. 3382.58	Rs. 3473.63 lakhs.
Unit II	Main Canal & Branches.	Rs. 1160.55	Rs. 1160.55 lakhs.
Unit III	H.E. Installation.	Rs. 1529.82	Rs. 1529.82 lakhs.

Appendix C.

Classification of Land and percentage of cultivable area to gross area in the Catchment of Tapi Basin (All areas are in acres).

Sl No.	District.	Grossarea.	Classification of area.			Total of column 4 plus 5 plus 6.	Cultivable area column 3 minus column 7.	Percentage of column 8 to 3.
			Forests.	Not available forcultivation.				
				Land put to non-agricultural use.	Barren uncultivable land.			
1	2	3	4	5	6	7	8	9
1.	Betul	9,95,062	3,88,425	36,560	15,937	4,40,922	5,54,140	56
2.	Amravati	18,71,553	7,59,859	-	36,213	7,96,072	10,75,481	57
3.	Akola	15,73,760	1,18,165	40,244	20,340	1,78,749	13,95,011	88
4.	Buldana	13,95,780	1,89,496	-	35,462	2,24,958	11,70,822	84
5.	East Khandesh	28,30,612	4,83,388	62,813	1,49,462	6,95,663	21,34,949	75
6.	West Khandesh	31,04,609	9,17,796	9,782	1,42,162	10,69,740	20,34,869	65
7.	Aurangabad.	3,15,964	31,440	8,000	1,508	40,948	2,75,016	87
8.	Nimar (Khandwa)	8,60,548	4,47,561	35,017	14,303	4,96,681	3,63,867	42
9.	Nimar (Khargone)	4,44,800	3,65,626	10,163	22,867	3,98,656	46,144	10
10.	Nasik	14,41,820	3,87,313	1,668	1,05,960	4,94,941	9,46,879	66
11.	Broach.	1,51,312	20,480	6,304	18,000	44,784	1,06,528	70
12.	Surat	8,68,156	1,08,596	17,986	82,178	2,08,760	6,59,396	76
	Total:	1,58,53,976	42,17,945	2,28,537	6,44,392	50,90,874	1,07,63,102	68

= 24.772 Sq.miles. Say 25,000 Sq.Miles.

(Compiledfrom Sub Basin Reports).

CLASSIFICATION OF LAND AND PERCENTAGE OF CULTURABLE AREAS TO GROSS AREA IN THE CATCHEMENT OF TAPI BASIN (ALL AREAS IN ACRES).

(REGION WISE BREAK-UP)

Sl. No.	Region	Gross area	Classification of area			Total of column 4 + 5 + 6.	Cultivable area column 3 minus column 7.	Percentage of column 8 to 3.
			Forests	Not available for cultivation.				
				Land put to non-agricultural use.	Barren uncultivable land.			
1.	2	3	4	5	6	7	8	9
1.	Old Madhya Pradesh (S.Nos.1,2,3,4,8)	66,96,703	19,03,306	1,11,821	1,22,255	21,37,382	45,59,321	68
2.	Old Madhya Bharat (Sl.No.9)	4,44,800	3,65,626	10,163	22,867	3,98,656	46,144	10
3.	Old Bombay (except Surat & Broach) (S. No.5,6,10)	73,77,041	17,88,497	74,263	3,97,584	22,60,344	51,16,697	69
4.	Aurangabad.	3,15,964	31,440	8,000	1,508	40,948	2,75,016	88
5.	Surat and Broach.	10,19,468	1,29,076	24,290	1,00,178	2,53,544	7,65,924	75
	Total:	1,58,53,976	42,17,945	2,28,537	6,44,392	50,90,874	1,07,63,102	68

.-.-.-.-.

Percentage of cropped area to culturable area.

Sl. No.	District.	Culturable area.	Cropped area.	Percentage of Col.4 to Col.3.
1	2	3	4	5
1.	Betul.	5,54,140	3,46,382	62
2.	Amravati	10,75,481	8,22,528	76
3.	Akola	13,95,011	11,92,609	85
4.	Buldana	11,70,822	9,72,477	83
5.	East Khandesh.	21,34,949	19,95,128	93
6.	West Khandesh.	20,34,869	17,70,253	87
7.	Aurangabad.	2,75,016	2,11,797	77
8.	Nimar (Khandwa)	3,63,867	2,65,725	73
9.	Nimar (Khargone)	46,144	44,086	95
10.	Nasik.	9,46,879	8,06,868	85
11.	Broach.	1,06,528	86,752	82
12.	Surat	6,59,396	5,60,592	85
	Total	1,07,63,102	90,75,197	84.0

Compiled from Sub Basin Reports.

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PERCENTAGE OF CROPPED AREA TO CULTURABLE AREA.

(REGIONWISE BREAKUP)

Sl. No.	Region.	Culturable area.	Cropped area.	Percentage of Col.4 to Col.3
1	2	3	4	5
1.	Old Madhya Pradesh (S.Nos.1,2,3,4,8)	45,59,321	35,99,721	78
2.	Old Madhya Bharat (S.No.9)	46,144	44,086	95
3.	Old Bombay (except Surat and Broach) (S.Nos.5,6,10)	51,16,697	45,72,249	89
4.	Aurangabad	2,75,016	2,11,797	77
5.	Surat and Broach	7,65,924	6,47,344	84
	Total :	1,07,63,102	90,75,197	84

A P P E N D I X "D"

NOTE I

-:Minimum free catchment above Ukai:-

(1.0) Areas available below the lowest weir sites upstream upto Ukai, were planimetered from the plan.

(1"-4M) Contained in the P.W.D. Bombay's Note, showing all probable sites after topo-sheet study.

This was found to be 5407sq.miles i.e., say 'a' square miles.

(2.0) Areas between last storages and last weirs upstream was planimetered from the above plan and was found to be 7312 sq.miles say 'b' Sq.miles.

Run-off from this area would spill over the weirs in monsoon as there are no storages. Monsoon run-off is over 90% of the total run-off. While monsoon requirements would hardly be 40% of utilisation. Further even during monsoon especially during September, October, several smaller tributaries would not give heavy requirements of irrigation in these two months. Hence 50% of 'b' is the minimum that can be taken as free and available for Ukai.

(3.0) Equivalent free catchment:-

a = 5403 sq.miles.

b = 7312 sq.miles.

Total catchment above Ukai 24,000 sq.miles allow a factor of 0.9 to account for possible variation in run-off yielding characteristics of free chatchment. Although average rainfall in free catchment zone would be about the same.

Equivalent free catchment

$$= \frac{0.9\ (\ a + \frac{b}{2})}{24000} \quad = \frac{0.9\ (5403 + 3656)}{24000}$$

$$= \frac{0.9 \times 9059}{24,000} = \underline{0.33}$$

Hence 33% run-pff would be freely available.

N O T E II

REGENERATION

1.0 Basic regeneration assumed as 20%, which is quite conservative.

2.0 Utilisation from lowest works:-

(P.W.D. Note)

		Utilisation M.C.ft.
H/26	Hatnur.	98,561
W/27	Waghur.	5,706
G/28	Girna.	29,982
B/30	Bori	5,220
P_z// 31	Panjhra.	14,960
B_y/32	Buray.	1,820
Ar/36	Amravati.	1,141
	Total :	1,57,390

Total utilisation 2,77,519 M.Cft.
(P.W.D.Note)

3.0 Utilisation under para 2.0 above is

$$\frac{1,57,390}{2,77,519} \text{ i.e., } 60\% \text{ say.}$$

4.0 Minimum free regeneration available for Ukai would be 0.6 of 20% i.e., 12%, while remaining 8% would be available for use and reuse for u/s commands.

.....

N O T E III.

-: Calculation of Run-offs at Ukai :-

It has been assumed that upstream areas would exploit all available water and only balance would reach Ukai. Let utilisation upstream be U, yearly run-off R and Monsoon run-off R_M

(1) Equivalent catchment available to upstream area. 66.6%

(2) Equivalent free catchment available to Ukai. 33.3%

(3) Regeneration. 20%

Maximum utilisation (if unrestricted) $U = \frac{2R}{3} + \frac{8}{100} \frac{(2R)}{3}$ (available from regeneration).

$= 0.72\ R.$

Water available to upstream area. $= \frac{8U}{100} + \frac{2R}{3}$

(filling carryovers of upstream reservoirs are not accounted for simplicity. Results would not appreciable change as carryovers would remain as balance.)

Water available to Ukai from catchments covered by upper schemes:-

$$= \frac{2R}{3} + \frac{8U}{100} - U \quad (1)$$

Water available to Ukai from free catchment :-

$$= \frac{R}{3} + \frac{12U}{100} \quad (2)$$

Total available to Ukai = (1) + (2)
= R-0.8U
= R-4.8 (for U=6.0) (3)

No water would be available from 2/3 rd intercepted catchment above when $0.72\ R$ = or less than U

i.e. when R=or less than 1.38 U
= or less than 8.28 (U=6.0)

Water available to Ukai would be only from free catchment and through regeneration

$$= \frac{R}{3} + \frac{12U}{100}$$
$$= \frac{R}{3} + \frac{12}{100} (0.72\ R)$$
$$= 0.418\ R \text{ (for R= or less than 8.28) (4).}$$

Runoff to Ukai in dry weather and monsoon.

(a) Weather flow is taken as 6.6% of Monsoon Runoff vide C.W.P.C. Project Report.

Years in which R is more than 8.28

Total regeneration from 60% utilisation

$$= \frac{60}{100} \times 0.2U = \frac{60}{100} \times 0.2 \times 6$$

$= 0.72$ per year.

Available in dry weather $= 0.72 \times \frac{2}{3}$

$= 0.48$ M.A.Ft.

Total dry weather flow available to Ukai

$$= \frac{1}{3} R_M \times \frac{6.6}{100} + 0.48 \quad (5)$$

Monsoon inflow (3) - (5).

(b) Years in which R is equal to or less than 0.28

Total yearly regeneration available. $= \frac{12}{1000} \cdot U$

$$= \frac{12}{100} \times 0.72 \, R$$

Available regeneration in dry weather $= \frac{8}{100} \times 0.72 \, R$

Total dry weather inflow $= \frac{1}{3} \times \frac{6.6 \, R_M}{100} + 0.0576 \, R \quad (6)$

Monsoon inflow = (4) - (6)

The tables are prepared on the above basis. Upstream areas cannot utilise 100% water that is available. Hence in leaner years, the availability to Ukai from upstream intercepted catchment would increase depending a distribution of upstream projects and available run-offs etc. The above basis is, therefore, quite conservative.

TABLE NO.1.

MONSOON AND DRY WEATHER RUN-OFFS AT UKAI.

Year.	Total water available at Ukai.	Dry weather flow including regeneration.	Water available during monsoon.
1898	4.93	0.68	4.25
1899	-	-	-
1900	5.96	0.70	5.26
1901	4.86	0.67	4.19
1902	5.04	0.68	4.36
1903	7.85	0.74	7.11
1904	2.68	0.50	2.18
1905	3.37	0.64	2.73
1906	10.50	0.80	9.70
1907	2.54	0.48	2.06
1908	5.73	0.70	5.03
1909	5.34	0.69	4.65
1910	12.55	0.84	11.71
1911	1.66	0.31	1.35
1912	2.82	0.53	2.29
1913	7.90	0.74	7.16
1914	7.60	0.73	6.87
1915	8.50	0.70	7.74
1916	16.15	0.91	15.24
1917	11.39	0.81	10.58
1918	-	-	-
1919	8.55	0.76	7.79
1949	18.23	0.96	17.27
1950	3.37	0.64	2.73
1951	2.60	0.49	2.11
1952	1.76	0.33	1.43
1953	5.68	0.70	4.98
1954	12.96	0.84	12.12

For years with total run-off greater than 8.28 M.a.ft.

Availability at Ukai = (R - 4.8) ..... (1)

Dry weather inflow $= \frac{1}{3} \times \frac{6.6}{100} R_M + 0.48$.....(2)

Monsoon inflow = (1) - (2)

For years with total run-off less than 8.28 m.a.ft.

Availability at Ukai = 0.416 R. .....(1)

Dry weather inflow $= 1/3 \times \frac{6.6}{100} \times R_M + 0.0576$ R (2)

Monsoon inflow = (1) - (2)

.....

N O T E .IV

1. Start with F.R.L. 345.00

Assume power requirement 0.25 M.a.ft per month.

(a) Monsoon requirements:-

	Power or Irrigation d/s M. a.ft.	U.L.B.C. M.A. Ft.	Total M.A.Ft.
July.	0.25	0.024	0.274
August.	0.259	0.063	0.322
September.	0.301	0.085	0.386
October.	0.311	0.098	0.409
	1.121	0.27	1.391
	Add evaporation.		0.150
		Total..	1.541

(b) Dry weather requirements.

November.	0.304	0.079	0.383
December.	0.314	0.082	0.396
January.	0.276	0.057	0.333
February.	0.250	0.033	0.283
March.	0,250	0.015	0.265
April	0.250	0.015	0.265
May	0.250	0.027	0.277
June.	0.250	0.036	0.286
	2.144	0.344	2.488
	Add evaporation.		0.4000
		Total:	2.888

(c) Dry weather inflow 8.2% of a good year inflow

Assume	0.22
Add regeneration	0.48
	0.70

(d) If water level on 1st November is at R.L.345.00; the position on 30th June would be as under:-

Live storage	5.75
Add dry weather flow (c) above.	0.70
	6.450
Less withdrawal.	2.888
	3.562 M.a.ft.

Corresponding F.R.L. with gross capacity 3.562 + 1.15 i.e.,4.912 is 329.00

$$H = \frac{345 + 329}{2} - 155$$

$$= 337 - 155 = 182 \text{ ft.}$$

with 90,000 K.W. @ 0.6 L.F.

$$Q = \frac{54,000 \times 14.5}{182} = 4,300 \text{ cusec.}$$

i.e. monthly requirement of 4,300 x 30 x 2=0.258 M.A.ft. as assumed.

(e) If there is negligible runoff in next year, the following firm power would be possible:-

Balance on 1st July.	3.562
Regeneration(remaining)	0.240
Total...	3.702

Assume irrigation requirements for first 3 months are met with, thereafter irrigation would be stopped except that which can be done with power draft.

Irrigation would fail in such years on U.L.B.C.

$$1.54 \times \frac{3}{4} = 1.15 \text{ M.a.ft.}$$

Net available for power for 9 months = 3.702

less = 1.150

2.552 M.a.ft.

Less take losses. 0.400

2.152 M.a.ft.

F.R.L. (corresponding) = 312

Average Head 291-155 = 136 ft.

Power potential = $\frac{2.15 \times 136 \times 10^6}{2 \times 270 \times 14.5}$

= 36,000 K.W. continuous OR
60,000 K.W. @ 0.6 l.f.

(f) Minimum inflow in next monsoon to tide over lean year.

Balance at begining of monsoon.	3.70	
Less monsoon utilisation.	1.54	
	2.16	
Regeneration of fair weather.		3.20
Maximum inflow necessary.		2.16
		1.04 M.a.ft.

(g) Calculations for Power in year 1952 - 53 vide Cycle No.IV

As balance on 1st July 1952 was only 0.94, no irrigation would be started unless the 1952 monsoon brings in substantial runoffs.

Total water available 0.94 + 1.45 + 0.33
= 2.72 M.a.ft.

Power $\frac{2.72 \times 136 \times 10^6}{2 \times 365 \times 14.5}$ = 35,000 K.W.

Say at least 30,000 K.W. if water is released for irrigation for first one or two months.

2. Requirements of water with various starting capacities on 1st November. Assume capacities 5.00, 4.00 and 3.00 M.a.ft. in beginning of November. Monsoon requirements will not be

be appreciably affected as irrigation requirements are more than power requirements.

(a) Capacity 5.00 M.a.ft. on 1st November,

corresponding R.L. 340

utilisation in dry weather. 3.00
deduct dry weather flow plus regeneration. 0.68

Net utilisation 2.32
Balance capacity. 5.00 - 2.32
= 2.68 M.a.ft.

Corresponding R.L. 319.00
Average head 330 - 155 = 175

requirements on power = $\frac{183}{175}$ x 0.256
= 0.268

Consequent requirement = 2.988 say 3.0

(b) Capacity 4.00 M.a.ft. on 1st November

Corresponding R.L. 333
Utilisation in dry weather 3.10 assumed
deduct dry weather flow Plus regeneration. 0.60

2.50

Balance capacity 1.5.
Corresponding R.L. 303
Av. head $\frac{333 + 303}{2}$ - 155

= 318 - 155 = 163.

Requirements of power = $\frac{183}{163}$ x 0.288

= 0.288

Excess. 0.21
Less owing to small evaporation. 0.05

0.16

Total 3.05 say.

Capacity:- 3.0

R.L. 323.00
Utilisation 3.20 assumed.
Dry weather flow and regeneration. 0.50 assumed.

Net. 2.70

Balance capacity. 0.3
Corresponding R.L. 279
Av. head $\frac{323 + 279}{2}$ - 155 = 301 - 155 = 146 ft.

Requirements of power 0.26 x $\frac{183}{146}$ = 0.326

Total excess. 0.38
deduct due to less evaporation. 0.10

0.28 Net.

i.e. 2.88 + 0.28 = 3.16 , Say 3.20

TABLE-2 APPROXIMATE WORKING TABLE.

Period	Balance storage 1st Nov. of preceeding year.	Dry weather flow Plus Regeneration	Total of (2)+(3)	Utilisation during dry weather.	Balance on 1st July of succeeding year.	Inflow of monsoon Plus Regeneration.	Sum of (6)+(7)	Use in Monsoon	Balance at end of Oct of succeeding year.	Remarks.
1	2	3	4	5	6	7	8	9	10	11
				IST CYCLE-1898-1919						
1898-1899	5.75	0.68	6.43	2.89	3.54	Nil	-	Refer para 1(e) Note 4		*Refer para 1(c) Note 4-
1899-1900	*	-	*	*	-	5.26	-	1.54	3.72	... (36,000KW. continuous vide
1900-1901	3.72	0.70	4.42	3.05	1.37	4.19	5.56	1.54	4.02	(Note 4 Para
1901-1902	4.02	0.67	4.69	3.05	1.64	4.36	6.00	1.54	4.46	1(c)
1902-1903	4.46	0.68	5.14	3.05	2.09	7.11	9.20	1.54	5.75(spill)	
1903-1904	5.75	0.74	6.49	2.89	3.60	2.18	5.78	1.54	4.24	
1904-1905	4.24	0.50	4.74	3.00	1.74	2.73	4.47	1.54	2.93	
1905-1906	2.93	0.64	3.67	3.20	0.47	9.70	10.17	1.54	5.75(spill)	
1906-1907	5.75	0.80	6.35	2.89	3.66	3.06	5.71	1.54	4.17	
1907-1908	4.17	0.48	4.65	3.05	1.60	5.03	6.63	1.54	5.09	
1908-1909	5.09	0.70	5.79	3.00	2.79	4.65	7.44	1.54	5.75(spill)	
1909-1910	5.75	0.69	6.44	2.89	3.55	11.71	15.26	1.54	5.75(spill)	
1910-1911	5.75	0.84	6.59	2.89	3.70	1.35	5.05	1.54	3.51	
1911-1912	3.51	0.31	3.82	3.15	0.67	2.29	2.96	1.54	1.42	
1912-1913	1.42	0.53	1.95	1.95	0.0	7.16	7.16	1.54	5.62	38,000KW.continuous.
1913-1914	5.62	0.74	6.36	2.89	3.47	6.87	10.34	1.54	5.75(spill)	
1914-1915	5.75	0.73	6.48	2.89	3.59	7.74	11.33	1.54	5.75(spill)	
1915-1916	-	0.76	-	-	-	15.24	-	-	5.75(spill)	
1916-1917	-	0.91				10.58			5.75(spill)	
1917-1918	5.75	0.81	6.56	2.89	3.67	Nil	3.67	Refer para 1(e) of Note IV.		
1918-1919		Nil			0.0	7.79	7.79	1.54	5.75(spill)	36000 KW continuous vide Note 4 para 1(e)

Contd...2.

IIND CYCLE 1919-1920-1921.

This can be tided over in view of Note IV Para 1(f) as Minimum run-off at Ukai would be 0.416 x 3.32 = 1.4 m.a.ft.

IIIRD CYCLE 1924-1925-1926-1927.

This may be compared with 1910-11-12-13.
Extra run-off available would be (4.68 + 8.38)-(4.36 + 6.7)= 2.0 M.a.ft.
Extra available at Ukai. 2.0 x 0.416 = 0.83 M.a.ft.
Hence balance storage on 1st November 1923 would be (balance on 1st November,1912)+ 0.83 i.e.

1.42 + 0.83 = 2.25
Weather flow: = 0.70

2.95 with irrigation supply stopped.

Full power of 54,000 K.W. can be generated.

Period.	Balance storage 1st Nov. of proceeding year.	Dry weather inflow + Regeneration.	Total of (2)+(3)	Utilisation during dry weather.	Balance (4)-(5) on 1st July of succeeding year	Inflow of monsoon + Regeneration.	Sum of (6)+(7)	Use in Monsoon	Balance on 31st Oct. of Succeeding year.	Remarks.
1	2	3	4	5	6	7	8	9	10	11
				CYCLE NO.IV.						
1949-1950	5.75	0.96	6.71	2.89	3.82	2.73	6.55	1.54	5.01	
1950-1951	5.01	0.64	5.65	3.0	2.65	2.11	4.76	1.45	3.31	
1951-1952	3.31	0.49	3.80	3.2-0.34 2.86	0.94	1.43	2.37	1.45	0.92	
1952-1953	0.92	0.33	1.25	1.25	0.0	4.98	4.98	1.45	3.33	30,000 K.W. continuous vide para 1(g) of Table IV.
1953-1954	3.33	0.70	4.03	3.2	0.83	12.12	12.95	1.45	5.75 (Spill.)	

POWER GENERATION.
AVAILABILITY AND COSTS.

1.0 75% availability of water.

75% availability of water has been assumed as the design basis for irrigation and power.

	m.a.ft.
Run off in 75% dry year ...	9.18
Upstream utilisation ...	6.00
Balance available @ Ukai..	3.18
Water due to regeneration.	1.20
Carry over to ensure power in monsoon months. ...	0.86
	5.24
Withdrawals from U.L.BC	0.60
	4.64
Deduct evaporation. ...	0.5
Balance.	4.14

Power draft $\frac{4.14 \times 10^6}{730}$ = 5,670 Cusecs.

Equivalent H = 145

Power available

$\frac{5,670 \times 145}{14.5}$ = 56,700 KW continuous.

or say 90,000 KW @ 0.6 L.F.

1.1. Height of Dam to enable above utilisation.

Allow monsoon utilisation of 2 months.

i.e. $\frac{5.24}{6}$ = 0.87 m.a.ft.

Deduct regeneration	0.20
Net use	0.67

(contd.... 2)

Balance to be stored	...	3.18 - 0.67
	=	2.51
Add carry over	...	0.86
		3.37
		1.15 dead storage
Total	....	4.52
Corresponding F.R.L.	...	327.00

Cost of Dam - 25.00 Crores.

1.2 Power available in 95% years with above storage.

Total run off	....	4.28 M.a.ft.
Available @ Ukai from free catchment		1.43
Add regeneration	....	0.35
		1.78
Carry over.	....	0.86
		2.64
Evaporation less		0.40
		2.24

Power draft $\frac{2.24 \times 10^6}{730}$ = 3068 cusecs.

Power available

$\frac{3068 \times 140}{14.5}$ = 29,600 KW continuous.

or say 44,000 Kw @ 0.6 L.F.

2.0 Reservoir with F.R.L. 345.00

2.1 Power available in 95% years.

Additional carry over of 2.4 M.a.ft enables additional utilisation of about 1.5 M.a.ft. Allowing for evaporation 1.3 M.a.ft.would be available for power generation.

Additional power draft = $\frac{1.3 \times 10^6}{930}$ = 1780 Cusecs

(contd...3)

Total power draft 5,670 + 1,780 = 7,450 Cusecs

Power available = $\frac{7,450 \times 160}{14.5}$ = 82,000 KW continuous.

or say 1,30,000 KW at 0.6 L.F.

2.2. Power available in 95% years is examined for all the years from 1891 to 1954, vide Table 2 and works out to 90,000 KW @ 0.6 L.F.

3.0 Costs.

3.1 Difference in costs of dams between F.R.L.S. 345.00 and 327.00 = 7.0 crores.

Additional capacity required to generate extra 40,000 KW in 75% years = 40,000 KW

Additional cost of Civil works directly chargeable to power = Rs. 0.8 crores.

Additional cost of Electrical Plant and equipment. = Rs. 1.1 crore.

3.2. Additional working expenses:-

	Rs. lakhs.
(i) Civil works Rs.780 lakhs @ 5.25 % =	40.8
(ii) Electrical Plant and equipment Rs.110 lakhs @ 8% =	8.8
Total	Rs.49.6 lakhs.

Cost per additional unit (46,000 KW. of firm power)

$= \frac{49.6 \times 10^5 \times 16}{46000 \times 5256}$

= 0.328 Anna

3.3 Annual working expenses.

Power available in 75% years - 1,30,000 KW

Cost of Dam chargeable to power	Rs. 1438.00 lakhs.
Cost of Direct Civil works.	Rs. 318.00 lakhs.
Total cost, Civil works.	Rs. 1756.00 lakhs.

(contd...4)

Electrical works Rs.438.00 lakhs

$\frac{1756.00 \times 5.25}{100} + \frac{438 \times 8}{100}$

= Rs.127.23 lakhs.

Cost of energy generation = $\frac{127.23 \times 16 \times 10^5}{1,30,000 \times 5256}$

= 0.298 Anna.

Power available in 75% years. 1,30,000 KW

Power available in 20% years. 1,00,000 KW(av.)

Power available in 5% years. 50,000 KW

Average power available 1,20,000 KW @ 0.6 L.F.

Average cost of generation = $\frac{0.298 \times 1,30,000}{1,20,000}$

= 0.328 Anna which compares very favourably with the cost of thermal of generation in this area.

Hence proposition of Raising to R.L. 345.00 is very economic.

4.0 Basis of Costs adopted.

4.1. Cost chargeable to Irrigation:-

	Rs.Crores.
Cost of Dam for Irrigation alone (2.0 M.a.ft. live capacity)	20.00
Add for Additional reliability to irrigation with Reservoir @ R.L. 345.00	2.00
Total	22.00

4.2. Costs.

	Rs.Lakhs.
Unit I Dam and appurtenant works.	3637.66
Unit II Main Canals and Branches.	1172.64
Unit III H.E.Installation.	1346.47
Total	6156.77

APPENDIX-"E"

UNIT I

ABSTRACT

(All figures in lacs)

Sub-head.	Provision as per 1955 estimates.	Increase made in 1956 estimates(Applicable to Dam with FRL 345.0)	Increase accepted by CW &PC (Applicable w to Dam with FRL 345.0)	Increase now suggested.	Final provision required.
I.					
A.Preliminary.	19.00	-	10.00	-	29.00
B.Land.	418.08	-	-	22.50	440.58(details attached)
C.Works.	2255.53	-	51.15	99.62	2406.30
D-Regulators.	60.00	-	-	-	60.00
G-Bridges.	25.00	-	-	-	25.00
K-Buildings.	95.24	-	15.00	-	110.24
M-Plantation	1.00	-	-	-	1.00
O-Miscellaneous	71.93	-	5.00	30.50	107.43
R-Communication.	57.57	-	5.40	11.00	73.97
P-Maintenance.	25.85	-	-	2.28	28.13
Q-Special T & P.	75.00	6.25	69.00	-	150.25
7.Loss on Stock.	10.00	-	-	-	10.00
8.Unforeseen items.	10.00	-	-	-	10.00
Total I-Works	3124.20	6.25	155.55	165.90	3451.90
II					
(a)Establishment.	175.90	-	-	-	195.74
(b)Leave & Pensionary charges.	18.47	-	-	-	20.55
III.					
Tools & Plant.	31.24	-	-	-	34.52
Deduct R/R on Capital account	(-)19.37	-	-	-	(-) 21.60
Total Direct Charges.	3330.44	-	-	-	3681.11
Indirect charges.					
Capitalisation of land 5% of B-Land.	20.90	-	-	-	22.03
Audit & Accounts charges.	31.24	-	-	-	34.52
Total Direct & Indirect charges	3382.58	-	-	-	3737.66
		Less credit on disposal of Special Tools & Plant.			100.00
Net Total.		...			3637.66

UNIT II

Abstract.

Sub-head.	Provision as per 1955 estimates.	Increase accepted by the CW & PC.	Increase now suggested.	Final provision required.
A-Preliminary	6.58	-	-	6.58
B-Land.	32.52	-	-	32.52
D-Regulator.	13.62	-	0.14	13.76
E-Falls.	1.94	-	0.02	1.96
F-Cross Drainage works.	303.68	-	3.04	306.72
G.Bridges.	49.84	-	0.50	50.34
H.Escape	1.41	-	0.01	1.42
K-Buildings.	46.37	3.00	-	49.37
L-Earthwork.	361.70	-	-	361.70
M-Plantation.	1.08	-	-	1.08
O-Miscellaneous.	17.15	0.50	-	17.65
P-Maintenance.	8.0 3	-	0.08	8.11
3- Distributaries & Minors.	162.58	-	-	162.58
F-Drainage & Protective works.	3.50	-	-	3.50
5-Water courses.	1.92	-	-	192
6-Special T & P.	7.50	-	3.5	11.00
7-Losses on stock.	2.00	-	-	2.00
8-Unforeseen.	20.00	-	-	20.00
Total IWorks.	1041.42	3.50	7.29	1052.21
Establishment 9%	90.80		0.97	91.77
Leave & Pensionary charges.	9.54		0.10	9.64
Tools & Plant.	15.62		0.16	15.78
R/R on Capital account.	(- 8.87		(-) 0.04	(-) 8.91
Total Direct charges.	1148.51		11.98	1160.49
Indirect Charges				
Abatement of land revenue.	1.63		-	1.63
Audit _ Accounts charges.	10.41		0.11	10.52
Total direct & indirect charges.	1160.55		12.09	1172.64

UNIT III

A B S T R A C T.

Sub-heads.	Provision as per 1955 estimates.	Increase already recommended.	Further increase now suggested.	Final provision required.
Civil works	313.75	-	4.95	318.70
P-Production.	626.30	-	(-)188.30	438.00
T-Transmission	589.77	-	-	589.77
	1529.82		(-) 183.35	1346.47

UNIT.I.

A-PRELIMINARY.

As per 1955 estimate.	19.0 lakhs.
Increase accepted by CW & PC	10.0 lakhs.
	29.0 lakhs

B.LAND(Revised Details)

(a) 27,000 Acres uncultivated area @ Rs.200/-	54,00,000
(b) 40,000 acres cultivated area @ 450/-	1,80,00,000
2.(a)6,400 Kutcha House @ Rs,200/-	12,80,000
(b)900 pucca Houses @ Rs.1500/-	13,50,000
3.(a)7 Nos other public buildings - Kutcha@ Rs.500/-	3,500
(b)14 Nos other public buildings - pucca @ Rs.3000/-	42,000
4.(a)260 Nos. wells Kutcha @ Rs.100/-	26,000
(b)140 Nos wells pucca @ Rs. 1500/-	2,10,000
5. 6000 Nos. Fruit bearing trees @ Rs.20/-	1,20,000
6. Item Road tanks etc.	7,50,000
7. 1000 acres compensation for colony area including houses etc., @ Rs.200/-	2,00,000
8. 860 acres land required for Dam etc. @ Rs.200/-	1,72,000
9. 230 acres land required for spillway etc.,@ Rs.200/-	46,000
10. 200 acres - Road quarries etc., @ Rs.200/-	40,000
11. 48,000 people (12,000 families) cost of rehabilitation @ Rs. 500/- per family of four members.	60,00,000
	3,36,39,500

C.O.

	B.F.	3,36,39,500	
12.	Cost of boundary stones etc., @ 3% on item 1,7 to 10	7,39,740	
13.	Compulsory acquisition @ 15% on item 1 to 10	41,45,925	
14.	Interest charges @ 4% for 2 years on item 1 to 10 and 13	25,42,834	
15.	Clearing reservoir area L.s.	5,00,000	
16.	Transport of displaced families.	10,00,000	
17.	Establishment contingencies etc. @ 3½%	14,89,881	
	Total	4,40,57,880	440,57,880
C.WORKS.			
(i)	Clearing site and diversion roads as per 1955 estimates		26,50,000
(ii)	Earth Dam as per 1955 estimate.	7,44,83,000	
	Increased cost of earthwork accepted by C.W. & P.C. 5,34,000 Units @ Rs.5/- per unit.	26,70,000	
	5% Contingencies thereon.	1,33,500	
		28,03,500	772,86,500
(iii)	Concrete Dam. As per 1955 Est.	14,8420000	
	Increase already accepted by CW & PC.		
	(a) Sluice & emergency gates 3776 sft. @ Rs.200/- per sft.	7,55,200	
	(b) Crest Gates 48,195 sft. @ Rs.30/-per sft.	14,45,850	
	(c) Contingencies @ 5% on (a) + (b)	1,10,500	
	Increase now suggested		
	(a) Increased cost of cement 5,69,000 units @ Rs.15/- per unit.	85,35,000	
	(b) Contingencies at 5% on(a)	4,26,750	1596,93,300

C.O.

B.F.	1596,93,300
Extra now suggested	
(iv) Illumination of Dam, galleries etc.	10,00,000
Total	Rs.2496,29,800
Say.	Rs.2406,30,000

A. BUILDINGS.

As provided in 1955 Estimate	95.24 lakhs
Extra accepted by CW & PC.	15.00 lakhs
	110.24 lakhs.

B. MISCELLANEOUS.

As provided in 1955 estimate	71,92,500
Extra accepted by CW & PC.	5,00,000
Increase suggested.	
Initial equipment for water supply & laying of pipe lines etc.	2,00,000
Printing of Pamphlets etc.	1,00,000
Maintenance of lawns and gardens.	50,000
Electrical distribution system, street lighting etc. including maintenance.	5,00,000
Increase in provision for R/m of Hospitals.	3,00,000
Increase for designs.	19,00,000
R. COMMUNICATIONS.	
Provision as per 1955 est.	57,57,000
Extra accepted by CW & PC.	5,40,000
Extra now suggested.	11,00,000
	73,97,000

(Contd....4)

-4-

SPECIAL T & P.

Provision as per 1955 estimates.	75.00 lakhs.
Increase made in 1956 estimates	6.25 lakhs.
Further increase accepted by the CW & PC.	69.00 lakhs.
	150.25 lakhs

UNIT II.

D. REGULATORS.	13.62
Add for increased cost of cement and steel.	0.14
	13.76
E. Falls.-	1.94
1% Extra.	0.02
	1.96
F. Cross Drainages.	303.68
	3.04
	306.72
G. Bridges.	49.84
	0.50
	50.34
H. Escapes.	1.41
	0.01
	1.42
K. Buildings.	46.37
Extra accepted by CW & PC.	3.00
	49.37 lakhs.
O/ Miscellaneous.	17.15
Extra accepted by CW & PC.	0.50
	17.65 lakhs.
Special T & P	7.5 lakhs.
Extra now suggested.	3.5 lakhs.
	11.0 lakhs.

UNIT-III

P. Production - Civil works.

C-Works.		257.42
Increase towards increased cost of steel and cement(now recommended)	-	5.00
		262.42 lakhs.
K. Buildings.		29.45
Extra now suggested.		0.50
		29.95 lakhs.

UNIT-III

HYDRO ELECTRIC INSTALLATION

P.Production

	Rs. in lakhs.
A. Preliminary works B. Land C. Works.	Covered under Unit I.
1. Telephone, Lights and Power system illumination of power-house & switch yard and telephone system etc.	6.0
2. Power House equipment	
a. Main Generating Units including all associated auxiliary equipment 4 units each of 40,000 KW (160,000 KW)@ Rs. 125/- per KW	200.0
b. Power Station auxiliary electrical equipment comprising station transformers, L.T. Switchgear, 11 KV Switchgear, D.C. equipment, Power and Control cables etc.	24.0
c. Other auxiliary equipment comprising Power House Crane, conduit work cable racks and trays, cooling watter supply, lubricating and Generator oil storage and piping earthing connections, @ 20% on items a & b above.	44.8
d. Erection & Commissioning @ 10% on a,b&c above.	26.88
Total	301.68
3. Step-up Sub Station equipment.	
(a) Main equipment comprising (i) 4- 11/132 kV 45,000 KVA transformers @ Rs. 12/- per KVA	21.6

Cont'd.....2/

(ii)	9-KV breaker equipment with isolators, structures etc. @ Rs.2.0 lakhs each.	18.0
(iii)	4-132 KV lightning arrestors at Rs. 10,000 each	0.4
(b)	Auxiliary equipment including conduit work, cable, tunnels, racks, trays cooling water supply, insulating oilstorage and piping foundation works, earthing connections, railings etc. @ 20% of (a) above.	8.0
(c)	Erection and commissioning @ 10% on (a) & (b) above.	4.8
	K-Buildings - covered in Unit No. III	
	Total	354.48
	Add 5% contingencies.	17.72
	Total of C. Works	372.20
	O. Miscellaneous works including general water supply system compressed air system, air conditioning, free lightning equipment, station grounding system, testing arrangements for units, temporary electrical works, charges for procurement of equipment etc. @ 7.5% on C. Works.	27.91
	P. Maintenance during construction @ 1% on Works.	3.72
	7-Issues on Stock @ 0.25% on C-Works.	
	8-Unforeseen items.	0.93
	Total for I Works	404.76
	II Establishment.	
a.	6% on I Works.	24.29
b.	Leave & Pensionary charges @ 21% of 50% on Establishment	2.55
	III Tools & Plant @ 1% on I Works.	4.05
	IV Suspense.	Nil.
	V Deduct R/R on Capital Account	(-) 0.50
	Direct Charges	435.15

Cont'd.

	B/F	435.15
Direct Charges.		
(i) Capitalisation of abatement on Land Revenue.		nil
(ii) Audit & Account Charges @ 0.5% on I. Works.		2.02
Total Direct & Indirect charges.		437.17 Lakhs.

.....

Dharan,
29 11 1958.

UKAI PROJECT

Analysis of Earthwork Rate.

(i) SHOVEL

Production of 3½ Cyd. Shovel = 109 CFC/Hr. (CP. 103 of R&C Report)

With 65% Operating efficiency = operating time 50 min/hr add 85% compaction factor.

Hourly output = $109 \times 0.65 \times \frac{50}{60} \times 0.85 = 50.18$ CFC

Say ..... 5 Units.

Hourly cost of shovel @ Rs. 89 (P. 238 of R&C Report)

∴ Unit cost = $\frac{89 \times 1}{5}$ = Rs. 17.8 per 1000 Cft.....(i)

(ii) TRACTOR DOZER

Hourly cost of 130 H.P. Tractor Dozer = Rs. 32.0 (P. 238 of R&C Report)

Allowing 1 Dozer for 4 shovels.

Unit cost for Dozer = ¼ x 32.0 = Rs. 8.0

Hourly output 5 units

∴ Cost of Dozer per unit of E.W. = Rs. $\frac{6}{5}$ = 1.6 .....(ii

(iii) TRANSPORT VEHICLES.

Bottom Dumpers = Capacity 17/22 Cyds.

Operating time
- Fixed time 1.5 mins. (P. 119)
- Loading time 3.0 mins.
- Round Haul - 2 miles. @ 15 M.P.H. 8.0 mins.
- Total per trip ... 12.5 mins.

Production per trip = 20 cyds. loose.

Production per hour = 96 cyds.

Compaction factor. = 0.63

∴ Compact bank = 96x0.63 = 60.5 Cyds. = 1630 Cft.

With operating efficiency 65% and operation period of 50 min/hr.

Net hourly output = $1630 \times 0.65 \times \frac{50}{60}$ = 890 Cft.

Hourly cost of Dumpers = Rs. 47/-.

∴ Cost per Unit = $\frac{47 \times 1}{0.89}$ = Rs. 53/- per 1000 Cft. ....(ii

Cont'd,,,,,,2/

(iv) LEVELLING, ROLLING, WATERING ETC.

Sheep-foot Roller.

Average output 1x2 = 50 CFC/Hr.

∴ Production of 1x4 = 100 CFC/Hr. (Borrow Pit).

Hourly rate of 1 tractor and 1 x 4 S.F.R. = Rs. 35/- per h

∴ Unit Cost $\frac{35x1}{10}$ = Rs. 3.5

Unit cost for Sheep-foot roller	= Rs. 3.5	per 1000 Cft.
Add for levelling @ 25%	= Rs. 0.9	-do-
Watering.	= Rs. 2.5	-do-
Dressing.	= Rs. 2.5	-do-
Total for levelling etc.	= Rs. 9.4	-do- ....(iv)

Total of (i) to (iv) above.... = Rs. 81.8 per 1000 Cft.
Say Rs. 82/- per 1000 Cft.

For the fact that an extra rate of Rs. 15/- per 1000 Cft. has been provided for the earthwork in the River portion for 100 Mcft. which adds about Rs. 3/- per 1000 cft, the overall estimated rate of earthwork becomes Rs. 77/- per 1000 cft. The increase of Rs. 5/- per 1000 cft. in bank work will increase the cost of earthen dam by about Rs. 30 lakhs.

LEAD FOR EARTHWORK

Total earthwork quantity.

impervious - Dam & Dykes.	334.2 Mcft.
Semi-pervious - Dam & Dykes.	199.8 Mcft.
Total	534.0 Mcft.

LEAD FOR IMPERVIOUS SOIL

Total quantity. 334.2 Mcft.
Taking the depth as 20 ft.
Average area of earth-base = 16.7 M.sft.
With a length of 10,000 ft.

∴ Average width of B.Pit = $\frac{16.7x60'}{10,000}$ = 1670 ft.

Width of half -do-	= 835 ft.
Allowing clearance from toe	= 600 ft.
Half the dam width.	= 450 ft.
Total lead.	= 1885 ft.

Inclusive of lifts & turns etc.

The average lead for impervious soil = 3,000 Ft.

SEMI-PERVIOUS SOIL

On an average this lead may be taken as 1½ miles-
Say 8000'

Quantity = 200 Mcft.

∴ Lead for the purpose of working the earthwork rate
$= \frac{334 \times 3000 + 200 \times 8000}{534}$ = 4900 ft. Say 1 mile.

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UKAI PROJECT

Break-up of overall concrete rate in Ukai Dam

		Cost per 100 Cft. of Concrete
1.	Mass Concrete 1:3:6	
1.	Coarse Aggregate.	Rs. 32.78
2.	Fine Aggregate.	Rs. 13.74
3.	Cement.	Rs. 87.29
4.	Water.	Rs. 3.00
5.	Batching, mixing & laying.	Rs. 40.75
6.	Other Items.	Rs. 7.00
7.	Workshop charges.	Rs. 1.50
8.	Form work.	Rs. 10.00
	Total	Rs. 196.06

2. Richer concrete in faces(1:2:4)

Extra cement = 17.0 - 12.65 bags = 4.35 cwts. at Rs. 138 per ton.

= Rs. 30.02

Therefore rate for 1:2:4 concrete= Rs. 226.08

3. Combined average rate for concrete in Dam.

The rich concrete will be about 10%

Therefore overall average rate = 0.1(226.08) 0.9(196.06)
= 22.6 + 176.4 = Rs. 199/-

4. The flank dam can be in masonry at an average rate, of Rs. 140/- per 100 Cft. and the quantity is about 20%.

5. Overall rate for concrete in main dam and masonry in flank dam:

0.80(199.0) +0.20(140) = 159.20 + 28 = Rs. 187.20

Add 15% for contractor's burden & profit = Rs.28.05

Overall rate for complete item on contract=Rs.215.25

6. Rate provided in the estimate. = Rs. 200/-

Increase.....Say.....Rs. 15/- per Unit.

Supporting calculation for the break-up of overall concrete rate in Ukai Dam

Mass Concrete.	Unit.	Qty.	Rate.	Amourt.	
1. Coarse Aggregate.					
1.1 Quarrying	100 cft.	0.94	9.61	9.03	(RCC.282)
1.1.A Removal of Overburden	"	"	0.961	0.90	-do-
1.2 Transport to Crusher 2 miles	100	0.94	6.3	5.90	-do-
1.3. Crushing, processing and conveyance to stock pile.	"	0.94	12.5	11.75	-do-
1.4. Transport from Stock piles to Batching Plant	"	0.94	5.53	5.20	-do-
		Total for C. aggregate.		32.78	
2. SAND.					
2.1 Quarrying	CFC	0.47r	10.0	4.70	(R.C.C.)
2.2 Transport to stock lead 2 miles	"	0.47	6.7	3.15	
2.3 Washing.	"	0.47	7.0	3.29	
2.4 Transport from stockpile to batching plant	"	0.47	5.53	2.60	
		Total for sand.		13.74	
3. CEMENT					
3.1 Upto batching Plant as per analysis.	1.0 Cwt.	12.65 Cwt.	138/- per ton.	87.29	(rate as per analysi
4. Water.	L.S.	3.00	3.00	3.00	(H.K.D)
5. Admixture.	-	-	-		
6. Batching, Mixing and laying.					
6.1 Batching and mixing.	CFC	1.0	5.19	5.19	(Maithon R.C.P.282).
6.2 Placing including transport from Batching Plant including vibrating	CFC	1.0	23.56	23.56	(RCC-282)
6.3 Cleaning slurry					
Curring and finishing					

Cont'd....2/

(a)	Cement for slurry.	CWT	1.0	110/-	5.50
(b)	Sand blasting and cleaning with sand and water.	-	-	-	5.50 (H.K.D)
(c)	Compressed air for batching & other sundries.	CFC	-	L.S.	1.00(RCC P-283)
			Total item 6.		40.75
7.	OTHER ITEMS				
7.1.	Precooling Plant and expenses.	CFC	-	L.S.	7.0(Vaitarna & III Siminar Srinagar P. 192)
8.	Workshop charges	CFC	L.S.	L.S.	1.50(RCC-P-283)
9.	Form work	CFC	-	L.S.	10.00(Hirakud)

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Analysis of the rate of Cement.

11.1	Bulk cement at Sonegadh	Rs. 117.50	*Per ton. Standard rate in bags 102 less for bags 15.
11.2	Sales Tax @ -/-/9 per Rs.	Rs. 3.94	
11.3	Rail freight Sonegadh to Dam Site - 6 miles @ 0.4 anna per ton mile (P. 158 R.C.C)	Rs. 2.40	
		123.84	
	Depreciation of silos	Rs. 2.00	
	Depreciation of cement handling Plant	Rs. 8.00	
	Working of cement handling plant.	Rs. 2.50	
	Unforeseen expenditure.	Rs. 1.80	
	Total per ton.	Rs. 138.34	

Say Rs. 138/- per ton.