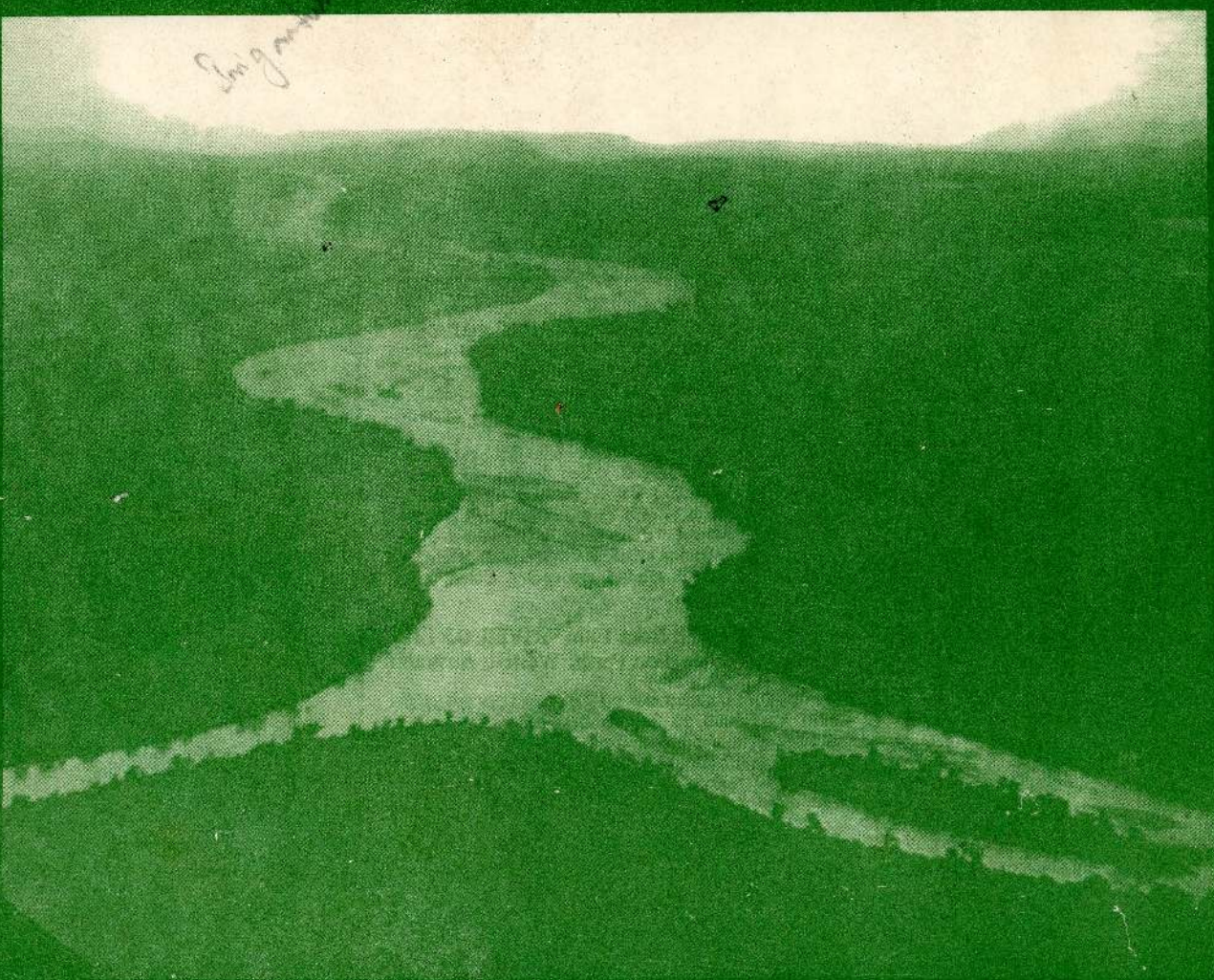
MAHAWELI

PROJECTS & PROGRAMME



MINISTRY OF MAHAWELI DEVELOPMENT

OBJECTIVES OF THE ACCELERATED PROGRAMME

The Accelerated Mahaweli Development Programme was embarked upon with a veiw to providing solutions to three of the major problems facing Sri Lanka in 1977 viz: acute unemployment, drain of foreign exchange for agricultural imports and shortage of power. While the fiscal and economic reforms, policy changes and other development projects have had some impact towards a solution to these problems, the basic problems still remain. Employment creation in the period 1977 – 1980 in the organised sector has been about 280,000 due to the several policy changes and economic measures adopted. Shortages of manpower have occurred in the technical and skilled categories as a result of employment creation locally and due to emigration to the Middle East. Additional jobs have also been created in the unorganised private sector, in the agricultural sector and in self-employment. This high rate of growth of employment in the last three years due to liberalisation policy cannot be maintained at the same level. Annual addition to the workforce is about 125,000. The Mahaweli Programme has already provided employment in opening up of new areas in the Kalawewa region to about 50,000 people in agriculture and support services. The three Headworks under construction at Victoria, Kotmale and Maduru Oya provide employment for about 8,000 persons. Downstream development of irrigation facilities, infrastructure and civic facilities also provide a substantial amount of employment through many big and small scale contractors. The opening out of about 50,000 hectares (123,500 acres) over the next three to four years in Systems C & B will provide permanent employment to about 100,000 persons in agriculture and a further number in support services.

Policy changes in the Agricultural Sector and the attractive open market prices for paddy and other agricultural crops have led to a substantial increase in agricultural production. Though the volume of rice and wheat imports has decreased, increased world market prices of these commodities result in a substantial drain on foreign exchange resources. Over Rs. 6,000 Million was spent on the import of rice, flour, wheat, sugar and dairy products in 1980. The new lands brought under irrigated agriculture under the Mahaweli will contribute substantially towards a reduction in the volume and value of these imports.

Another objective of the Accelerated Programme was to provide electricity to meet the requirements of industry and rural electrification. The consumption of electricity in Sri Lanka is one of the lowest for Asia. After a period of sluggish growth in demand for power of 6% in the period 1970-1977, the import liberalisation policies and the development of new industries led to a sudden upsurge in the demand for electricity resulting in an average annual rate of growth of 12% for the period 1978-80. This increased demand together with adverse weather conditions in the catchment areas of Maskeliya Oya and Kehelgamuwa Oya led to severe power cuts adversely affecting industrial and commercial activities in 1980. Gas Turbines with a capacity of 60 MW have been installed by the Ceylon Electricity Board and a further 60 MW are being ordered to meet requirements of power till the Victoria and Kotmale Projects are commissioned in 1984/85 and the Randenigala Project a while later. These three projects will double the existing hydro-energy capacity of 1,750 GWh (inclusive of Bowatenne and Canyon).

The areas taken up for development under the Accelerated Programme are in the comparatively undeveloped North Eastern Sector of the Island. The development of these areas under irrigation and the settlement of a large number of families will change the socio-economic picture of the entire region. As these areas are sparsely populated and the settlers will have to be brought in from outside, it will also relieve landlessness and socio-economic problems of some of the thickly-populated areas of the country.

THE ACCELERATED PROGRAMME

The UNDP-FAO-IRRIGATION DEPARTMENT Master Plan for the development of the resources of the Mahaweli was a culmination of about 20 years of data gathering, investigations and planning by the Irrigation Department and external agencies like the USOM and the Hunting Technical Services. On the phasing of Mahaweli development over a period of 30 years in step-wise implementation, there would not have been a substantial impact on Sri Lanka's problems described earlier. It is in these circumstances that the Accelerated Programme, dove-tailing as many of the projects of the Mahaweli as possible into the shortest implementation period, was decided on. After an initial review with the World Bank at the end of 1977 a priority programme of investigations and feasibility studies for five Reservoir Headworks and the associated downstream development of 140,000 hectares (350,000 acres) was tentatively decided on. It was estimated, on the basis of the UNDP Master Plan estimates escalated for inflation and variations in currency parities, that this programme will cost Rs. 8,000 Million at 1977 constant prices and Rs. 11,000 Million with provision for escalation during construction. Detailed plans, designs and estimates, however, indicated that the eventual costs will be substantially greater. The scope of the reservoirs was also considerably altered as a result of the detailed studies and designs with considerably increased storage capacities and power output. The installed capacity of Victoria has been increased from 120 MW in the UNDP Report to 210 MW with provision for further expansion by an additional 210 MW at a later stage. Similarly, the installed capacity of the Kotmale Project has been increased from 100 MW to 200 MW. Worldwide inflation which has taken place since 1977 has been high and local inflation, as a result of the considerable investment in the Public and Private Sectors, has been higher. The estimated cost of the current programme of construction of the 4 reservoirs, Victoria, Maduru Oya, Kotmale and Randenigala, the Minipe Transbasin Canal and the development of 50,000 hectares (120,000 acres) in Systems C & B is approximately Rs. 31,000 Million.

FEASIBILITY STUDIES

Simultaneously with the decision to embark on the Accelerated Programme of Mahaweli Development, discussions were held with friendly countries and international agencies and technical assistance for the engagement of consultants was obtained for five Reservoir Headworks and associated downstream development. An Implementation Strategy Study was also commissioned to review the Master Plan, examine the implications of alternative phasings and to recommend an Action Plan taking into account the technical, financial, economic, institutional and manpower aspects. This study was to proceed simultaneously with the on-going feasibility studies. Feasibility studies which had to be carried out on the different headworks and the downstream development areas as well as the preparation of plans, designs, estimates and tender documents for the headworks involved maximum effort by the different agencies involved. The Survey Department has carried out surveys covering about 1,500,000 acres; for 1,000,000 acres maps produced were on the 1:10,000 scale with 5 metre contours; the balance 500,000 acres had maps on the 1:5,000 scale with 1 metre contours. The Irrigation Department was involved in geological investigations with a total depth of drill holes amounting to

about 5,000 metres. It also carried out detail soil surveys and land classification of the irrigable areas, and engineering material investigations as well as hydraulic model testing. The Central Engineering Consultancy Bureau, the Mahaweli Development Board and the Irrigation Department had to deploy their staff to carry out the studies and prepare the necessary plans, designs and estimates for the major engineering works.

IMPLEMENTATION STRATEGY

The feasibility studies of the various projects were completed in 1979 and detailed reports covering all aspects of development, engineering, hydrology, water use, land classification, settlement planning, agriculture development and research, marketing, sociology and environmental aspects, etc., have been issued in respect of the Reservoir Headworks of Kotmale, Victoria, Maduru Oya, Randenigala-Rantembe and Moragahakanda as well as the downstream development areas of Systems A, B, C & D. The outcome of the feasibility studies indicated that the Reservoir Headworks of Victoria and Randenigala-Rantembe are economic on the value of power alone with an internal rate of return of more than 12% and so also Kotmale, with a slightly less favourable internal rate of return of 9.5%. The downstream development areas have an equally favourable internal rate of return. The Implementation Strategy Study which was carried out separately came to similar conclusions. The Implementation Strategy Study indicated that the water resources of three reservoirs viz: Victoria, Kotmale and Maduru Oya were sufficient for the irrigation of the 140,000 hectares (350,000 acres) in Systems A, B, C & D and that the water resources of Randenigala-Rantembe and Moragahakanda could be used for irrigation of other areas.

The possible areas in which these excess water resources of the Mahaweli could be used is under study by a team of consultants financed by the World Bank. Three areas viz: the North Western Dry Zone, the South Eastern Dry Zone and the North Central region have been studied for possible diversion. The planning report issued by the consultants indicate that the optimal economic solution is for the development of 40,000 hectares (98,800 acres) in the South Eastern Dry Zone which yields benefits of Rs. 120 Million per year at a discounting rate of 10%. The North Western Dry Zone gives a negative return of Rs. 225 Million at 10% discount rate. The development of 62,500 hectares (about 155,000 acres) in Systems M & I in the North Central region gives a negative rate of Rs. 605 Million at the discounting rate of 10%, and a negative return of Rs. 1,585 Million for the full region of 190,000 hectares (469,300 acres).

The final plans, designs and tender documents for Kotmale, Victoria and Maduru Oya projects were finalised, tenders called for and contracts awarded between the latter half of 1979 and the first half of 1980. Preparatory work undertaken by Sri Lankan agencies in the provision of access roads, construction camps, water supply, electricity and other facilities enabled the selected contractors to establish themselves and commence work on the construction of the projects without any setbacks or delays. Similarly, in the case of downstream development areas, while the feasibility studies were going on, work was commenced on the basic access roads required for construction purposes and camps, offices, quarters and other facilities required for construction, agriculture development and settlement in Systems C and B areas. Expenditure incurred inclusive of cost of surveys, investigations and planning on the Accelerated Programme up to end of 1980 amounted to approximately Rs. 4,000 Million of which the expenditure incurred in 1980 amounted to Rs. 2,800 Million. In addition an expenditure of approximately Rs. 1,300 Million was incurred in the development of System H area up to 1980 with a total expenditure amounting to Rs. 440 Million. Provision in the 1981 Budget for the Accelerated Programme is Rs. 3,750 Million and for 1982, Rs. 6,500 Million.

International financing agencies and friendly countries appreciated the economic problems facing Sri Lanka and the vital role which the Accelerated Mahaweli Development Programme would play in their solution. These countries came forward readily with assistance towards the successful implementation of the Programme. The World Bank took an active interest co-ordinating the foreign aid required and special sessions were held at the Annual Aid Group Meetings to discuss exclusively the Accelerated Programme. The Government of the U.K. financed the feasibility studies of the Victoria Project and the downstream development of System C under a technical assistance grant of approximately £ 1 Million. In addition, the geophysical and geological investigations costing £ 1.5 Million, drilling and laboratory testing equipment for the Irrigation Department, at a cost of £ 450,000 the purchase of Bailey Bridges costing £ 700,000 and construction equipment to the value of £ 1,100,000 for preliminary work on access roads, etc., were financed under technical assistance grants. The Victoria Project itself is being financed by the Government of U.K. with a grant of £ 100 Million spread over five years commencing 1980 at the rate of about £ 20 Million annually. In addition to meeting the shortfall in the financing of the foreign component of the Victoria Project, commercial credit of £ 20 Million for the purchase of electro-mechanical equipment has been arranged with the U.K. repayable in 20 half-yearly instalments carrying an interest of 7½ per cent. The Maduru Oya Project is being financed by the Government of Canada with an interest free loan of Canadian $ 76 Million and a technical assistance grant of Canadian $ 7 Million, the latter to cover the cost of the engineering services required for the project. The Kotmale Project is being financed by Swedish import support amounting to Swedish Kroner 630 Million. In addition, bridge financing of Swedish Kroner 330 Million repayable in six half-yearly instalments from 1985 has also been arranged. Commercial credit has been arranged in a sum of Swedish Kroner 252 Million for the electro-mechanical equipment required for the Project. The feasibility studies of the Randenigala Project and associated downstream development areas have been financed under a technical assistance grant of DM. 6,600,000 by the Federal Republic of Germany and the construction of the Randenigala Project is being financed by a long-term interest free loan of DM. 400 Million. The World Bank is financing the construction of the Minipe Right Bank Canal and the development of Zones 3 to 6 of System C with an International Development Agency credit of US $ 90 Million. The co-financing for System C by Japan and Kuwait in sums of US $ 45 Million each are being finalised. Zone 2 of System C is being financed by the European Economic Community in a sum of US $ 22.5 Million, approximately. The United States Agency for International Development (USAID) is financing the development of System B in a sum of US $ 95 Million spread over a period of four to five years. In addition, a further sum of US $ 50 Million has been pledged by USAID for the Mahaweli Programme to meet part of local expenditure. System G is being financed by the EEC in a sum of US $ 2.5 Million. The development of the main road network required for the downstream development areas of Systems B and C are being financed by the Asian Development Bank in a sum of US $ 10 Million. At current rates of exchange, the Aid package amounts to Rs. 7,600 Million by way of grants and import support on which no repayment is due. Rs. 10,700 Million in interest free or nominal interest long-term credit with 10-year grace periods and repayment periods of 30 – 40 years thereafter and export credit guarantee short-term financing of Rs. 1,700 Million, making a total of about Rs. 20,000 Million. The considerable escalation in costs during the construction period still leaves some shortfall in the financing requirements for the Accelerated Programme.

THE MODIFIED PROGRAMME

Reference had been made earlier to the high increases in cost estimates of the Accelerated Programme which have occurred over those originally envisaged both due to inflation and enlargement in the capacities of the reservoirs and their hydro-power potential. The Programme is being kept under constant review and is being modified to keep within the public investment policies and programmes of the Government and the financial resources that can be made available within that context. The investment programme over the next three to four years has been confined to the completion of construction of the three reservoir Projects – viz: Maduru Oya, Victoria and Kotmale, the commencement of construction on the Randenigala Project in 1982 and the development of System C and the left bank of System B. To enable the investment programme to be kept within the financial resource limits in the short-term, the power component of the Maduru Oya Project, estimated to cost Rs. 350 Million inclusive of the power house building and equipment, has been deferred to be taken up at a later stage. The cost estimates of Kotmale Project which had escalated due to adverse geological conditions and other factors were reviewed and it has been decided to reduce the crest level of the dam from 735 MSL to 706 MSL with provision for later increase to the original designed height and the installed capacity of power to two units of 67 MW each with provision for later addition of the third unit.

HEADWORKS

Victoria

The Victoria Project consists of a reservoir of 730 million cubic meters capacity (about 600,000 acre ft.) created by the construction of a double curvature arch dam with a height above foundation of 118 meters (387 ft.), a 5,400 meter long tunnel (3.35 miles) and a power station with an installed capacity of 210 MW made up by three units of 70 MW each. The total value of contracts awarded is about Rs. 3,750 Million and the project costs, inclusive of costs of engineering, work of local agencies and provision for contingencies, at constant prices is Rs. 5,000 Million and with provision for escalation and changes in parity values of currency during construction, Rs. 8,000 Million. Satisfactory progress has been made by the contractors on the river training and diversion works. Bulk excavation of blocks 4 to 14 is complete and concreting in blocks 4 and 6 is in progress. About 1,500 meters (0.93 mile) out of the 5,400 meters (3.35 miles) of tunnel has been excavated. Excavation of foundation is in progress for the power station building. The Victoria Project will provide irrigation water to 45,000 hectares (120,000 acres) in Systems C and B. The power station will generate 800 GWH of energy, with an annual value of over Rs. 1,200 Million. The project is expected to be completed in the latter half of 1984.

Maduru Oya

The Maduru Oya Project is mainly for irrigation and will regulate the water resources of its own catchment augmented by the Mahaweli waters transferred through the Minipe Right Bank diversion canal and the Rathkinda-Maduru Oya link tunnel. The Maduru Oya reservoir will have a storage capacity of 555 Million cubic meters (450,000 acre ft.). The contract for the construction of the dam and the link tunnel has been awarded in a sum of approximately Rs. 1,350 Million and the estimated cost of the project, inclusive of the cost of consultants and expenditure by local organisations, is approximately Rs. 1,600 Million at constant prices and Rs. 2,150 Million with provision for escalation of costs. Satisfactory progress has been being made in the construction. Excavation of the centre and right side of the dam foundation is complete and foundation treatment works are in progress. Rockfill on the right side has commenced and approximately 5,000 cubic meters of rockfill per day is being placed. The tunnel adits have been completed and about 25% of the excavation

on the main tunnel has been completed. The reservoir is expected to be completed in time for storage of the water by the last quarter of 1982.

Kotmale

The Kotmale Project consists of a reservoir with a crest level at 706 MSL (2,320 ft.) with a storage capacity of approximately 180 Million cubic meters (150,000 acre ft.), a tunnel 6,750 meters (22,135 ft.), and an underground power station with two units of 67 MW each with provision for the installation of a third unit of the same size later. The contract for the civil work was awarded on a negotiated contract in three different sections, the initial works, the main civil works Part I-underground works and Part II-reservoir works in a sum of approximately Rs. 4,500 Million. Contracts have been entered into for part of the electro-mechanical equipment. The total cost of the project, inclusive of engineering services and expenditure by local agencies, is approximately Rs. 6,200 Million and with provision for cost escalations and changes in currency parities during construction, Rs. 9,000 Million. The construction camps, access roads, access tunnel to the power house which forms part of the initial works are almost complete and the diversion tunnels, which also forms part of the initial works, are nearing completion. Excavation of a little over 3,000 meters (1.86 miles) of the tunnel have been completed. The contract for the construction of the dam was awarded at the end of September 1981 but instructions for excavation of the dam foundation was given to the contractor by a variation order and about 30 per cent. of the excavation has been completed. The project is expected to be completed at the beginning of 1985 and will contribute 430 GWH of energy at an estimated annual value of about Rs. 650 Million.

Randenigala

The Randenigala Project consists of a rockfill dam 90 meters high (295 ft.) with a storage capacity of 800 million cubic meters (650,000 acre ft.), with a power house with an installed capacity of 122 MW consisting of 2 units of 61 MW each. The estimated cost of the project is Rs. 2,500 Million and with provision for escalations during construction the estimated cost will increase to Rs. 4,560 Million. Applications received for pre-qualification of civil contractors are under evaluation. The contract for the project will be awarded in 1982 for completion in 1986/87. The Randenigala power station will have an annual energy output of 525 GWH with a value of Rs. 800 Million.

DOWNSTREAM DEVELOPMENT

Downstream development over the next three to four years involves the development of approximately 24,000 hectares (59,280 acres) in System C and a similar extent on the left bank of System B. These areas will be irrigated by diversion of the run-of-the-river flows of the Mahaweli till the Victoria reservoir is completed when an assured regulated supply of water will be available. The Minipe Right Bank Canal will be the main conveyance for the diverted waters of the Mahaweli. It consists of a diversion barrage downstream of the ancient Minipe anicut, a lined canal 31 kilometers (19.26 miles) long with several level crossings and structures, the Ulhitiya-Rathkinda reservoirs and the link tunnel to Maduru Oya. The contract for the construction of the Minipe anicut and the first 3½ kilometers of the canal as well as the Ulhitiya Reservoir has been given to state agencies and the contract for the Badulu Oya tunnel and the Rathkinda reservoir to a local private firm. The construction of the canal from 3½ kilometers to 30.8 kilometers has been given after calling for international bids to a foreign construction firm. Satisfactory progress is being made in the construction of the Right Bank Canal. The construction of the Ulhitiya reservoir is nearing completion.

System C will be irrigated by left and right bank canals from the Ulhitiya-Rathkinda reservoirs. The left bank canal will irrigate

Zone 2 and the right bank canal Zones 3 – 6 of System C. A system of branch and distributory canals with balancing reservoirs will be provided and a group of about 10 to 15 farms will be served by one distributory turnout. The canals will be lined where the soils are permeable. The land will be cleared and developed and the necessary social infrastructure for the community services will be provided. About 24,000 worker-settlers will be settled with each settler being allotted 1 hectare (2.5 acres) irrigated plot and a .2 to .3 hectare homestead. A training centre and farm is being set up at Girandurakotte for the training of extension and management staff and also of farmers. The necessary organisation for the agricultural extension, farm power, agricultural support-services and credit and for monitoring are being set up. The development of System C commenced in 1980 and the settlement of 2,500 worker-settlers has been completed. The estimated cost of development of System C, inclusive of the cost of the Minipe Trans-basin Canal and the regulating reservoirs, is Rs. 3,800 Million. The development of System C is programmed to be completed in five years.

The feasibility studies for the development of System B under the Maduru Oya Project was carried out by Acres International Ltd., of Canada. The Maduru Oya Project covers a total area of approximately 135,000 hectares (333,500 acres) with a population of about 26,000. About 62,000 hectares (153,000 acres) are under the irrigable command of the Maduru Oya reservoir and about 80 per cent. of this is suitable for paddy cultivation, while the balance 20 per cent. is suitable for upland crops. The upland crop areas are, however, considerably dispersed. The nett farm irrigable area is now reckoned to be about 3,600 hectares (9,000 acres) of new land and 4,000 hectares (10,000 acres) of existing paddy land. The farm sizes and the general pattern of development of infra-structure facilities will be similar to that of System C. The design of the main and branch canals as well as the main drainage system and the detailed planning of a pilot area of about 4,000 hectares (10,000 acres) has been entrusted on contract to a firm of consultants financed by USAID. The tender documents for the first stage of System B Left Bank development have been finalised and are being reviewed. A draft feasibility report on System A indicates the possibility of using 21,000 hectares (52,500 acres) i.e. 15,000 hectares (37,500 acres) new land and 6,000 hectares (15,000 acres) of existing paddy land for paddy cultivation and 17,000 hectares (42,500 acres) for pasture development.

Construction work on the development of System H is nearing completion and the System is being handed over for operation and maintenance. About 22,000 families have been settled. The area developed under irrigation provides employment for over 50,000 persons in agriculture. Considerable additional employment is being provided in agricultural support-services. The average paddy yield in System H in 1979/80 was 89.7 bushels per acre and in 1980/81 93.3 bushels per acre, being the highest average yield in the Island. This indicates the predominant role played by an assured water supply in maximising production in the Dry Zone. Assured of water, farmers do not hesitate to invest in the other agricultural inputs to obtain optimum yields.

ENVIRONMENTAL IMPACT

The need for an in-depth study of possible adverse impact on the country's eco-system by the Accelerated Mahaweli Development Programme was realised at an early stage and an agreement was entered into with the USAID for a study to be carried out by a US firm of consultants. Its final report was issued in December 1980. The environmental impact of the development of reservoirs and the downstream development has been studied and reported on. This study has indicated that there is no adverse impact in the upper catchment area. The upper catchment area consists of well-managed

plantations, forests and badly-managed or misused land.

There has, however, been a considerable reduction of forest area over the last 15 to 20 years. As a result there is heavy erosion, specially in the badly managed and neglected lands but the sediment load from the catchment area is not of such a volume as to affect the functioning of reservoirs over a long period. However, remedial action by development of forestry in the catchment areas, specially along mountain ridges and steep slopes, the development of fuel-wood plantations and engineering structures where necessary to prevent erosion, have to be adopted. The development of the downstream area while not causing serious problems of erosion considerably reduces the forest cover and wildlife habitats. Remedial measures are necessary by way of forest plantations and fuel-wood plantations as well as extension of wildlife reserves to compensate for the areas taken up for development.

Several recommendations have been made by the consultants on the forestry and wildlife reserves and these are receiving the attention of the Government. The quality of the water is suitable for irrigation and drinking purposes and no serious problems are anticipated. The construction of the reservoirs will reduce the marshy areas in the flat plains (villus). The movement of a large number of settlers and supporting personnel into the area will have its social and economic impact. Continued irrigation will have its attendant health problems due to water-borne diseases and the use of agro-chemicals and fertilizer will affect the quality of return flows. Remedial measures have been recommended by the consultants and these are receiving attention.

PROGRAMME SUMMARY 1982:

The tempo of activity in the Accelerated Mahaweli Programme area will considerably increase in 1982, as can be seen from the budgetary provision of Rs. 6,500 Million for the financial year. The Maduru Oya reservoir and the Minipe Right Bank Canal will be substantially completed while construction activities on the Victoria and Kotmale dams, tunnels, power houses and associated structures will be at a peak. Similarly, construction activities in downstream development of Systems C and B will be on a more intensive scale. In System H construction activities will all be completed and the emphasis will be on agricultural, socio-economic, community and cultural development.

MANAGEMENT
IN THE MAHAWELI PROGRAMME

One of the management problems posed by the Programme is that of creating an organisational structure which will be adequate for it. From the 1930s onwards it has been assumed that settlement projects in Sri Lanka should be entirely public sector projects and that they should be implemented by the relevant government departments. In the early settlements projects started by Mr. D. S. Senanayake as Minister of Agriculture and Lands (1931 – 1947), the Irrigation Department constructed the irrigation system, the Agriculture Department gave agricultural advice, the kachcheri selected the settlers and gave them their land, and so forth. There were managerial disadvantages in such a purely vertical division of functions with each government department operating under strict financial and administrative controls.

In order to overcome some of these difficulties, the Gal Oya Development Board (GODB) and, later, the River Valleys Development Board (RVDB) were constituted. These Boards united all the functions under one roof, so to speak, and also had the slightly higher degree of flexibility given in this country to statutory boards. While they rendered yeoman service in many respects, they, too, had their disadvantages.

Development boards tend to be expensive in their ways during the construction phase. It follows that the Treasury as well as the Boards themselves want to hand over areas, where the construction work has been more or less completed, to the normal governmental agencies, and to move on to developing new areas with the funds at their disposal. One result of this sequence is that the full productivity of the new areas is not realised, and in fact, the return on investment is low. The government departments which were asked to take over their respective functions in the new areas, such as the Gal Oya valley, were not provided with the resources to handle them and, moreover, tended to operate within their vertical lines of command.

The Mahaweli Development Board, which was set up in 1970, was better constituted than its predecessors and had wider powers, but it had essentially the same objectives. It was not structured to handle the Accelerated Programme, i.e., several headworks as well as several downstream areas simultaneously. Nor did it have the technical and managerial skills to set up several multi-purpose development boards, each fully responsible for a single large project. In the circumstances, an organisational framework consisting of an apex body and three functionally specialized executing agencies was evolved. The Mahaweli Authority of Sri Lanka was set up as the central body responsible for planning and implementing the entire Programme. The Central Engineering Consultancy Bureau (CECB) was selected to be the agency responsible for the construction of the headworks. The Mahaweli Development Board remained responsible for the physical development of the new areas downstream of the headworks. A new organisation was to be set up to undertake the economic development of the downstream areas. This includes settling the new farm families, ensuring that they are provided with the basic social services, such as health and education, and providing the complete package of services required for production, such as agricultural credit, supplies, water management and marketing. These functions are at present being performed by a separate branch of the Mahaweli Authority, known as the Settlement and Agriculture Branch.

The growth of the Settlement and Agriculture Branch has itself presented many challenges. At the beginning of 1980, it was made responsible for providing the services indicated above in the H 5 pilot project at Nochchiyagama consisting 6,070 hectares (15,000 acres) of new irrigable land, most of which will be cultivated during the coming Maha season. In mid-1980, it was made responsible for providing these services for the development of 5,050 hectares (10,000 acres) of new irrigable land, which will be commanded by the new Minipe Right Bank Canal and the Ulhitiya reservoir. At the beginning of 1981, it took over the management of the rest of the Kalawewa basin from the MDB, consisting of 20,200 hectares (50,000 acres) of land which had become irrigable after 1976. In mid-1981 it was also made responsible for providing these services in the Uda Walawe Project, which has 14,170 hectares (35,000 acres) of irrigable land developed between 1970 and 1980. So it is now responsible for servicing about 44,500 hectares (110,000 acres) of irrigable land, most of which is double cropped, in projects with about 40,000 settler families.

The proposal that the areas developed by the MDB, and even the RVDB, should be handed over from these agencies not to the normal government departments, but to a specialised economic development organisation is a fairly significant one.

Settlers in the older colonization schemes administered by the line government departments had to go to a number of functionaries working in vertical lines of command – the agricultural extension officer for technical advice, the banks for agricultural credit, the agrarian services officers and the co-operatives for the supply of inputs, various other functionaries for the distribution of water, and so forth. The tendency gradually manifested itself even in the larger schemes administered by the statutory boards such as the RVDB and the MDB for strong functional divisions acting independently of each other. In order to get away from this, the Mahaweli Authority placed unit managers at the grass-root level. Each unit manager is expected to reside in a hamlet of a 100 – 250 settlers and be responsible to ensure that the settlers in his unit receive all these services. He is also responsible for ensuring that the social welfare services reach the settlers and for undertaking community development programmes. In the larger hamlets, he is assisted by field assistants, one of whom will specialise in agricultural extension and the other in ensuring an equitable operation of the irrigation system. About 10 unit managers are supervised by a block manager who is provided with specialised officers in agriculture, water management, credit and marketing, and land administration. It is to the block managers' organisation that the unit managers turn to when they have problems in ensuring that these specialised services reach all the settlers in their units adequately. The block managers in turn are backed-up by a resident project manager responsible for up to six blocks, who would have senior engineers, agricultural officers, land administrators, community development officers and such other specialist officers as their immediate deputies. The key to the success of the whole organisation will undoubtedly be the unit managers.

PROGRESS OF SETTLEMENT

During the year 1981, settlement work was limited to System H (Kalawewa) and System C (Ulhitiya). It was in these Systems that physical infrastructure development had progressed sufficiently for new farmer families to be settled. Settlement planning was being done in System B (Maduru Oya) and System G (Elahera), and the Mahaweli Authority also associated itself with the feasibility studies of System A.

SYSTEM H

As at the end of December 1980, 20,756 families had been settled and by the end of 1981, the total number settled would be 22,000, leaving about 500 families to be settled in 1982; with that the settlement programme in System H would be completed. Settlement activity during the year 1981 was confined to H 4 (Eppawela – Tambuttegama) and H 5 (Nochchiyagama) areas.

During the year, 3,610 hectares (9,027 acres) needed jungle-clearing, 7,745 hectares (19,362 acres) levelling, 3,925 hectares (9,812 acres) bund marking, and 4,533 hectares (11,333 acres) ploughing. All clearing and levelling work was completed, bund marking done in 2,400 hectares (6,000 acres) and 1,600 hectares (4,000 acres) ploughed.

Production support services and community services were provided on a planned basis.

A total of 15,913 hectares (39,783 acres) were cultivated in the newly developed H1, 2, 7, 4 & 5 areas in Maha 1980/81. The yields recorded were 1.7/86 (H1-2-7), 2.1/106 (H9), 2.0/98 (H4) and 2.2/109 (H5) tonnes/bushels per hectare/acre. In Yala 6,837 hectares (17,093 acres) were cultivated in paddy and 2,634 hectares (6,584 acres) in *other field crops;* in addition rainfed gingelly cultivation amounted to 1,436 hectares (3,591 acres).

SYSTEM C

As at the end of 1980, 1,398 farmers had been taken in as worker-settlers. During the year, all of them were shown their individual hamlet plots and assistance was provided for housing.

The concept of worker-settler which was first introduced in this System was continued through 1981 and the target for 1981 was 2,100 farmers of whom 1,640 have been settled as at the end of August 1981. The target would be reached before the end of this year.

Settlement activity was centred in Zone 2. It is planned to take up Zone 3 for development in 1982.

On-farm development work has commenced early in the year. The target for the year was 600 hectares (1,500 acres) out of which 50% had been completed as at the end of August 1981.

SYSTEM G

A project study report on System G which was made by FAO-UNDP in 1979 was taken up for implementation in June 1981. It was decided to commence work with the Department of Irrigation as the construction agency. In view of the period that had lapsed since the preparation of the report, it was revised and a new implementation programme drawn up to cover the

years 1981 – 1986. It envisages the rehabilitation of the existing Elahera Scheme and the development of about 4,000 hectares (10,000 acres) of new land lying between the old scheme and the Amban Ganga.

During 1981/82, it has been programmed to establish a Demonstration and Training Centre at Attanakadawela, to carry out a land encroachment and socio-economic survey, rehabilitation of Tract No. 18, completion of on-farm development in that tract and also to construct certain project buildings.

SYSTEM B

An implementation programme is being drawn up to commence settlement activities in Zone 5 L.B. in 1982. It is expected to develop this area for irrigated cultivation under the Maduru Oya Project.

As a first step to the establishment of project management, the Pimburettawa Scheme, which falls within System B and which will be augmented by water from the Maduru Oya reservoir, was taken over by the Mahaweli Authority for agricultural and community development commencing with the Maha season 1981/82.

A letter of intent has been signed by the Mahaweli Authority with Messrs. Guthrie Lanka Ltd., to set up a nucleus plantation of 12,000 acres in oil palm and another 12,000 acres are to be developed by out-growers in System B.

ENVIRONMENT

Considering the large extent and the geographical diversity of the area that is covered by the Accelerated Mahaweli Development Programme, it was found essential to implement an environment conservation plan. With that in view, specialist establishments, outside the Mahaweli Authority as well, were formed into a committee to draw up a programme, with USAID assistance. This covers the fields of watershed management, forestry, wild life, wetland and aquatic vegetation control, water/soil management, water supply, land-use planning, regulation of rivers, water levels, flood patterns, etc.

The Department of Wild Life is taking action to declare certain areas as wild life reserves. A comprehensive net-work of such reserves, providing sufficient wild life habitat and interlinks, is planned. Government approval is awaited on this matter.

With the proposed declaration of Maduru Oya National Park, certain communities of Veddha origin, scattered over the area need re-settlement outside the area. Before their re-settlement, considering the historical and anthropological value, a research/survey of Veddha culture is being made with the assistance of the Department of Sociology, University of Peradeniya.

Wild elephants pocketed in and around the area south of Meegalewa (H2) needed removal from that area as they were a threat to life and property. The Department of Wild Life has undertaken to organise a drive to move them into the Wilpattu Sanctuary.

THE TREND SETTER
- SYSTEM - H

The first transbasin diversion of the Mahaweli, under Stages I and II of the Mahaweli Programme, benefited 53,725 hectares (132,700 acres) of existing land and 28,745 hectares (71,000 acres) of new land located in and around Kalawewa, now generally known as System H. It is significant that after the completion of Stage I, namely the Polgolla–Bowatenne complex and delivery of Mahaweli waters to the existing land extending over 53,725 hectares (132,700 acres), the World Bank evaluated that the economic benefits from the Polgolla–Bowatenne complex exceeded their original expectations by over 100 per cent.

System H constituted the first irrigation system consisting of new land for development and settlement under the Mahaweli diversion and symbolised a development model based on a package of central planning, implementation, management and monitoring vested initially with the Mahaweli Development Board.

PLANNING OBJECTIVES

Besides the UNDP-FAO Mahaweli Master Plan which gave an overview of development of System H, a full feasibility study was made by Messrs SOGREAH of Grenoble, France – Consultants to the Mahaweli Development Board (MDB) in collaboration with the local counterpart experts. This study was further modified by a consortium of donors, namely, the World Bank, Britain, Canada, USAID, The Netherlands and the EEC, who co-financed a major part of the development and construction activities in the project area.

The development under System H constituted the first major integrated development of new lands under the Mahaweli Programme and was designed taking into account the experience gained from previous major irrigation and settlement schemes in Sri Lanka. The development model was designed for replication in the future areas of irrigation systems under the Master Programme and basic design concepts and development criteria provided for :–

1) Optimal use of available water resources to intensify rice production and diversify cropping patterns to maximise farm incomes.

2) To provide equal opportunities to settlers by distributing Project benefits through settlement on equal size holdings each unit being 1 hectare (2.5 acres).

3) To develop a spirit of self-reliance among settlers by their participation in farm development work, for which payment was made by the MDB.

4) To create settlements that are socially cohesive and economically viable by providing the basic social infrastructure and agricultural extension and supporting services.

5) To establish strong co-ordination at the project management level through the appointment of a resident project manager assisted by deputies for agriculture, community development and water management.

6) To achieve closer community participation both in planning and implementation of the project

through close co-ordination between Farmer's Organisations and Project Officers.

The selection criteria for settlement envisaged about 2.5 labour units per family with full-time employment in agriculture. The settlement pattern also provided for considerable non-farm employment in agro-based industries, trade, commerce, services, etc.

Under the umbrella of the Mahaweli Development Board, several state institutions such as the Land Commissioner's Department, Agriculture Department and the Irrigation Department, in collaboration with the World Bank and donor countries, developed a project implementation plan which was implemented through the existing departmental regulations for purposes of planning and implementation of social infrastructure like health, education, co-operatives, transport, etc. The MDB set up several technical committees with the respective departments for planning and implementation of such services.

PRE-PROJECT STATUS

Apart from comparatively settled conditions of farming under Kagama and Kattiyawa, the teeming villages around the Kalawewa area depended on village tanks and "chena" cultivation. This system of farming gave only subsistence level incomes. The total project area consisted of 28,745 hectares (71,000 acres) of new land and 14,170 hectares (35,000 acres) of old irrigated land. The latter area mainly under the irrigation schemes of Kagama-Kattiyawa and Rajangane were integrated into one irrigation system, namely, System H, although the area physically came under the districts of Anuradhapura, Kurunegala and Matale. Sixty per cent. of the soils in the area were found to be "well" to "imperfectly drained" and suitable for production of high value upland crops such as chillies, pulses, vegetables, etc., for purposes of import substitution while 40% of soils in the valley bottoms were ideal for paddy cultivation. Annex (1) illustrates the integrated plan of the existing and new areas in System H which are benefiting from the diverted Mahaweli waters.

STATUS OF PHYSICAL DEVELOPMENT

Preliminary work for the development of System H began in mid-1974 with the construction of camps, access roads, etc. and work on improvements to Kalawewa and Kandalama tanks and construction of the Dambulu Oya tank, together with irrigation infrastructure development in Galnewa, Meegallewa, Madatugama and Galkiriyagama areas. These works were funded by the Government of Sri Lanka until credit under the consortium of donors became effective by the end of 1977. Although the original target of project completion was mid-June, 1983, development and settlement has been accelerated and is now nearing completion with only a small amount of balance work left for the year 1982.

The main thrust of physical development in System H was on the following items of work.

a) Improvements to Kalawewa and Kandalama tanks and the construction of Dambulu Oya tank.

b) 112.6 km (70 miles) of main canals for the above tanks 64.36 km (40 miles) of branch canals.

c) 1,931 km (1,200 miles) of distributory and field canals.

d) 1,126 km (700 miles) branch canals.

e) Improvements to 120 village tanks.

f) 209 km (130 miles) road formation.

g) 161 km (100 miles) road surfacing.

h) Construction of 2,300 buildings to

house project staff and social infrastructure services such as health, education, postal, police, banks, etc.

i) 29,230 hectares (72,200 acres) of jungle clearing in irrigable and residential lands.

The status of work outlined above as at September 30, 1981, is shown diagrammatically in annex (2) and (3).

LAND REFORM AND SETTLEMENT PATTERN

About 6,073 hectares (15,000 acres) of privately owned paddy lands and undeveloped high lands in System H were acquired by the Mahaweli Development Board for which compensation was paid. This land together with Crown land within the project was developed for irrigated farming and re-distributed in uniform parcels of 1 hectare (2½ acres) in extent per family.

SETTLEMENT STRUCTURE

The pattern of settlement was based on the cluster system as opposed to ribbon settlement pattern along canals or scattered settlement mainly with the objective of providing easy access to basic services and even possible amenities such as pipe-borne water, electricity supply for domestic purposes, etc., in the future. The land holding size for irrigated agriculture was determined as 1 hectare (2½ acres) after careful study of the experiences gained in the earlier settlement schemes and also based on the results of two pilot settlement projects conducted in Maha Illuppallama and Pelwehera. This size was considered an economic unit for cultivation during both Maha and Yala seasons and was expected to generate high farm incomes and also maximise farm employment while reducing on costly mechanization. The smallest settlement consisted of a hamlet with 100 to 125 families and four to five such hamlets formed a village centre where basic services for the farming population were provided. Two to four such village centres were placed under the umbrella of a township which catered to around 3,000 farm families. The township was provided with social infrastructure facilities at a higher level, like post offices, multi-purpose co-operative societies, peripheral hospitals, etc.

By August, 1981, 21,600 settler-families were settled in a farm area of 21,852 hectares (54,000 acres) in an area of approximately 24,291 hectares (60,000 acres) set apart for new settlement in System H. Apart from those within the project area, farm families have been brought in for settlement from over 25 electorates, including Kundasale, Gampola, Medawachchiya, Maskeliya, Walapone, Kotmale, Hanguranketa, Udunuwera and Kandy. Progress in settlement is diagrammatically represented in annex (4).

ASSISTANCE TO SETTLERS

Assistance was given to the new settlers to transport household goods to the hamlets, a hut allowance of Rs. 1,000/- per family, basic agricultural implements, seed and planting material for the first cultivation season and food rations from the World Food Programme for a period of 15 months for a maximum of five members per family. These food rations included wheat flour, sugar, cereals, dryfish, etc., and was of great benefit until the farmer reaped his first crop from his allotment.

POST-SETTLEMENT PROJECT MANAGEMENT

The original concept of management by a resident project manager supported by deputies in agriculture, community development and water management had shown certain inadequacies especially in attaining horizontal co-ordination at different levels, more particularly at the village level. Therefore, a unitary system of management based

on the results of the pilot study conducted in H5 area has now been adopted by the Mahaweli Authority in the entire project, except in Galkiriyagama (H9) where the responsibility for agricultural production and marketing is vested with the Ceylon Tobacco Company. In this unitary system of management, each unit consisting of about 200 farm families in about 12 to 15 continguous "turnouts" – (a turnout is the irrigable area under a field canal) – is under a unit manager who is responsible for all services to all farmers under his unit. He is assisted by an agriculture extension worker and a jalapalaka sevaka or ditch-rider. Several of these units constitute a block, managed by a block manager assisted by specialist officers in agriculture, community development, marketing and credit, land administration, water management and administration. The overall responsibility of project management is vested with the resident project manager, who in turn is assisted by deputies in agriculture, water management, community development, etc.

AGRICULTURAL PRODUCTION

Of the total extent of 19,312 hectares (47,700 acres) of new land developed for cultivation, 18,502 hectares (45,700 acres) were cultivated in Maha 80/81. In the previous Yala of 1980 however, only 11,984 hectares (29,600 acres) were cultivated due to shortage of irrigation water resulting from drought and also due to lack of saving adequate water in the previous Maha season. In System H 60% of "well" to "imperfectly drained" soils are suited for crop diversification and cultivation of *other field crops* like chillies, onions, vegetables, legumes, etc., while 40% of the land in the valley bottom is ill-drained and ideal for paddy cultivation. During the Yala season in 1980 a concerted effort was made by the project management to cultivate more land with subsidiary food crops and a record of 1,439 hectares (3,555 acres) of such crops were grown under irrigation while 729 hectares (1,800 acres) of gingelly were raised under rainfed system of cultivation. In the Maha season 80/81 1,887 hectares (4,661 acres) of subsidiary crops were grown under rainfed conditions. In Yala 1981 season the area under irrigated subsidiary crops was 2,662 hectares (6,572 acres) and 2,394 hectares (5,912 acres) of gingelly were grown under rainfed conditions.

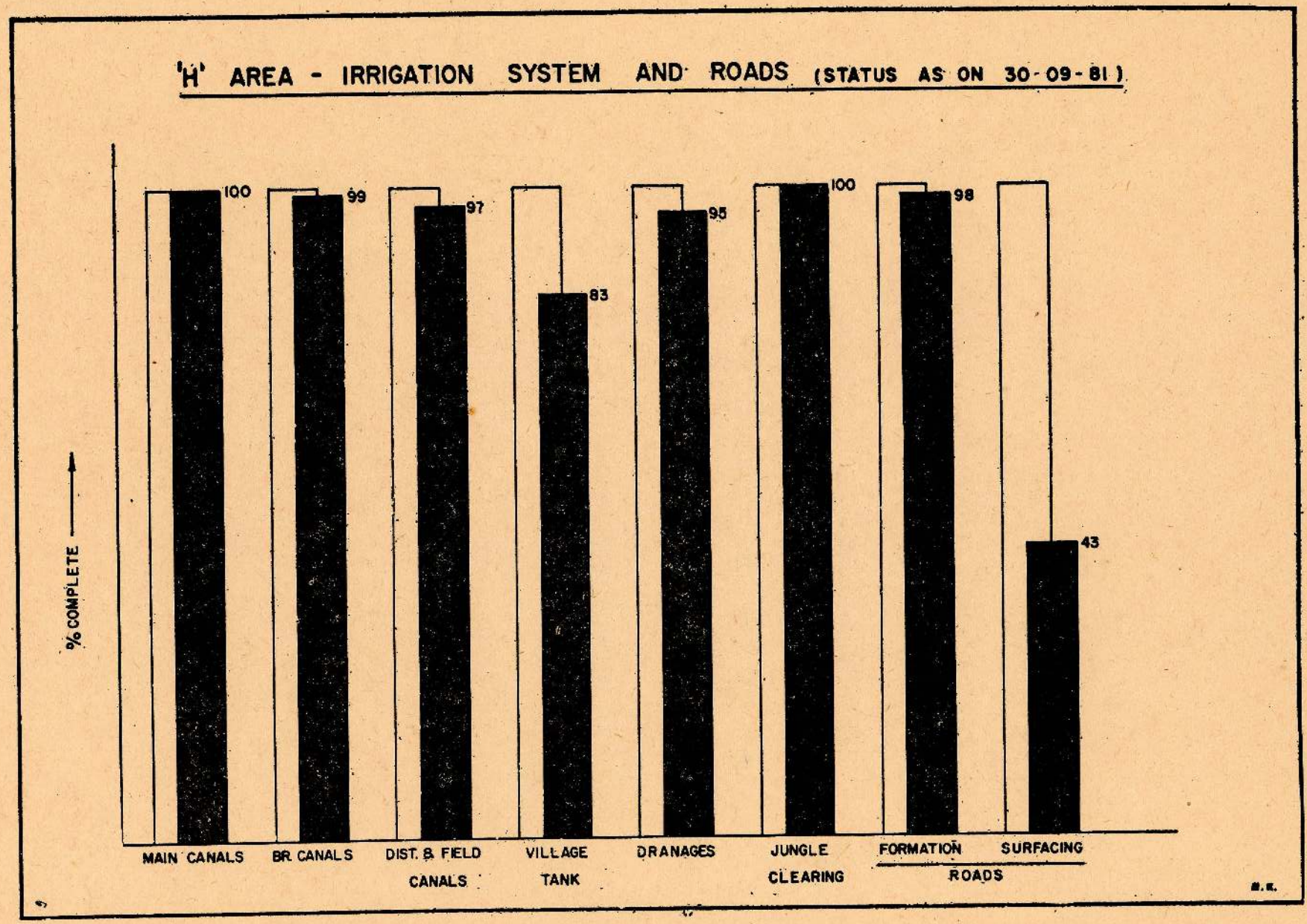
Encouraging increases in paddy yields in System H have been recorded since 1977, culminating in a record yield of 93.62 bushels per acre in the Maha 1980/81 season. This is the highest yield per acre for any district in the country. System H in fact contributed 2.95 M bushels of paddy to country's production last Maha. See Annex 5.

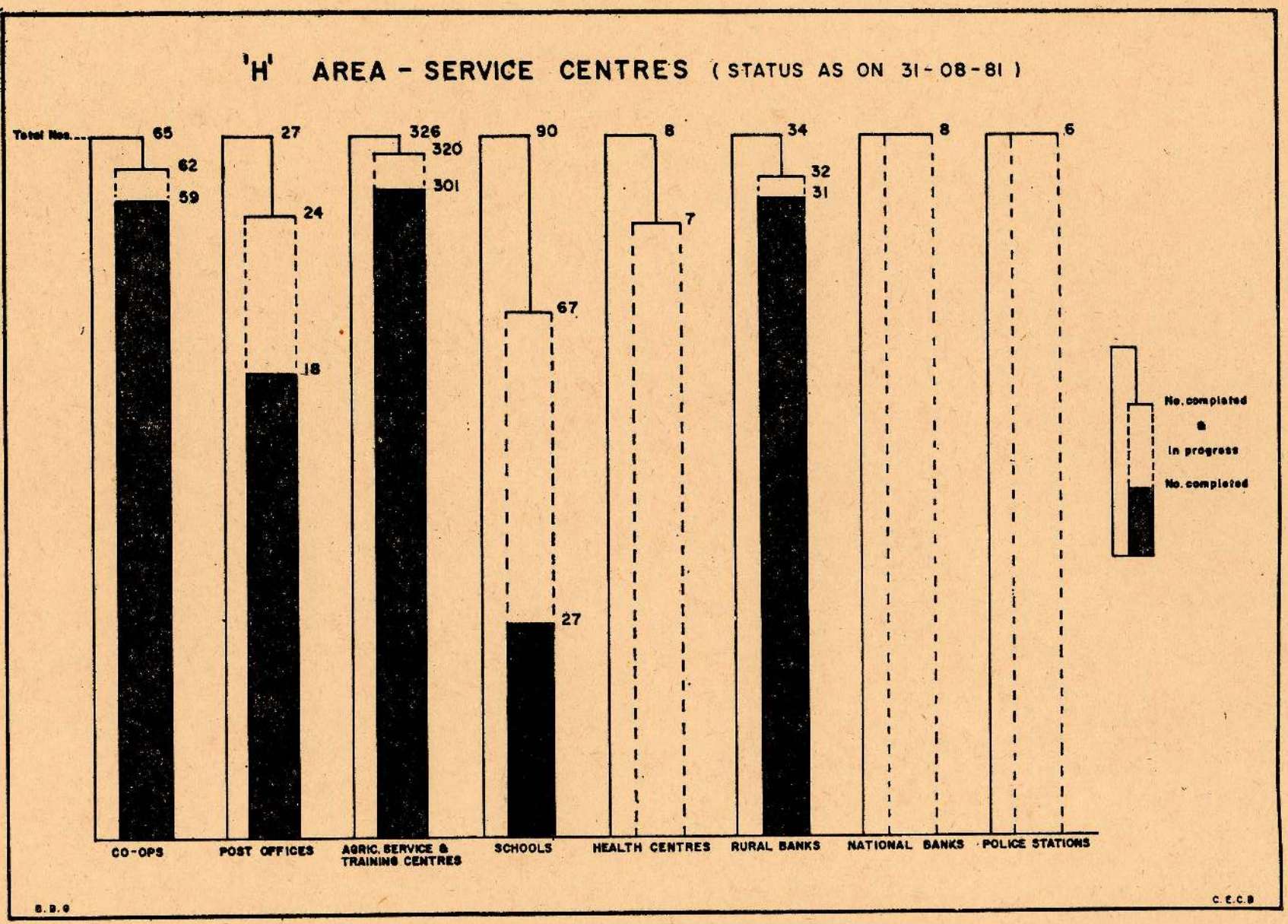
The statistics regarding paddy yields in System H released by the Director of Census & Statistics are tabled below :

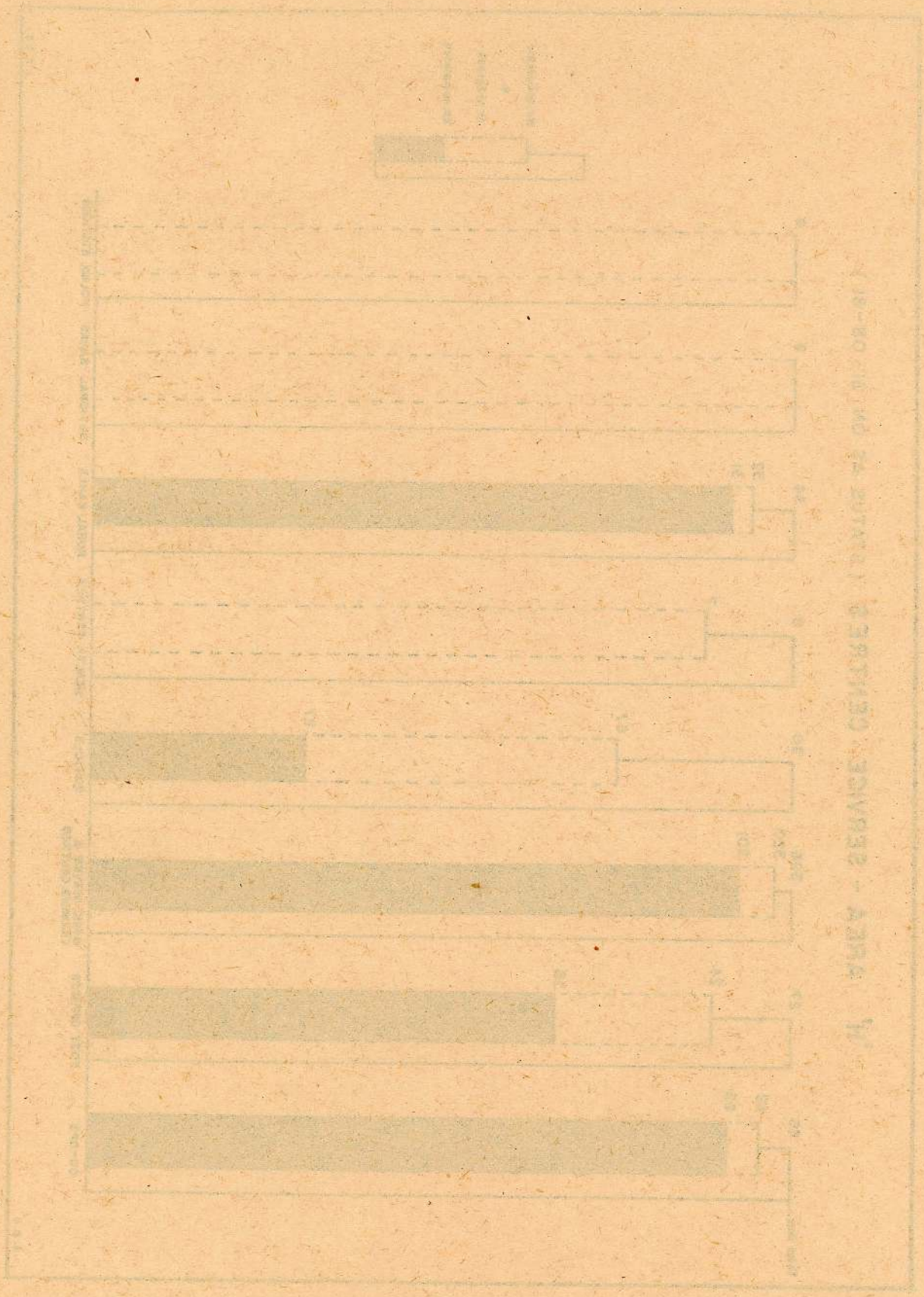
Yala 1980

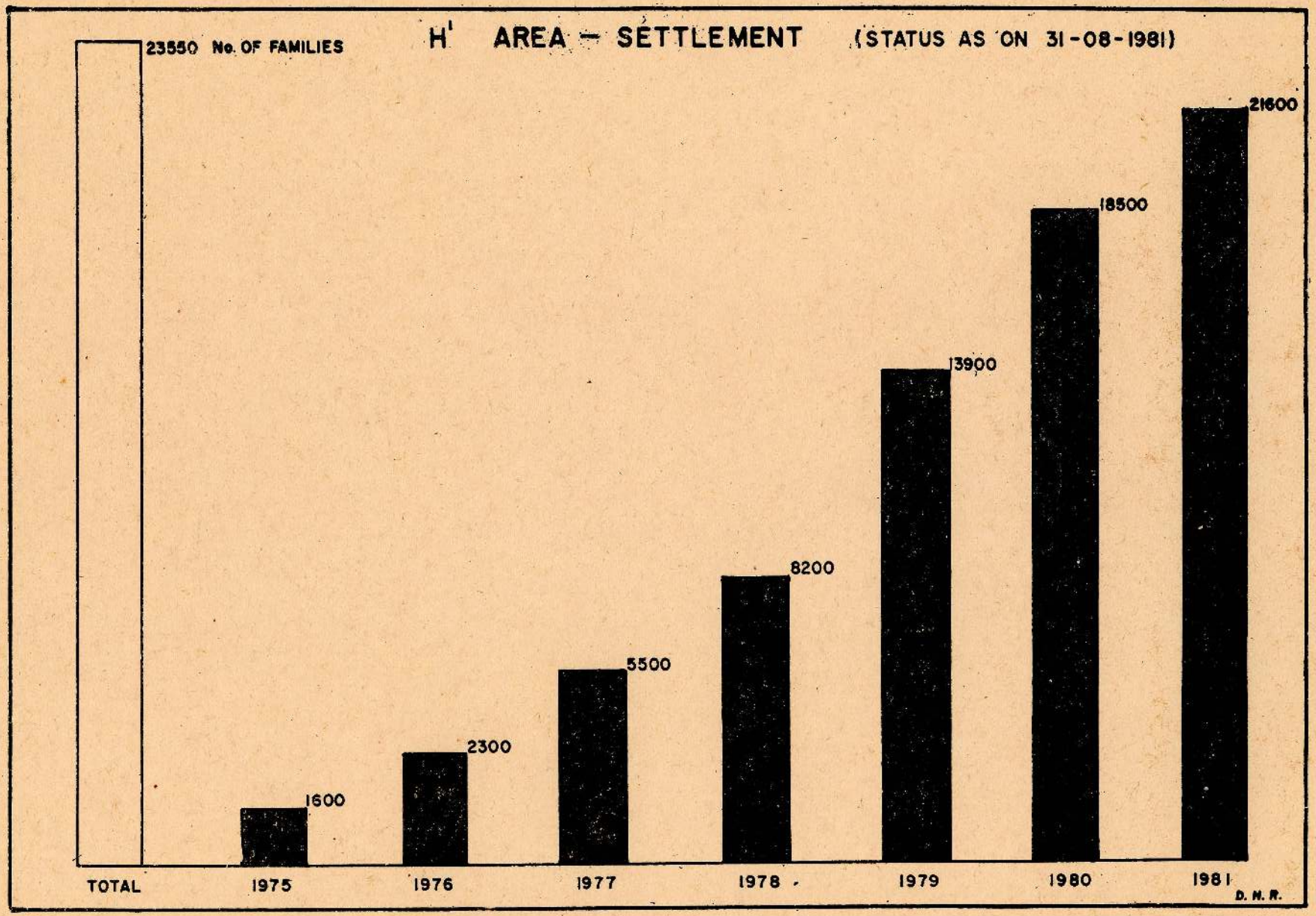
Area	Managed by	Net Acreage Harvested	Yield Bu/Net Ac.	Total Prodn. (Bushels)
Galnewa H1	MDB	6,129.49	54.02	331,115
Tambuttegama H4	MDB	597.85	56.11	33,545
Nochchiyagama H5	MASL	596.24	109.19	65,103
Galkiriyagama H9	CTC*	2,663.42	52.25	139,163

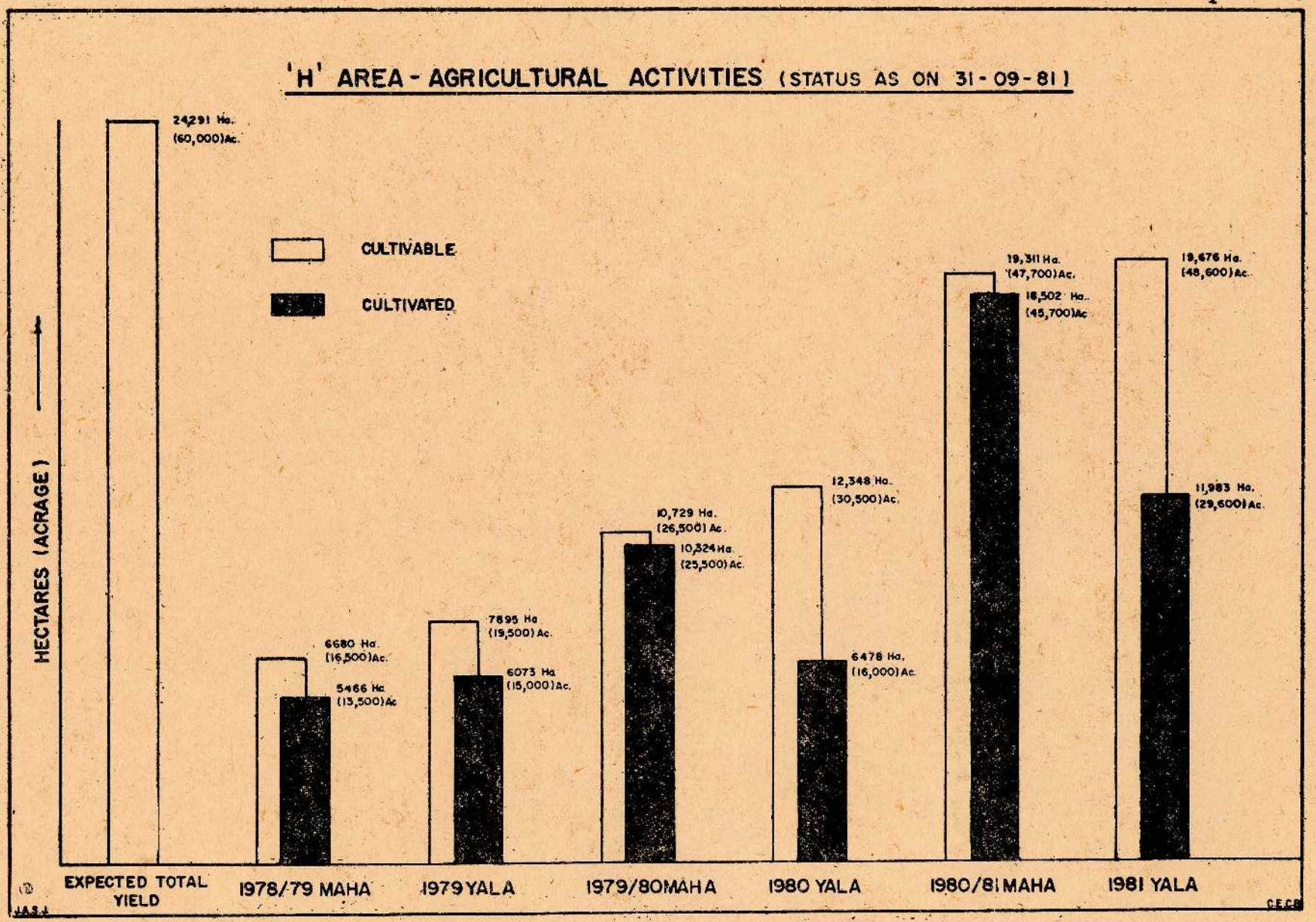
* Ceylon Tobacco Company Ltd., Colombo 13.











Maha 1980/81

Area	Managed by	Net Acreage Harvested	Net Average Yield Per Acre in Bushels
H1	MDB	8,996	83.45
H2	MDB	4,510	88.30
H4	MDB	9,399	97.75
H5	MASL	4,482	108.75
H7	MDB	6,009	85.55
H9	CTC	4,599	106.00
Total H Area a		37,995	93.30

H1, 2, 4 and 7 were managed by the MDB with Agricultural Extension Services provided by the staff of Department of Agriculture till January 1, 1981. H9 was managed by the Ceylon Tobacco Company at our request. H5 consists of a pilot project managed solely by MASL staff under the new system of management.

LAND ADMINISTRATION

Post-settlement administration of land within the project area as follows :–

(1) Allocation of vacant irrigable lands to new settlers.

(2) Eviction of encroachments where necessary.

(3) Collection of water rates.

(4) Issue of timber permits.

COMMUNITY DEVELOPMENT

Post-settlement community development included the provision of services on education, health, postal and telecommunication, co-operatives, banks, etc. These services were jointly planned with the respective departments or agencies and implemented by the Mahaweli Development Board. At present, 38 schools, one district hospital, and nine [illegible] centres, four multi-purpose co-operative societies with 57 retail outlets, 21 post offices, 20 bank branches, community service centres, two police stations, 27 grain stores – complexes and 27 fertilizer stores are functioning in System H.

In addition to the hospitals and health centres, special efforts have been taken by the Department of Health to control and monitor the incidence of malaria. The project community development officers have assisted the Department of Health in the following activities.

1. Distribution of prophylactic drugs.

2. Spraying of houses with malathion.

3. Training the farming community in malaria control measures through lectures, film shows, publications, etc.

A programme of construction of latrines and community wells is being implemented in order to improve domestic sanitation. Construction of protected wells, which commenced in 1977, assisted by the UNICEF has been accelerated and an additional 1,400 wells would be constructed before 1981. Also with UNICEF assistance, child-care centres have been established in order to relieve farm

women from child-care during the day and so enable them to be gainfully employed. Two hundred and twenty (220) health volunteers were trained and are engaged by the project management for assisting in malaria control, family planning activities, etc.

WATER MANAGEMENT

Proper water management is the key to the success of irrigation settlement schemes in Sri Lanka. The major departure in the layout and distribution of the irrigation delivery system in System H as compared in turnout units, which in combination with the new cropping patterns and farmer participation in the management, was intended to optimise the use of water. At the turnout level, farm leaders are elected by farmers themselves for proper distribution and maintenance of field channels and drainages.

In System H water management pilot projects have been established to determine the following.

1. Optimum land preparation and farm irrigation, techniques adaptable to local conditions and development techniques for scheduling and controlling water.

2. A pilot project based on underground pipe line irrigation system in contrast to open channel with the object of providing water on demand to each farmer. The preliminary results so far indicate that construction cost of this system is around Rs. 2,500/- per acre more than the conventional system and that this system is beneficial in that it has eliminated water conflicts among farmers and lends itself to cultivation of *other field crops* where regular irrigation is essential.

SUPPLY OF AGRICULTURAL INPUTS, CREDIT AND MARKETING

In the 1980 Yala season the Mahaweli Development Board set up a special marketing unit to purchase subsidiary food crops produced within System H and offered a guaranteed price for the produce. This acted as a catalyst in promoting the extended cultivation of *other field crops* on well-drained soils. The Mahaweli Authority has modified this system of direct purchase and encouraged private sector buyers to procure subsidiary food crops while the Paddy Marketing Board continued to purchase paddy through multi-purpose co-operative societies and private authorised dealers. In Galkiriyagama area where the Ceylon Tobacco Company is responsible for production and marketing, paddy was procured by the company.

In the 1981 Yala season arrangements have been made with the banks operating in each area to make payment to farmers direct for their produce on the basis of a special scheme.

Collection centres for farm produce have been established in the different regions as follows :

Regions	Number of collection centres
H1, 2 & 7	7
H4	7
H5	11
H9	3

The supervised credit scheme presently implemented in H5 area of System H by the Hatton National Bank would be extended to cover the other areas as well. Under this scheme, credit is released in stages to meet the requirements of land preparation, procurement

of seed, fertilizer, agro-chemicals and, finally, harvesting.

Production inputs are arranged by the resident project manager and paid for directly by the bank disbursing credit. This procedure has been designed to eliminate possible misuse of agricultural credit.

In Maha 80/81 the Hatton National Bank disbursed Rs. 1,745,411 among 876 farmers in area H5 and recovered 82% while in areas H1, H2, H6, H7, H4 and H9 Rs. 12,925,780 was jointly disbursed by the Bank of Ceylon and People's Bank and 63% was recovered.

ULTIMATE STRUCTURE AND PROJECT BENEFITS OF SYSTEM H

New and existing lands after development would comprise of 42,510 hectares (105,000 acres) of irrigated land and System H has already been declared a separate agricultural district for the purpose of integrated management of distribution of irrigation water and agriculture extension. The headquarters of project management will shift to Tambuttegama, the services of which town have been designed with the ultimate object of making the project manager's headquarters to serve as a government agent's office after the management of System H is handed over to the Civil Administration.

Project implementation commenced at a slow pace around mid-1974 with the construction of access roads and preliminary works. The projected estimated cost was Rs. 1,659 millions for the entire development of System H, which included the supply of both construction and operational machinery and equipment. The contribution from donor agencies, which became effective by the end of 1977, amounted to Rs. 1,035 millions. The total cost of development per acre, inclusive of irrigation and social infrastructure facilities, is around Rs. 26,155/-. The recent price escalations, however, have almost doubled the development costs. The project benefits, however, should not be measured only in economic terms of agricultural production. The social benefits are immeasurable and only too obvious to visitors to System H.

THE MADURU OYA
RESERVOIR PROJECT

The Maduru Oya reservoir is one of the major reservoirs to be constructed under the Accelerated Mahaweli Development Programme. The reservoir will be formed by the impoundment of the Maduru Oya. The Maduru Oya basin lies on the eastern side of the Mahaweli basin. It is proposed to augment the Maduru Oya reservoir with the water of Mahaweli, which will be conveyed from the Minipe anicut, along a Right Bank transbasin canal to the Ulhitiya – Ratkinda reservoirs and then through a link tunnel into the Maduru Oya reservoir. The reservoir will provide assured irrigation requirements for about 46,750 hectares (115,473 acres) of virgin land and 3,750 hectares (9,263 acres) of developed land. The area to be developed under this scheme is demarcated as System B in the Mahaweli Master Plan.

After very extensive studies, the dam was located on the present site where a portion of a breached earth dam constructed many centuries ago has been found.

Access to the site is from Manampitiya.

PROJECT FEATURES

The dam will be of the rockfill type with a central core of impervious material. The maximum height of the dam will be about 40 metres (131.23 ft.) and it will have a crest length of 1,800 metres (3,306 ft.). A free flow spillway of 150 metres length (492 ft.) will be located on the left bank rock abutment.

Two sluices for controlled release of irrigation water will be provided on either side of the dam.

The main parameters of the dam, appurtenant structures and the link tunnel are as follows :–

Dam

i)	Catchment area	– 453.0 sq.km (175 sq.miles)
ii)	Full supply level	– 96.0 m (314.98 ft.)
iii)	Gross storage up to FSL	– 596.6×10^6 cu.m (483,730 ac. ft.)
iv)	Dead storage	– 88.0×10^6 cu.m (71,350 ac. ft.)
v)	Live storage capacity	– 508.5×10^6 cu.m (412,380 ac. ft.)
vi)	Maximum height above foundation	– 41.0 m (134.52 ft.)
vii)	Crest Elevation	– 101.0 m MSL (331.38 ft.)
viii)	Length along crest	– 1,008.0 m (3,307 ft.)
ix)	Length of Spillway	– 150.0 m (492 ft.)
x)	Capacity of Right Bank Irrigation Outlet	– 32.5 cumecs (1,150 cusecs)
xi)	Diameter	– 4.0 m (13.12 ft.)
xii)	Capacity of Left Bank Irrigation Outlet	56.2 cumecs (1,985 cusecs)
xiii)	Diameter	– 4.5 m (14.76 ft.)

Link Tunnel

i)	Length of Link Tunnel	– 5,640.0 m (3.50 miles)
ii)	Diameter of Link Tunnel	– 4.5 m (14.7 ft.)
iii)	Length of Inlet Channel	– 920.0 m (3,020 ft.)
iv)	Length of Outlet Channel	– 140.0 m (460 ft.)
v)	Bed width of the Channel	6.0 m (19.7 ft.)

PROJECT COSTS

The estimated financial costs of the project (expressed in terms of 1979 prices) are :

	Local	Foreign
Dam	185,925,200	51,018,960
Spillway	23,519,970	5,668.550
Sluices	24,397,830	6,385,490
Roads	1,389,000	343,000
Tunnel	53,768,000	15,584,000
Total :	289,000,000	79,000,000

FINANCES

The project headworks are financed by a loan from the Government of Canada. The amount of the loan is 76,000,000 Canadian dollars. The loan is free of interest, commitment or service charges. The loan will be repaid in 80 semi-annual instalments commencing on March 31st, 1990, and ending on September 30th, 2029. This loan is intended to meet the foreign component of the project. The local cost of the project will be met by the Government of Sri Lanka.

CONSULTANCY SERVICES

Detailed site investigation, preparation of plans, designs and tender documents were done by the Central Engineering Consultancy Bureau (CECB).. Further Canadian aid was provided by the Canadian International Development Agency (CIDA), the organisation of the Canadian Government responsible for monitoring the project and disbursement of the funds. CIDA has provided as a grant, the engineering consultant, Messrs Crippen International Limited, who is responsible for development of the construction drawings and for supervision of works on site. In these functions it is supported by the CECB.

CONTRACT AWARDS

The Mahaweli Authority, after a previous pre-qualification exercise, invited tenders from pre-qualified contractors in Canada for the following works in August 1979. The closing date was November 20th, 1979.

Contract No. 2 – Dam and Associated Works

Contract No. 4 – Link Tunnel.

The work under both these contracts has been awarded to FAFJ, a joint venture of the Canadian contractor, comprising the following firms :

1. The Foundation Company of Canada Ltd., Canada (F) (Sponsors)
2. Atlas-Gest International Inc., Canada (A)
3. Fitzpatrick Construction Ltd., Canada (F)
4. Janin Construction Ltd., Canada (J)

The value of the contracts awarded are :

	Local	Foreign	Total
Contract No. 2	Rs. 235,031,981	Rs. 849,369,671	Rs. 1,084,401,652
Contract No. 4	Rs. 53,834,927	Rs. 200,141,600	Rs. 253,976,527
	Rs. 288,866,908	Rs. 1,049,511,271	Rs. 1,338,378,179
	(22%)	(78%)	(100%)

(Conversion rate used is 1 C. $ = Rs. 13.25)

INFRA-STRUCTURE DETAILS

The Maduru Oya reservoir site is situated in jungle far away from habitations. The nearest town is Polonnaruwa, which is about 64.4 kms (40 miles) away.

It is therefore a great challenge to provide the required infra-structure to undertake the construction of this project. The infra-structure can be classified under the following headings :

(a) Roads,
(b) Camp facilities,
(c) Power supply, fuel supply,
(d) Water filtration and other facilities.

Roads :

(i) Previously, access from Manampitiya to Pimburettawa was by a narrow road 3–4 metres (10–12 ft.) wide. This road was widened to 10 m. (32 ft.) for its entire length of 22 km. (13 miles). Six new bridges and some 50 culverts were constructed.

(ii) Endereatemulla – Kudawila Road : Length 19 km. This road was constructed to provide access from the dam site to the link tunnel outlet. The length of the road is 19 km. (12 miles) and width 10 m. (32 ft.). About 38 structures were constructed, along its length.

(iii) Inlet-outlet road : The length of the road constructed to join the ends of the tunnel is 10 km. (6 miles) and its width is 10 m. (32 ft.). About 21 structures were constructed here.

(iv) Pimburettawa – dam site road: This road was constructed by the River Valleys Development Board (RVDB) through the tank bed as a temporary access to the dam site. The approximate cost of all the access roads was Rs. 20 million.

CAMP FACILITIES

All the buildings required for the contractors, consultants and CECB staff, housing, shopping, schooling and recreational facilities has been completed. Almost 100% of the required staff are now resident in Maduru Oya and almost all the required facilities are provided for a mixed community in the area, including a swimming pool for the staff, circuit bungalow and luxury bachelors' quarters for the consultants.

POWER SUPPLY, FUEL SUPPLY

The required electric power for the construction purposes and domestic purposes are provided by the Ceylon Electricity Board (CEB) from power lines extended from Mahiyangana through Polonnaruwa.

The Ceylon Petroleum Corporation (CPC) has constructed a special refuelling station at Welikanda to cater to this project. This depot has a storage capacity of 250,000 litres (50,000 gallons) diesoline and 22,500 litres (5,000 gallons) of petrol.

WATER SUPPLY

A water supply scheme for the construction staff and workers has been completed. The purified water for this purpose is supplied from the Pimburettawa reservoir.

TELECOMMUNICATIONS

A radio link between Colombo and the site was established two years ago. Now a telephone link is installed and functioning in the Chief Resident Engineer's Office at Elawakumbura.

IMPLEMENTATION SCHEDULE

It is planned to complete the dam and associated structures by November 1982 at which time the reservoir will begin to fill during the rainy season of 1982-83. Thus, irrigation waters can be released during the dry season of 1983.

It is realised that this schedule will require great efforts from all responsible for the project and concerted action towards achieving these goals is being taken. The implementation schedule for the major elements of the project is given in bar chart form.

PRESENT POSITION OF THE PROJECT

The contractor FAFJ, Consultant Messrs Crippen International Limited and CECB staff are now fully established on the site. All the services required for their comfortable living and working are completed. The contractor has completed all the preliminary works and is successfully keeping to the schedule on the main contract. The core trench excavation for the main dam is nearing completion. Placing and compaction of fill, drilling and grouting of dam base are on schedule. The contractor has started work on four faces of the tunnel which has an area of 20.43 sq. m. (219.9 sq.ft.). This work is about 15% complete and the balance work is expected to be finished on schedule. The fabrication of hydrau-mechanical equipment, which includes gates and trash rack, has been awarded to a Chinese sub-contractor named Hydraulic Engineering Corporation of China. Work has commenced on these fabrications.

Most of the plant and machinery required for the project have been imported or locally bought and brought to the site. Temporary diversion of the Maduru Oya by means of a coffer dam for construction purposes was studied in detail and a final scheme was formulated. Work is proceeding on the basis of this scheme. It is expected to make the best use of the dry weather period available in the area for the construction work. The construction of left bank and right bank structures is in progress.

PROJECT BENEFITS

The Maduru Oya project is a multi-purpose project, which when completed would provide hydro-power, irrigation facilities, housing and employment to a considerable segment of the unemployed population of Sri Lanka. The existing land under Pimburettawa and Vakaneri Schemes (3,750 hectares – 9,300 acres), which are under paddy cultivation during Maha and Yala seasons, with a variable degree of success, will be assured of planned irrigation facilities. Agricultural land consisting of 46,750 hectares (115,500 acres) will be distributed among 47,000 new farming families. When completed, the project will generate a large number of new agricultural jobs and several permanent jobs in the project organisation. Further, it will generate some one thousand non-skilled and semi-skilled jobs during construction. In short, this project will significantly contribute to alleviating some of the problems that the country faces in regard to employment and the production of food crops.

In addition to all these benefits, it is envisaged that the present flood damage experienced in this area will be greatly reduced.

THE KOTMALE
HYDRO-ELECTRIC PROJECT

The Kotmale Project was one of the first projects taken up under the Accelerated Programme for development of the Mahaweli Ganga basin. The basic elements of the project are a dam on the Kotmale Oya (a tributary of the Mahaweli Ganga) and a tunnel system leading to a power station with the outfall of the Mahaweli Ganga. The primary function of the project is the generation of electric power. Additional benefits will arise from an increase in the amount of irrigation water available at Polgolla due to regulation of flows in the Kotmale Oya.

Preliminary studies of the Kotmale Project were carried out by the Government of Sri Lanka with the assistance of US Agency for International Development (USAID) in 1961 and sebsequently by UNDP-FAO from 1964 to 1968. A feasibility study of the project was carried out by the Water and Power Development Consultancy Services (India) Limited (WAPCOS) from 1973 to 1976.

Sir William Halcrow and Partners in association with Messrs Kennedy & Donkin and the Central Engineering Consultancy Bureau (CECB) were appointed in 1979 to provide consultancy services for the project.

SCOPE

The Kotmale Project envisages the construction of a 87 m (285 ft.) high rockfill dam across the Kotmale Oya. The dam would create a reservoir having an effective storage capacity of about 174 m. cm. (141,000 acre feet) enabling regulation of a large proportion of the recorded mean annual flow of the Kotmale Oya at the dam site. The water impounded by the reservoir would be conveyed through an underground water conductor system to an underground power station located at about 7.2 km. (4.5 miles) from the dam for generation of electric power. After power generation, this water will be discharged through the outfall into the Mahaweli Ganga at the Atabage Oya confluence.

In addition to the generation of power, the regulated water will improve the pattern of inflows of the Mahaweli Ganga at the existing Polgolla diversion dam. This will firm up the power benefits from Ukuwela power station as well as from the Bowatenne power station (recently commissioned) and serve to increase the irrigation water supplies from the Bowatenne dam.

LOCATION AND ACCESS

The dam site at Kadadora is located at about 6.6 kms. (4.1 miles) from the Kotmale Oya – Mahaweli Ganga confluence. The underground power house site is situated in the neighbouring Atabage Oya valley on the right of the Kotmale valley, near the confluence of the Mahaweli Ganga – Atabage Oya or 6.4 kms. (4 miles) downstream of the Mahaweli Ganga – Kotmale Oya confluence.

The project area is located on the right bank of Mahaweli Ganga and is covered partly in the Kandy District and partly in Nuwara Eliya District. It is well connected to Colombo through 2 main road routes. Three towns, namely Gampola, Ulapane and Nawalapitiya located on the left bank of Mahaweli Ganga are in the project vicinity. The distance from Nawalapitiya to Gampola is about 16 kms. (10 miles) with Ulapane situated midway. The right bank of the dam is located at mile 7 of the existing Ulapane – Pussellawa minor road. The left bank of

the dam is located at mile 7 of the existing Nawalapitiya – Pussellawa minor road. The power house site is situated at about 4 kms. (2.5 miles) from mile 2 (approximately) of the existing Gampola – Pussellawa principal road. The railway line connecting Hatton with Colombo via Peradeniya, Gampola, Ulapane and Nawalapitiya passes close to the road connecting Gampola, Ulapane and Nawalapitiya.

HYDROLOGY

The river and its tributaries originate in the south central massif at an elevation of 2,134 m (7,000 ft.). Along its main course, the Kotmale Oya is 70 kms. (43.3 miles) long. It drains a total area of 58,534 ha (226 sq.m.) and drops by 1,585 m (5,200 ft.) before its confluence with the Mahaweli Ganga. At the dam site, the bed elevation of the river is 620 m (2,035 ft.) and the catchment area is 54,390 ha (210 sq. ml.).

Historical flow series on a monthly basis are available for 24 years (1950 – 73) along with rainfall data for 66 years (1907 – 72) from 19 stations located within the catchment area of the project. A unit hydrograph of 3-hour unit duration was derived using short interval rainfall data and by iterative tallying of the derived and observed flood hydrographs.

Using the design storms and unit hydrograph, the design flood (probable maximum flood) with a peak of 5,550 cumecs (196,000 cusecs) was arrived at. The flood hydrograph based on the unit hydrographs storm maximisation approach has been found acceptable for adoption in the spillway flood routing studies.

GEOLOGY

A review of the previous geological studies and the additional investigations performed since 1979 were carried out by a panel of experts who were appointed by the Ministry of Mahaweli Development to advise on the layout to be finally selected. The panel identified a variety of adverse geological features such as unstable soil and rock masses in the reservoir area, solutioned and cavernous limestone in the reservoir and below the dam site and deep and irregular weathering of rock associated with strong lineaments representing either master joints or faults. The protential problems considered were reservoir landslides, leakage of water either into adjacent valleys or beneath the dam, sliding stability of the dam under varying conditions and the potential for piping around the foundation.

The panel considered that these problems could be handled within reasonable costs by the present design with some additions and modifications recommended by them. Most of these have now been incorporated in the design and their recommendations regarding further investigation are being carried out.

PROJECT FEATURES

Taking into consideration the financial constraints associated with the project the Hon. Minister of Lands, Land Development and Mahaweli Development directed that the scheme be modified leaving provisions for later raising of the dam. The modified scheme is described below.

A 600 m (1,968 ft.) long rockfill dam with a concrete membrane is proposed across Kotmale Oya. The full supply level of the reservoir would be 703 m (2,306 ft.) MSL which would provide a gross storage capacity of 174 m.cm (141,000 ac. ft.). The crest elevation will be 706.5m (2,317 ft.) MSL. The concrete membrane on the upstream face will have a thickness of 300 mm (1 ft.) at the crest increasing to 474 mm (1.6 ft.) at the plinth. The chute spillway located on the left bank will have three gates of size 14 m x 15 m (46 ft. x 49 ft.) capable of discharging 5,550 cumecs (196,000 cusecs) with all three gates open.

River diversion will be effected through

two 9.2 m (30 ft.) diameter "D" shaped lined tunnels capable of discharging 1,700 cumecs (60,000 cusecs) which is the 1 in 100 year flood. The bottom outlet installation will be situated in an underground chamber on the right bank and access thereto will be through an access tunnel from a point downstream of the dam. Water will be drawn in through an inlet tunnel and will be discharged to the river through an outlet tunnel. It should be capable of discharging a minimum of 420 cumecs (14,820 cusecs) with the water level at 690 m (2,263 ft.) MSL.

The intake structure, located on the right bank, is capable of discharging 113 cumecs (4,000 cusecs). The 5.2 m (17 ft.) diameter and 84 m (275 ft.) deep gate shaft is located 165 m (540 ft.) downstream of the intake.

The water conductor system consists of a 6,560 m (21,517 ft.) long 6.2 m (20 ft.) diameter horseshoe shaped lined low pressure tunnel, 15 m (49 ft.) diameter 160 m (525 ft.) deep surge shaft, and a high pressure tunnel system. The lower end of the high pressure tunnel system leading into the underground machine chamber will be steel lined. The steel lined section will initially be 4.8 m (15.8 ft.) diameter bifurcating twice to serve each machine with a gradual reduction of diameter to 2.5 m (8.2 ft.).

The machine chamber will be 70 m x 18 m x 34.7 m (230 ft. x 59 ft. x 114 ft.) capable of housing three machines. The downstream surge chamber will be located just downstream of the machine chamber and the horseshoe shaped lined tailrace tunnel will be 6.2 m (20 ft.) in diameter and 442 m (1,450 ft.) long. The transformers and switchyard will all be located on the surface immediately above the machine chamber. A cable cum ventilation shaft will connect the machine chamber to the switchyard area.

Two Francis type turbines directly connected to the vertical shaft generators with an installed capacity of 134 MW will be commissioned initially. The increase in system firm energy due to the introduction of Kotmale Project has been estimated at 460 GWh with a long term average annual total of 500 GWh.

COST ESTIMATES

The estimated cost of the project is Rs. 6,000 million based on mid-1979 prices. A summary of the cost estimate is given below:—

	Description	Cost (Rs. Million)
a)	Work by Govt. Agencies	500
b)	Civil Works	
	(i) Initial Works	660
	(ii) Reservoir Works	2,221
	(iii) Underground Works	1,217
	(iv) Hydraulic Equipment	170
c)	Generating Plant	620
d)	Physical Contingencies	612
	TOTAL	6,000

PRESENT PROGRESS

Work on the project commenced in 1979 with the appointment of the Consultants and the signing of the framework agreement with the Main Civil Contractor. The undermentioned contracts have been awarded to date :

1. Initial Works Contract on 4th August, 1979, to Messrs. Skanska Cementgjuteriet.

2. Underground Works Contract on 18th December, 1979, to Messrs. Skanska Cementgjuteriet.

3. Power Station Plant Contract (KOT/P1) on 26th June, 1981, to Messrs. ASEA.

4. Reservoir Works Contract on 2nd October, 1981, to Messrs. Skanska Cementgjuteriet.

The undermentioned contracts are being negotiated at present :

1. High Pressure Steel Liner Contract. (KOT/E1) with Messrs. ASEA.

2. Substation Plant Contract (KOT/P2) with Messrs. ASEA.

3. Diversion and Low Pressure Tunnels, Gates and Screens Contract (KOT/E2) with Messrs. ASEA.

The Tender Documents of the Bottom Outlet Equipment Contract (KOT/E4) have been issued to Messrs. ASEA for pricing.

INITIAL WORKS CONTRACT

This contract is for the construction of :

a) Contractor's and Engineer's Camp and Offices

b) Access Roads

c) Diversion Tunnels

d) Access tunnel to the underground power station

e) Quarry investigation.

The progress to date is as follows :–

a) The main offices have been completed. All the houses in the Engineer's camp have been completed. Most of the houses in the Contractor's senior staff camp have been completed. The Contractor's dam site labour camp is nearing completion.

b) Work on all access roads have been completed

c) (i) Excavation of both diversion tunnels completed.

(ii) Invert concreting of both tunnels nearing completion.

(iii) Arch concreting of both tunnels have commenced. Average rate of progress 72 m per month.

(iv) Concreting of upstream portal in progress. Concreting of downstream portal to commence shortly.

d) Excavation of access tunnel to the underground power station complete.

e) Investigations at the quarry have been completed.

UNDERGROUND WORKS CONTRACT

This contract is for the construction of the intake structures, low pressure tunnel, intake gate shaft, surge shaft, high pressure tunnel system, machine chamber, ventilation cum cable shaft, surge chamber, tailrace tunnel, outfall structure and switchyard area.

The progress to date is as follows :–

a) Excavation of intake structure portal in progress.

b) Excavation of low pressure tunnel in progress, with about 55% of the work complete. Average rate of advance 40 m per week.

c) Excavation of the intake gate shaft nearing completion.

d) Excavation of upstream surge shaft in progress.

e) Excavation of high pressure tunnel system nearing completion.

f) Excavation work in machine chamber progressing satisfactorily.

g) Excavation of ventilation cum cable shaft in progress.

h) Excavation of surge chamber nearing completion.

i) Excavation of tailrace tunnel just commenced.

j) Excavation for portal at outfall structure in progress.

k) Earthwork in switchyard area in progress.

RESERVOIR WORKS CONTRACT

The stripping of the dam foundation is in progress with about 35% of the soft excavation and 25% of rock excavation complete.

PROGRAMME

Completion date for initial works contract was September 2, 1981. Owing to the change in location of the diversion tunnels and other allied problems it is envisaged that completion will be by April 1982.

Completion date for underground works contract is scheduled for the 30th of November, 1983. The Contractor is slightly behind schedule in the excavation of the low pressure tunnel. However, it is envisaged that he should be able to catch up and complete the work on schedule.

The Contract for the Power Station Plant has been awarded and it is envisaged that the first machine will be ready for testing and commissioning by November 15, 1984. The second machine will be ready for testing and commissioning by February 15, 1985.

The reservoir works contract was awarded and it is envisaged that impounding could take place by March 30, 1985. However, a bonus clause has been introduced into the Contract to enable a possible advancing of the impounding date to November 30, 1984.

KOTMALE PROJECT
Salient Features

Hydrology	Metric Unit	Imperial Unit
Catchment area	54,390	210 sq. miles
Maximum observed discharge	761.5 cumecs	26,890 cusecs
Reservoir		
Full reservoir level	703 m. – M.S.L.	2,306 ft. – M.S.L.
High flood level	704.5 m. – M.S.L.	2,311 ft. – M.S.L.
Maximum drawdown level	664.5 m. – M.S.L.	2,180 ft. – M.S.L.
Gross storage up to F.R.L.	174 m. cu.m.	141,000 ac. ft.
Dam		
Type	Rockfill with concrete membrane	
Maximum height above bed level	87 m.	285 ft.
Crest elevation	706 m.	2,317 ft.
Length along crest	600 m.	1,969 ft.
Spillway		
Type	chute spillway	
No. and size of gate	3.14 m. x 15 m.	3.46 ft. x 49 ft.
Discharge through spillway at H.F.L.	5,550 cumecs	196,000 cusecs
Diversion Tunnel		
No. and size of tunnel	2.9.2 m.	2.30 ft.
Type	"D" Type lined	
Maximum capacity	1,700 cumecs	60,000 cusecs
Headrace Tunnel		
Total length up to surge shaft	6,560 m.	21,517 ft.
Type	Horse-shoe line	
Diameter	6.2 m.	20 ft.
Maximum capacity	113.3 cumecs	4,000 cusecs

U/S Surge Shaft

Diameter	15 m.	49 ft.
Height	160 m.	525 ft.
Type	**Restricted Orifice**	
Pressure Shaft		
No. of type		One, circular
Diameter	5.3 m.	17.4 ft.
Length	91 m.	299 ft.

Power Plant

Type	Underground power house	
Size of cavern	70 m. x 18 m. x 34.7 m.	230' x 59' x 114'
Installed capacity		2 units of 67 MW
Type of turbine		Francis turbine
Gross head	226 m.	743.3 ft.
Total Annual Power	500 G.w.h.	
Firm power	460 G.w.h.	

Tailrace Tunnel

Length	442 m.	1,450 ft.
Diameter	6.2 m.	20 ft.
Type	Horsh-shoe line	

VICTORIA DAM
AND
HYDRO-ELECTRIC PROJECT

The Victoria Dam is located below the Polgolla Diversion barrage and above the Victoria rapids on the main stem of the Mahaweli Ganga. The construction of the Victoria Dam was taken up in 1980 and is programmed for completion in 1984.

The project envisages the construction of a double curvature arch dam across the Mahaweli Ganga to a storage level of 438.0 m. (1,437 ft.). The regulated releases from the impounded Victoria reservoir (storage 730 million cubic metres or 600,000 ac. ft. gross) will pass through a concrete lined tunnel to a Power Station located on the Right Bank. For the present, the Power Station will accommodate three units of 70MW each for the generation of hydro-power. Provision has been made for the construction of a second tunnel and the installation of 3 units of each about 70MW at a later date. The discharges from the tailrace will be further regulated at the proposed Randenigala reservoir which is being taken up for construction in 1982. Until such time as the Randenigala reservoir is constructed, the regulated releases from Victoria reservoir will flow down the Mahaweli Ganga upto the Minipe anicut (diversion weir) for diversion to the existing Left Bank canal and the Right Bank canal, which is under construction. The flows in the Right Bank canal will be further regulated in the Ulhitiya-Rathkinda twin reservoirs for irrigating lands in System C and for further diversion to the Maduru Oya reservoir which is also under construction.

DESIGN OF THE DAM

Investigations confirmed that a double curvature arch dam could be the most economical dam that can be constructed at the selected site between the Hulu Ganga confluence and the Victoria Falls.

Several studies were conducted to determine the optimum height of the dam. The study had to take into consideration the planning of the Randenigala reservoir immediately below the Victoria Dam. A combination of High Victoria-Low Randenigala or Low Victoria-High Randenigala was examined. The first study resulted in the selection of Victoria reservoir storage level of 430 metres (1,411 ft.) above sea level. Further studies indicated that a storage level of 438 metres (1,437 ft.) above sea level gave increased benefits which out-weighed the losses sustained by the inundation of the Teldeniya town. The height of the dam could not be raised any further as the operation of the Polgolla Diversion Dam would have been seriously affected. The storage level of 438.0 metres (1,437 ft.) corresponded to a crest level of dam of 442.5 m. (1,452 ft.) above sea level and a height of dam above lowest foundation level of about 118 m. (387 ft.)

Automatic crest gates which open when pre-determined water levels are reached have been adopted and electric power will be required only to close the gates. The consultants who designed these gates have won an award for innovation in civil engineering from the Institution of Civil Engineers of U.K. Eight radial gates 12.5 m. (41 ft.) wide and 6.5 m. (21 ft.) have been provided. The grated overspill with an effective width of 100 metres (328 ft.) is capable of passing a discharge of 8,200 cubic metres per sec. (289,542 cusecs) under the head of 11 metres (36 ft.). The overall nappe is dispersed by the combined effect of the splitters and ledge system located 13 m. (42.6 ft.) below the solid weir crest. Hydraulic model tests were

carried out at the Wallingford Research Laboratory to finalise the design of the crest and the stilling basin. Two low level sluices are provided in order to make provision for –

(a) Drawing down the reservoir at initial filling or on any subsequent time.

(b) To pass silt which may accumulate immediately above the dam. These gates have 4.1 m. (13.5 ft.) diameter pipes with centre line at 350 m. (1,148 ft.).

A 300 mm (12 inch) diameter branch pipe from each of the low level sluices is provided to pass compensating water. Model tests on these gates are being conducted at the Hydraulic Research Laboratory, Wallingford. The model tests will provide data for determining the protective measures to be adopted on the downstream.

POWER TUNNEL

A circular tunnel, 6 metres (19.7 ft.) diameter was chosen to provide maximum strength to resist the anticipated external water pressures. The tunnel will be concrete lined and 420 m. (1,378 ft.) length at the downstream end will be steel lined. The velocities in the tunnel will be limited to 4½ metres per second (14.8 ft. per second) for concrete lined sections and 6½ metres per second (21.3 ft. per second) for steel lined sections.

The tunnel route was selected so as to fit into the topography and anticipated geological conditions and also to reduce the length over which difficult ground conditions were anticipated and to minimise external ground water pressures.

TUNNEL INTAKE

The Intake Structure including the tunnel intakes, gate shafts, etc., will be provided initially for both the present and the proposed future tunnels. A length of the future tunnel has been constructed to a point 150 m. downstream of the gate shaft to ensure that the future tunnelling would not cause damage to the shaft or gates.

SURGE CHAMBER

A 21 m. (69 ft.) diameter concrete lined chamber has been designed to withstand hydrostatic pressures due to maximum groundwater pressure when the tunnel is dewatered.

The surge analysis has been carried on the basis of the following assumptions :–

(a) Full stroke opening time of turbine gates – 15 seconds.

(b) Full stroke closing time of relief valves – 25 seconds.

(c) No load flow, spining reserve – 10 percent of load flow.

(d) Turbine gate and relief valve operating times are linear with flow.

The maximum upsurge occurs when the reservoir is at flood level and all three machines are rejected to no flow in 25 seconds. The upsurge level has been computed to be approximately 463.0 m. (1,520 ft.).

The Power Station building 52 m. (170 ft.) long by 30 m. (98 ft.) wide, will be a reinforced concrete structure. The roofing will be of composite construction consisting of precast light weight concrete slabs treated after installation with a weather proof coating, and an outer layer of profiled coated and insulated steel sheeting. The three units will be at 13 m. (43 ft.) centres, and the tail race will lead the water back to the Mahaweli Ganga.

POWER STATION PLANT

Three Francis Turbines operating under

a design head of 190 m. (623 ft.) and a total discharge of 125.5 cubic metres per second (4,431 cusecs) will have a speed of 333.3 rmp. The rated capacity of the station will be 3 x 70 MW equals 210 MW. Pressure relief valves will be provided to limit the speed rise in the turbines. The generator will be directly coupled to the turbine and will have a thrust bearing and two guide bearings. The main generator transformers will be mounted on a deck on the upstream side of the Power Station. Transport restrictions necessitate 3 single phase units. The primary voltage of 12.5 KW will be stepped up to 220 KW. The station will be connected to a substation to be constructed at Kotmale for supplying the 220 KW transmission line which will link Kotmale to Colombo.

CONSTRUCTION PROGRAMME & PROGRESS

Construction work on the project was formally inaugurated by His Excellency J. R. Jayewardene, the President, on March 23rd, 1980. Preliminary works like construction of access roads and camp buildings commenced during 1979.

The construction of the dam was awarded to M/s Balfour Beatty-Nuttall (UK) on March 3rd, 1980. The total tender value for this contract is Rs. 1,467,625,620.20. The present financial progress on the contract is approximately 40%.

The excavation and concreting of the dam is simultaneously in progress. There has been a delay in the concreting programme on the dam mainly due to the delays in shipment of machinery, bad foundation conditions, extra excavation involved and two major floods which occurred during the period of construction.

The contract for the construction of the tunnel was also awarded to M/s Balfour Beatty-Nuttall (UK) at the same date, the total tender sum of the contract is Rs. 645, 391,793. The financial progress is about 40%. About 30% of tunnel has been excavated. Tunnel contract is behind schedule resulting from a rockfall at the outfall drive and other initial problems.

Already measures have been taken to accelerate the progress and achieve the scheduled commissioning date on this project. The contractor has arranged for additional equipment for the tunnel in order to keep the target dates for commissioning of the Power Station. The delay in the construction of the dam has been overcome by amending the river diversion procedures and general speeding up of the work.

The contract on the power station building was awarded to M/s Costain International Ltd. of UK on October 28th, 1980. The total value of the contract is Rs. 250,611, 011 and the financial progress is about 15%.

All other contracts for hydraulic equipment, turbines, generators, transformers, switchgear, station miscellaneous plants, cables, cranes and transmission lines have been awarded and work is in progress.

The construction schedule provides for the impounding to commence by April 1984 and the commissioning of the first unit by June 1984. The final completion will be by the end of 1984 when all the units are expected to be commissioned. According to present indications the work will be completed on schedule.

The Department of Highways has been entrusted with the task of relocating the roads that will be submerged by the reservoir. Plans and proposals for the relocation of the Kandy-Mahiyangana road, in the Teldeniya area, are being finalised and construction work is in progress.

Land acquisition and compensation inquiries relating to about 8,000 acres of land that will be submerged by the reservoir are proceeding.

COST ESTIMATE

All the contracts for the construction of the project have been awarded. On the basis of the contracts awarded, the total value of the works will be Rs. 7,456.5 millions as summarised below :–

SUMMARY OF ESTIMATE	(Total Cost) Rs. M.
1. Dam	2,337.7
2. Tunnel	939.2
3. Power Station	258.9
4. Hydraulic Equipment	612.7
5. Physical Contingencies	512.5
6. Bonus on civil contracts	60.0
7. Contracts C11 to C15 and C17 (Electro-Mechanical)	871.1
8. Cables	63.6
9. Transmission Line	102.0
10. Consultancy	431.8
11. Digana Township	103.6
12. Work by other agencies	328.3
13. Overall Contingencies + parity rate charges	835.1
	7,456.5

* Parity rate assumed £1 = Rs. 35.00

BENEFITS

The principal benefits from the scheme are hydro-power production and providing a regulated source of water for irrigation. There is a very high potential for the development of inland fisheries and development of tourism.

At present, all available flows in the Mahaweli Ganga are diverted at Polgolla, maximum capacity 57 cubic metres per second (2,000 cusecs) for generation of hydro-power at Ukuwela. When the Victoria reservoir is constructed the diversions at Polgolla will be limited to the minimum requirements for irrigation only, thereby reducing the total hydro-power production at Ukuwela. This loss will be more than compensated by extra energy generation from the higher heads available at Victoria and Randenigala. Studies reveal that about 600 GWh. (600 million units) of firm energy can be generated while about 200 GWh. of secondary energy can be added to the grid. The provision of 210 MW of installation and availability of regulation facilities downstream make this system capable of functioning effectively as a peaking station. The regulated releases from Victoria (even without Randenigala reservoir) can meet the irrigation requirements for lands in Systems B and C where about 70,000 hectares (175,000 acres) of new lands can be developed.

At the price of oil prevailing in 1979, and basing the benefits from hydro-power production in comparison with energy produced by oil, the internal rate of return had been computed to be over 12 percent. Though the inflationary trends have increased the investment cost of the project, the increase in price of oil is at a higher rate thereby making the project more attractive.

MINIPE ANICUT, R.B. CANAL AND IRRIGATION SYSTEMS B & C

System C on the right bank of the Mahaweli, downstream of Minipe Diversion, consists of about say 22,000 hectares (54,000 acres). These are entirely new lands which have been divided into five zones (2 to 6).

Zone 1 alone comprises existing land (developed) under Mapakada, Dambarawa and Soraborawewa, about 3,500 hectares (8,700 acres) in all. Zone 2 is the new area coming under the Left Bank of Ulhitiya reservoir. The balance Zones 3 to 6 are new areas that come under the Right Bank Canal from Ratkinda.

Water supplies for irrigation development of System C are dependent on augmentation from the Victoria reservoir through the Right Bank Canal from the Minipe anicut, which will be ready in 1983/84.

The programme of irrigation development of System C will be as follows :

1,400 ha (3,450 acs) in 1981/82 2,100 ha (5,190 acs) in 1982/83	These lands are in Zone 2 which can be irrigated with water from Ulhitiya reservoir's own catchment.
2,790 ha (6,890 acs) in 1983 4,500 ha (11,100 acs) in 1984 5,000 ha (12,350 acs) in 1985 and 5,000 ha (12,350 acs) in 1986	These lands are in Zones 3 to 6 under Ratkinda reservoir, which will need augmentation from Victoria through the Minipe Right Bank Canal.

The irrigated lands are suitable for paddy cultivation during both seasons. An experimental station has been set up at Girandurukotte for the cultivation of *other field crops* on irrigated lands, and a programme of trials on the cultivation of irrigated sugar cane is also being carried out.

One of the main items of work in System C is the new Minipe anicut and the Right Bank Canal. The construction work on the Minipe anicut and a part of the Right Bank Canal are being carried out by the State Development & Construction Corporation (SD & CC). The foundations have been laid between 20 m and 40 m, 130 m and 140 m, and 220 m and 235 m. Due to the unusual rain that fell during the dry season (i.e., July and August 1981), the coffer dam was washed away and progress has been delayed. This work will be completed by the end of 1982, before water from Victoria reservoir will be available for diversion at Minipe.

The Minipe anicut and the first part of Right Bank Canal are being done with government funds, up to and including the Badulu Oya Aqueduct. The remaining portion of the RB Canal will be financed by the World Bank up to (but not including) Ulhitiya reservoir.

The Right Bank Transbasin Canal is one of the largest irrigation canals to be constructed in Sri Lanka. Its first part from 0 to 3.24 km. is under construction, also by SD & CC. The work has been impeded by unexpected rains during the dry season (July and August 1981). The work involves rock excavation and bund formation from borrow material and concrete lining of canal sides. The concrete retaining wall and 3 undercrossings have been completed at 1,196 m and 2,305 m and 1,775 m. The crossing at 620 m is 75% complete.

The aqueduct across Badulu Oya (3.24 – 3.80 km.) is a major structure under construction by Messrs. Ceylon Development Engineering (CDE), the contractors. Excavation of foundations for two piers has commenced and

the work will be continued after the impending rainy season and completed next year.

The Badulu Oya Tunnel in the reach 3.80 km. to 4.70 km. is also a major construction work being done by Messrs. CDE (contractors). Tunnel excavation is in progress and about 1,300 cubic metres of rock excavation are being done per month. Decomposed rock has been encountered at the tunnel portal, which will be done in an open cut, as a result of which the tunnel length will be reduced by 205 m (672 ft.) at the intake.

The Right Bank Main Canal from 4.7 km. to 30.8 km. is the major part of Right Bank Transbasin Canal which is being carried out on international tender by Messrs. VIANINI (contractors) of Italy. Some of these activities have started late and are behind schedule although in some other items the progress surpasses the target.

The Main activities in progress are on :–

(i) Excavation in canal, forming embankments, and concrete lining of Canal between Heppola Oya and Diyabana Oya (13 km. + 830 m to 24 km. + 900 m).

(ii) Loggal Oya Diversion – 5.2 km. to 7.7 km. (foundations for dam across Loggal Oya and spillway which is a major construction work).

(iii) Heppola Oya Diversion – 9.2 km. to 13.8 km. (Excavation of foundations for a dam across Heppola Oya and spillway is also a major construction work).

The work on canal construction between Loggal Oya and Heppola Oya has commenced and the canal embankment between Heppola Oya and Diyabana Oya has also progressed ahead of schedule, on which the concreting programme has been completed up to 50%.

There are two retention reservoirs being constructed at the end of the Right Bank Canal with dams across Ulhitiya Oya and Ratkinda Oya, from which water issues will be made to System C new lands in Zones 2 to 6.

The Ulhitiya reservoir is made of an earthen embankment about 4,760 metres total length (15,600 ft.) with concrete spillway and sluice. The final portion of the dam including the river closure has now been completed by the River Valleys Development Board (RVDB) with Government funds. The spillway concreting is going ahead of schedule and is expected to be completed (with radial gates) by the end of November 1981. The sluice will also be completed with bulk head gates, trash rack, etc., before the tank starts filling up at the end of this year.

Under the irrigation network in System C, the first 3,500 hectares (8,700 acres) of new lands to be provided with irrigation facilities and settled are in Zone 2, which can be irrigated from Ulhitiya reservoir through a Left Bank Canal. The programme is for irrigation development and settlement on 1,400 hectares (3,450 acres) in 1981/82 and 2,100 hectares (5,190 acres) in 1982/83. The main, branch and field canals under Ulhitiya Left Bank were designed and are being constructed by the Mahaweli Development Board (MDB). Financial assistance for this part of the work (in Zone 2) is from the European Economic Community. Three thousand five hundred (3,500) worker-settlers have been brought into this area and are working on the irrigation canals system.

The 1,400 worker-settlers who were brought into Zone 2 of System C in mid-1980 were originally housed in camps constructed by the MDB close to small tanks which provided water for domestic requirements. They were given their individual homesteads and irrigated allotments in 1981 and are expecting to receive water from the Ulhitiya reservoir through the first section of the main canal under it, towards the tail-end of the 1981/82 Maha season.

The other 2,100 worker-settlers, who have been brought into Zone 2 of System C in 1981, are being housed in camps constructed by the Mahaweli Authority Settlement Branch and provided drinking water from shallow-wells and deep-wells constructed by the Mahaweli Authority Settlement Branch. They are expected to do their first irrigated cultivation in the balance of Zone 2 under Ulhitiya reservoir in the Maha 82/83 season.

The Ratkinda reservoir, consisting of an earthen embankment, is under construction by Messrs. Ceylon Development Engineering Company (CDE), with Government financial resources. This work will be completed along with the link canal from Ulhitiya to Ratkinda in the latter part of 1982. This work has been delayed to enable the completion of the inlet to the Maduru Oya tunnel, which will otherwise get inundated under the Ratkinda reservoir.

The irrigation canal system for Zones 3 to 6 in System C will commence in 1982. The designs for the Right Bank main canal from Ratkinda (and Branch canals) to irrigate Zones 3 to 6 will be done with financial assistance from Japan and Kuwait. The designs for these works are now ready with the MDB. Tenders are being called for this work to commence early next year.

As the System C area was hitherto sparsely populated with hardly any development, except in Zone 1, there were hardly any road systems. About 90 km. (60 miles) of roadway have been planned out of which 64 km. (40 miles) of roads have been constructed in the irrigable area on the Mahaweli Right Bank below Minipe as follows :

From	To	mileage	remarks
Balegama	Girandurukotte	20 km. (12.4 mls.)	Complete
Batalaya	Girandurukotte	5 km. (3.1 mls.)	Complete
Mahiyangana	Hembarawa	10¼ km. (6.3 mls.)	Complete
Ceylon Tobacco Company area		2 km. (1.2 mls.)	Complete
Hembarawa	Divulupellessa	10 km. (6.2 mls.)	Complete
Ginnoruwa	Ulhitiya	5 km. (3.1 mls.)	Complete

The following roads 25 km. (15 miles) are yet to be done on the programme :

From	To	mileage	remarks
Ginnoruwa	Mahagirandurukotte	5¾ km. (3.5 mls.)	not started
Ulhitiya	Divulupellessa	8¼ km. (5.1 mls.)	not started
Hembarawa	Belagamunuwewa	5¾ km. (3.5 mls.)	not started
Alutarama	Agala Oya	5 1/3 km. (3.3 mls.)	not started

The System B area is also sparsely populated with hardly any road systems except to the irrigation scheme at Pimburettawa for which the village centre is at Aralaganwila. A new road from Manampitiya to Aralaganwila 17.5 km. (11 miles) has been constructed by the RVDB and now the surfacing is being done by the MDB. Over 60 structures on this road have been completed by the MDB.

The Manampitiya–Dehiyatakandiya road, which leads into System C, is 19.5 km. (12.1 miles) up to the system boundary. This trace has been set out and cleared of jungle.

The Aralaganwila–Maha Oya road 38.4

km. (23.9 miles) has been surveyed and plans submitted for design and construction to follow.

The Welikande–Thirukonamadu road 19 km. (11.8 miles), running north of the Manampitiya Valaichchenai trunk road, has been surveyed and plans submitted for design and construction to follow.

The trace of the proposed railway line running north and south of Welikande in System B has been set out for 20 km. (12.4 miles) but no progress was made this year due to lack of funds.

There will be more water available in Victoria reservoir than necessary to meet the water requirements in System C. The excess water will be diverted from Ratkinda through a tunnel to augment the adjacent basin of Maduru Oya for irrigation of System B.

System B is the area under the Maduru Oya reservoir, which comprises about 20,000 hectares (49,400 acres) of new land on the Left Bank and over 20,000 hectares (49,400 acres) of new land on the Right Bank.

The Maduru Oya headworks will be ready in 1982/83 and water can be supplied to about 9,000 hectares or (22,200 acres), that is, to a part of the Left Bank, known as Phase (1a) from its own catchment. Tenders for the main and branch canals in Phase (1a) are now being called, for work to commence at the beginning of 1982, with financial assistance from USAID, to be completed in 18 months time (i.e., in the latter part of 1983).

This programme will be extended to the balance area in Phase (1b) by mutual agreement between the Government of Sri Lanka and USAID, before Phase (1a) is completed. The programme for System B to be provided with irrigation facilities and settled with farmers in Phase (1a) is as follows :–

2,000 hectares (4,940 acres) in 1983,
3,600 hectares (8,900 acres) in 1984,
and 3,600 hectares (8,900 acres) in 1985,
all on Left Bank.

The Mahaweli Authority Settlement Branch has taken over the management of the Pimburettawa colonisation scheme from the Government Agent, Polonnaruwa in 1981, with a view to completing its development before the water supply to these lands is augmented, with the completion of the Maduru Oya reservoir.

The 2,000 hectares (4,940 acres) to be settled in 1982 consists of land which has been used for rainfed paddy cultivation previously. The settlers will be selected from these who had developed the land earlier and those now living in the Maduru Oya National Park, who have to be re-settled.

The consultants for downstream development of System B are Messrs. Louis Berger International & International Engineering Consultants of San Francisco USA, assisted by Resources Development Consultants (local consultants). The Mahaweli Development Board co-ordinates the work of the consultants and contractors.

SYSTEMS PLANNING FOR WATER MANAGEMENT

The Mahaweli Development Programme consists of several large multi-purpose projects which can function independently, but are interlinked with one another. Many of the ancient irrigation systems, which have been restored, are being fully utilised in the present network of irrigation systems.

In the Accelerated Programme, there are four multi-purpose projects, and priorities for water use and allocations have to be determined for the various systems. These projects are in different districts, and there will be conflicting demands from the different district authorities, which will have to be sorted out by a high level Water Management Authority, which will have to make allocations of water, according to national priorities.

The need for a proper Water Management System will be seen from a detailed description of the well planned lay-out of the inter-connected irrigation network in the Development Programme. (Vide water distribution diagram proposed by UNDP studies). It is like a chain which depends on its links to function properly.

THE IRRIGATION NETWORK

The Kotmale reservoir is the uppermost project, on a large tributary of the Mahaweli. The water stored here will be mainly used for power generation and the tail water (which will not be used immediately below it for irrigation purposes) flows down the Mahaweli up to Polgolla Barrage, near Katugastota.

At Polgolla, a part of the water up to 56.6 cumecs (2,000 cusecs) will be diverted to the adjacent Amban Ganga basin and the balance will flow down the Mahaweli to Victoria.

At Victoria reservoir, it will be stored and used for power generation.

The water releases from Victoria, after power generation, flow into Randenigala reservoir and Rantembe reservoir. There will be power generation in each of these systems in "cascade" (i.e., the same water flow is utilised to develop hydro-power, over and over again, taking advantage of the continuous drop in the elevation of the river).

The tail waters from Rantembe will go down to the Minipe anicut, where there will be two diversions; one part will be to the Left Bank to the existing Minipe irrigation System E and the other part to the Right Bank for irrigation of System C, consisting of a small extent of existing fields in Zone 1 and a large extent of new lands in Zones 2 to 6.

There will be no power generation at Minipe. Allocation of water to the Left Bank and Right Bank Canals have to be determined and fixed from time to time.

SYSTEMS C & B

The Right Bank Canal enters the Ulhitiya and Ratkinda reservoirs, where it will be used for irrigation purposes of new lands in System C – Zones 2 to 6.

As the water available from Victoria (and Randenigala, later) is more than what is required for irrigation of lands in System C, a part of the water will be diverted from Ratkinda through a 3.2 km. (2 miles) tunnel into the adjacent Maduru Oya reservoir. The extent of lands under the Maduru Oya reservoir is much larger than what can be commanded by the yield of its own catchment.

There can be a conflict at times between the demands at Ratkinda for System C and diversion from it to System B under Maduru Oya, especially during the dry season.

POLGOLLA DIVERSION

The water diverted from Polgolla, will be used for power generation at Ukuwela and sent down to the Amban Ganga to augment several irrigation systems. There is an irrigation by-pass at Ukuwela, to send water through the power-house without generating hydro-power (if one or other of the turbines is under repairs). The tail waters flow through the Amban Ganga to the Bowatenne reservoir.

There is already a control room at Polgolla headworks, which is in communication with Headquarters at Colombo and the Ukuwela Power House.

At Bowatenne there is a diversion tunnel 6.4 km. (4 miles) long which transfers up to 28.3 cumecs (1,000 cusecs) from Bowatenne into the Kala Oya basin, which is for irrigation purposes only. A small part of it, 7.1 cumecs (250 cusecs), is sent to Kandalama and Hurulu-wewa reservoirs and the bulk of the diversion 21.2 cumecs (750 cusecs) goes to Kalawewa reservoir.

Bowatenne is an important junction, at which there can be a conflict in demand between the needs for Amban Ganga and Kala Oya basins; each basin contains large extents of inter-linked irrigation systems.

The Kalawewa reservoir is an important junction, from which water is issued through the Left Bank Canal to new lands in System H and the Right Bank Canal (which has replaced the ancient Jayaganga) takes water to existing and new areas in System H and to the city tanks of Anuradhapura.

The flow past Bowatenne will be utilised for power generation and the tail waters flow down the Amban Ganga up to Elahera anicut.

The Elahera anicut is another important junction, from where about 56.6 cumecs (2,000 cusecs) of water are diverted along the Elahera – Minneri – Yoda-Ela to Minneriya Tank. About 32.2 km. (20 miles) down the Yoda-Ela, there is a bifurcation at Diyabe-duma to send about 14.2 cumecs (500 cusecs) of the water to Giritale Tank.

The Elahera – Minneri – Yoda-Ela is a trunk conveyance canal, from which there are now too many distributaries (over 40 taking water directly from it). These direct off-takes may be reduced to a minimum for better control.

The Minneriya reservoir is an important distribution centre under which there is a large extent of irrigable lands. It is from Minneriya that water is issued to Kaudulla and Kantalai major reservoirs.

The spillwaters from Minneriya flow to Kaudulla and Kantalai. There is also a high level sluice at Minneriya from which water can be issued to Kantalai and Kaudulla through the Minneriya – Kantalai – Yoda-Ela. This issue is often disputed by the cultivators under Minneriya during times of drought.

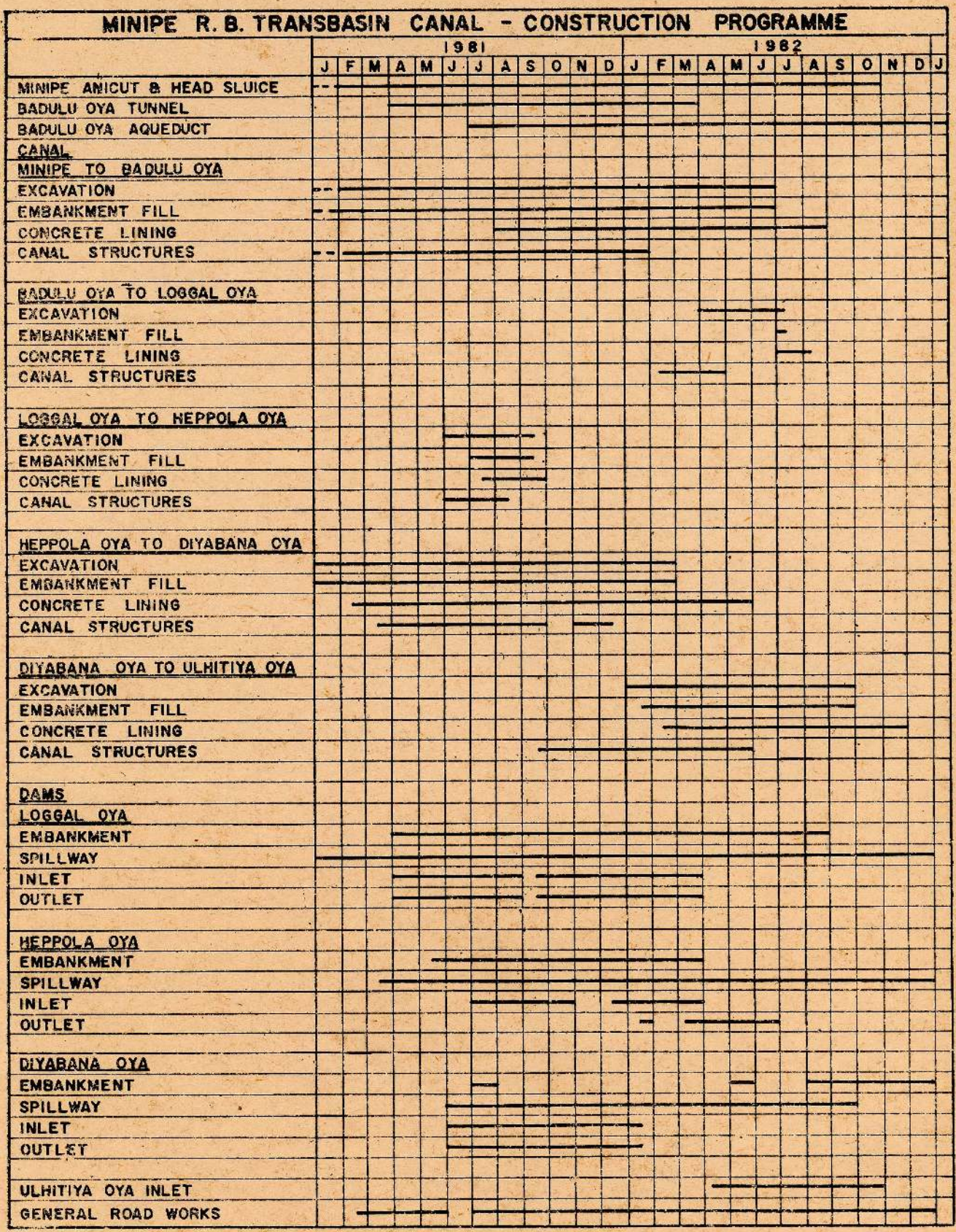
The flow past Elahera anicut goes down the Amban Ganga to Angamedilla anicut, where it is partly diverted to the Parakrama Samudra (through Angamedilla Yoda-Ela). Beyond Angamedilla anicut the water goes down the Amban Ganga, joins the Mahaweli Ganga, and is picked up at Kandakadu for diversion to Allai Scheme.

During times of normal rainfall, for which these schemes have been designed, the demands of the various components in this irrigation network can be met. However, during times of drought, it is essential that a proper control is exercised at each of these diversion structures, after justifiable allocations are made, based on careful water management studies.

DEMANDS FOR WATER

The various projects to which water from the Mahaweli will be issued contain

MINIPE R. B. TRANSBASIN CANAL - CONSTRUCTION PROGRAMME



existing (purana) lands as well as new areas which are now being developed, newly settled with farmers under the Accelerated Mahaweli Programme. The "purana" field owners claim first preference for water issues from the existing reservoirs.

The cropping patterns vary from tract to tract, and the consumptive use of water differs from crop to crop. Water management executives have to ensure strict adherence to approved cropping patterns and water allocations made according to these requirements, and not allow cultivation of other crops, which may need more water than what has been allocated.

The irrigated areas under different projects are often in different districts, which are administered by different government agencies, who press for their requirements independently. The Water Management Board has to make allocations after considering the overall supply and demand at a national level.

In some of the projects, there can be conflicts in the preferential demand for water between power and irrigation purposes, because a certain amount of dead storage has to be maintained for power generation, which cannot be released for irrigation purposes. There can also be conflicts between the demand for food crops in a settlement scheme and state farms for industrial cash crops like sugar, as for example at Kantalai. Though the sugar crop brings greater cash returns, the pressure from the farmers is so great, that sugar cultivation sometimes does not get priority. A former M.P., for Minneriya had often decided in favour of the farmer, as the Sugar Factory has no vote !

WATER MANAGEMENT BOARD (WMB)

There is now a Water Management Board (WMB) which has started functioning. This is chaired by the Director-General, Mahaweli Authority of Sri Lanka and consists of the Director of Irrigation, the Chairman of the Electricity Board, the Director of Agriculture, the Government Agents of Anuradhapura, Polonnaruwa, Trincomalee and Matale and such other members as may be required from time to time.

THE WATER MANAGEMENT SECRETARIAT

A Water Management Secretariat (WMS) will be a technical body set up to provide technical expertise to the Water Management Board and assist the WMB in making decisions regarding the allocation of water. It will also be responsible for implementing all decisions of the WMB. The chief resident project managers in the new irrigation systems will also be co-opted to the Water Management Secretariat (WMS).

Communications with regard to water availability and water requirements are now received from the various distribution centres, through existing telecommunication and radio networks and processed at the headquarters. These will have to be strengthened in order to receive information on a daily basis or even hourly, during times of severe water shortage, for better performance.

Water management panels are to be set up in each irrigation sub-system, consisting of the resident project manager, deputy project manager for irrigation, deputy project manager for agriculture and representatives of the water users.

The water management panels will be responsible for determining water allocation within the sub-system and for implementing water management schedules prepared by the WMS, according to the guidelines set out by the WMB.

Water Management Units (WMU) are to be set up in each sub-system under the Deputy Project Manager (Operation and Maintenance), to be responsible for providing technical back up to the WMP to formulate decisions for water allocation, within the sub-system at the micro-level and to develop water management schedules.

DATA PROCESSING

In order to collect and evaluate a mass of information, the WMS's and WMU's will require a number of things, some of which are already available on a small scale :

1. A main data processing computer centre of the WMS in Colombo (at the macro-level).

2. Micro-processing centres at each important water management distribution centre.

3. Communication network (radio, telephone) for the centre to the control points, power plants, and main distribution centre).

4. Collection and processing of hydraulic hydrological, meteorological and agronomic data.

5. Reservoir operation criteria.

6. Water balance studies of the Mahaweli System (i.e., supply and demand).

Computer programmes will be required for the various activities, such as storage in the field, water issues in bulk at the major distribution centres, (macro model) and water issues to the sub-systems (micro model). This will be based on the irrigation programmes in the various systems, starting with H.

There are a few other matters to which the WMB has to address its mind and find solutions.

INDIRECTLY BENEFITED SCHEME

There are some irrigation schemes that derive indirect benefits from the Mahaweli Diversion, which may not necessarily come under the purview of the WMB. With good water management and strict control on water issues, these schemes may be deprived of such additional benefits and suffer water shortages. The WMB may have to decide whether special water issues have to be made to ensure adequate water supplies to those schemes. Reference is made hereunder to a few of the larger schemes that are indirectly benefited.

The Rajangane reservoir gets its supply from Kala Oya, which is generally the overflow from Kalawewa. After Kalawewa was augmented, Rajangane has been getting a regular copious supply from return flows (drainage water from irrigation) from the fields under Kalawewa reservoir. These return flows amounting to about 25% of water issues run along the drainage lines to Rajangane, which has thus been able to have continuous cultivations ever since the Mahaweli waters started augmenting Kalawewa.

The Parakrama Samudra is normally augmented by the Amban Ganga flow past the Elahera anicut, diverted at Angamedilla anicut through the Yoda-Ela. After diversion of a part of the Mahaweli into Amban Ganga, its flows past Elahera have increased. The return (drainage) flows from the irrigated fields under Elahera (amounting to about 25%) also increased the Amban Ganga flow to augment the Parakrama Samudra, which is now almost full most of the time.

The Giant's Tank is augmented by a diversion of Malwatu Oya (called Aruvi Aru in the lower reaches) from an existing anicut at Tekkam, through an existing Yoda-Ela about 24.1 km. (15 miles) long. The Malwatu Oya is augmented by the return flows (drainage water) from the irrigated fields under Nachchaduwa, Tissa Wewa, Nuwara Wewa and Basawakulama, all of which are now augmented by Mahaweli waters.

SQUATTERS & ILLICIT CULTIVATIONS

There is a large extent of land under each major irrigation scheme which is illicitly

cultivated, some by the colonists themselves in addition to their own allotments, but mostly by squatters.

These areas have not been included in the irrigation specification, as they are mostly state reservations for forest belts, drainages, roads and canals, which cannot be alienated without considering adverse effects.

In Elahera, an area of about 4,000 hectares (10,000 acres) between the existing System G and the Amban Ganga, which were considered new lands to be developed under the Mahaweli Programme, are found to be mostly occupied by squatters. A team of sociologists and engineers is now examining the situation, to see whether these cultivations can be regularised with a proper settlement and irrigation system.

The water for these illicit cultivations are now tapped from the Elahera – Minneri – Yoda-Ela, by stealthily increasing the issues from the D – channel off-takes.

CONSULTANCY SERVICES

It is proposed to obtain technical assistance from The Netherlands to provide consultancy services to assist and guide the decision making process, for the operation of the overall Mahaweli System; i.e., the allocation of bulk water releases from the main reservoirs and control points to the sub-system, taking into account the multiple water uses in the system. This will maximise the benefits.

This will be followed by other consul tants (likely to be provided by Canada) to assist and guide the decision making process for the operation of sub-systems under System H in Kalawewa, viz., I(H) – under Anuradhapura City Tanks, and M(H) – under Huruluwewa.

The "models" so designed for computer use in the above system, will be adopted in other systems like G (Elahera), D (Polonnaruwa District), C (under Ulhitiya and Ratkinda) and B (under the Maduru Oya).

The Water Management Secretariat will provide competent personnel to be associated in the work of the consultants and to be trained in the process of carrying out field tests and field measurements for the calibration of the models. Water being a scarce resource in the Dry Zone compared to land which is available, the 'model' water management system to be adopted will enable the country derive maximum benefits from the available water resources.

THE RANDENIGALA RESERVOIR PROJECT

The proposed Randenigala reservoir is one of the major reservoirs under the Accelerated Mahaweli Programme. This will be the last of the major reservoirs on the Mahaweli Ganga cascade and will be situated immediately below the Victoria reservoir, about 9.7 km. (six miles) upstream of the Minipe anicut. Geological and other investigations have shown that the site for the Randenigala dam is very favourable and permits the construction of the dam with the power station and associated works.

The Government of the Federal Republic of Germany, at the request of the Government of Sri Lanka has provided necessary technical assistance for this project. A grant of DM 6.6 million (approximately Rs. 60 million) was made available to finance the cost of investigations and studies of the project leading to the preparation of the final designs, specifications and tender documents.

The Ministry of Mahaweli Development entered into a Consultancy Agreement on February 26, 1979, with the Joint Venture comprising Salzgitter Consult GmbH of Germany (as leading partner) Agrar-Und Hydro-technik GmbH of Germany and Electrowatt Engineering Services Limited of Switzerland for this project.

PROJECT STUDIES

Review Phase

The Joint Venture commenced work in Sri Lanka in April 1979. Specialists of the Joint Venture worked in very close collaboration with the Ministry of Mahaweli Development and with the Sri Lankan co-ordinators and field team counterparts from the Central Engineering Consultancy Bureau, the Mahaweli Development Board, the Sri Lanka Electricity Board, the Irrigation Department, Survey Department and other organizations. Based on studies carried out, the Joint Venture submitted the Review Report on June 30, 1979, to the Ministry of Mahaweli Development and the Kreditanstalt fur Wiederaufbau (KfW), the West German Bank through which the German Government's technical assistance is channelled. The findings and conclusions in the Review Report were studied, both by the Ministry of Mahaweli Development and the KfW, and were approved. During this phase, four alternate proposals for the optimum use of the hydro resources were studied in detail.

Due to technical and other considerations, two of these proposals were eliminated. The two alternate proposals that were subject to detailed study were as follows:–

(a) A dam at Randenigala site with power station and other appurtenant structures together with a lower dam at Rantembe (immediately below the confluence of the Uma Oya with the Mahaweli Ganga), and power station.

(b) A dam at Randenigala site with tunnel and power station near the Minipe anicut (the Rantembe reservoir will not be built in this proposal).

Feasibility Phase

Investigations and studies for the feasibility phase were commenced in July 1977, and the draft Feasibility Report was submitted by the Joint Venture to the Ministry of

Mahaweli Development and the KfW on November 15, 1979.

Investigations

Detailed geological investigations were done at the proposed sites during this period. Drillings were carried out by the Irrigation Department very expeditiously during the period June to August 1979. Nine No. drill holes totalling a depth of 923.5 m (3,030 ft.) were executed at Randenigala and 4 No. drill holes totalling a depth of 280.8 m (921.3 ft.) were executed at Rantembe. Extensive field and laboratory investigations were carried out by the Joint Venture together with the Irrigation Department to determine the availability and suitability of construction materials, both for a rockfill and concrete dam. These field and laboratory investigations involved a very considerable amount of work. This work was done entirely in the laboratories of the Irrigation Department.

Topographical Surveys

For purposes of the studies, a very large amount of topographical surveys had to be done and completed during a very short period of time. The Survey Department undertook all the field work necessary and prepared the necessary plans in a very expeditious manner.

The investigations and studies that were conducted were to determine the optimum solutions for the following:–

(a) The most suitable type of dam for the proposed site at Randenigala,

(b) The most suitable type of dam for the proposed site at Rantembe,

(c) The most suitable alternative from among the two alternatives that were subject to the feasibility study.

Detailed reports in respect of these matters were prepared by the Joint Venture, and submitted to the Ministry of Mahaweli Development and the KfW. These reports contained all technical details and the financial costs and other relevant matters. After the study of these reports, the following decisions were taken in respect of Randenigala and Rantembe Dams.

* A rockfill dam at Randenigala with a power house at the foot of the dam, together with other appurtenant structures.

* A concrete gravity type dam at Rantembe with a power house at the foot of the dam.

The above decisions were subject to further studies, and the Feasibility Report was submitted by the Joint Venture on November 15, 1979.

Detailed Design Phase

The detailed designs of the project were commenced by the Joint Venture in January 1980.

Further construction material investigations and topographical surveys were required for the preparation of the final designs and plans. During this phase, an additional 22 drill holes totalling a depth of 1,570 m (5,151 ft.) were executed at Randenigala. At Rantembe 9 additional drill holes totalling a length of 607 m (1,991.6 ft.) were executed.

Investigations were done by the Irrigation Department and completed very speedily by June 1980. In addition, the Irrigation Department carried out detailed testing of the construction materials required for the rockfill dam at Randenigala and for the concrete dam at Rantembe. All the necessary investigations and laboratory tests were done very speedily and the necessary data supplied to the Joint Venture. Detailed site surveys of all the major structures were done by the

Survey Department and the plans were prepared expeditiously.

Model Tests

The model tests of the Randenigala spillway and Rantembe spillway were carried out at the Hydraulics Laboratory of the Irrigation Department. Extensive tests on the behaviour of the spillway were carried out by the Irrigation Department with the assistance of the hydraulic specialists of the Joint Venture. These tests made it possible for the necessary modifications in the spillway to be done during the design phase itself to ensure smooth operation of the Randenigala and Rantembe spillways. It may be mentioned that this is the first project of the major reservoirs in the Mahaweli Accelerated Programme where the models were entirely built, operated and tested by local agencies.

Tender Documents

The design and the preparation of specifications and tender documents in respect of Randenigala Project and Rantembe Project were completed by the Joint Venture by the end of 1980 and the draft documents were submitted to the Ministry of Mahaweli Development and the KfW. These were studied in detail and approved, and the final documents were submitted by the Joint Venture in March 1981.

Project costs and Financing

The cost of construction of Randenigala Project allowing for physical and financial contingencies is estimated at Rs. 4,550 millions. The local cost is estimated at Rs. 1,400 millions and the foreign cost at DM 350 millions.

The Federal Republic of Germany has agreed to finance the project by means of a concessionary loan amounting to a sum of DM 400 millions. The disbursement of the loan will commence in mid-1982.

Contract Awards

The main contracts of the Randenigala Project will be awarded in respect of Civil works, Hydro-mechanical equipment, Electrical equipment, Mechanical equipment and Transmission lines. The tenders will be invited from prequalified firms in Federal Republic of Germany and West Berlin.

Implementation Schedule

It is proposed to implement the project on the following programme:

i) Preliminary works consisting of the construction of access roads, camps and services – October 1981 to December 1982.

ii) Prequalification of Civil Contractor – September 1981 to December 1981.

iii) Award of Civil Contract – mid-1982.

iv) Award of Electro-mechanical Contracts –

v) Commissioning of Project – December 1986.

PROJECT FEATURES

Dam

The Randenigala Dam will be a rockfill dam with a central impervious earth core. The maximum height of the dam will be 94 metres (308 ft.) and the crest length 485 metres (1,591 ft.). The total volume of the dam will be 3.7 million cubic metres (131 million cu. ft.). At a full supply level of 232 m MSL (761 ft.) it will impound 800 million cubic metres (648,800 ac. ft.) of water.

Spillway

The spillway will be located on the right

bank end and will be a gated chute spillway with flip bucket. Three radial gates each 16.70 m (54.8 ft.) wide and 15.26 m (50 ft.) high will have a maximum flood capacity of 8,085 cu. m per second (285,300 cusecs). A chute 232 m (761 ft.) long and 48.0 m (157 ft.) wide will end in a flip bucket which will throw the jet of water into the natural river bed approximately 120 m (394 ft.) downstream for energy dissipation.

Bottom and Irrigation Outlet

Bottom and irrigation outlets with two radial type service gates and two sliding/ roller gates will be incorporated into one of the two diversion tunnels 9.6 m (31 ft.) in diameter. The bottom outlet will have a capacity of 284 cu.m per second (3,055 cusecs) at drawdown level, and will enable the reservoir to be drawn down when required and will also serve as an irrigation outlet when the turbines are not operating.

Intake

The intake structure is located on the left bank and will have a penstock of 5.2 m (17 ft.) dia. and length 270 m (886 ft.) steel lined in its entire length.

Power house

The power house will be located at the toe of the dam on the left bank. It will have two Francis turbines with a discharge of 90 cu.m/sec (3,200 cusecs) each and the total installed capacity of the two generators will be 122 MW.

Switchyard

The switchyard will be located adjacent to the power house and will be connected at 220 Kv to a switching station at Rantembe. The operation of both Randenigala power station and the future Rantembe will be from this central switching station.

PROGRESS

Roads

The proposed route for transportation of heavy equipment and materials for the project will be the Colombo-Kurunegala-Habarana-Chenkaladi-Padiyatalawa-Mahiyangana-Minipe Road. For light traffic, the Colombo-Kandy-Mahiyangana Road, will be utilised. Necessary improvement works on these roads have been identified, estimates prepared and the work has been undertaken by the Department of Highways. The road from Weragantota to Minipe and up to the dam site, totalling approximately a distance of 22.5 kms. (14 miles) requires major improvements. These works are under construction by the Highways Department with a view to completion by mid-1981.

Construction Camps

Sites for the construction camps have been located, and lay-out plans have been prepared and tenders awarded for the construction. The construction is under way.

Services

Plans for the provision of electricity telephone and water services are being finalised.

PROJECT BENEFITS

Irrigation Benefits

The Randenigala reservoir will regulate the releases of Victoria reservoir and will provide supplemental irrigation benefits to Systems A, B and C. With the subsequent development of the systems outside the Accelerated Programme, irrigation benefits will be provided to the systems that will be developed later in the overall Mahaweli Programme.

Flood-Control Benefits

Flood-control benefits of the Randenigala

reservoir will be very substantial and would specially alleviate flooding problems in System A.

Power Benefits

The Randenigala power station will generate 428 GWH of firm energy and 100 GWH of secondary energy.

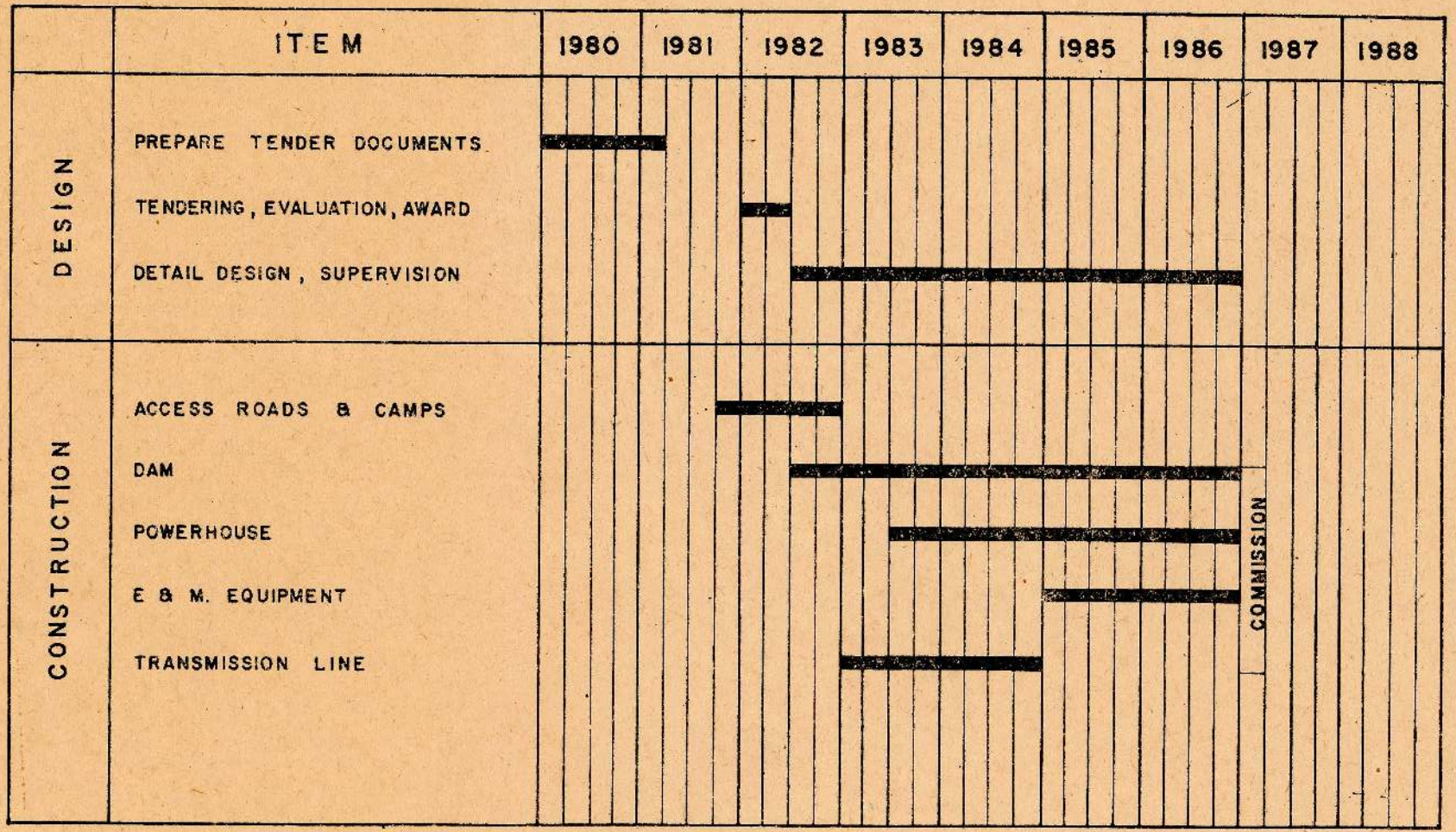
Non-Quantifiable Benefits

There are many other benefits that will accrue from the construction of these reservoirs. These will be mainly the development of inland fisheries, tourist and recreational facilities.

Benefit cost studies reveal that the Project would have an internal rate of return of about 16 per cent considering the power benefits alone. Allowing for likely price increases of fuel, the internal rate of return will be about 18 per cent on power benefits alone.

RANDENIGALA PROJECT

CONSTRUCTION PROGRAMME



D.H.R.

PRESERVATION
OF
THE ENVIRONMENT AND HERITAGE

The environment is determined by the natural endowments and the impact of the cultural activities of man. During the course of centuries man has attempted to modify nature by his activities in the fields of agriculture, horticulture, animal husbandry and industry. He has generally succeeded when he was not in conflict with nature, but failed when he was in conflict with her. There are many lessons to be drawn from these experiences.

Dam construction for purposes of power and irrigation, for agricultural purposes, have to be considered in the setting of limited resources in the background of population growth. The gigantic Mahaweli Programme will have far reaching consequences on land and water resources of our country.

In order to carry forward the Mahaweli Programme, it is obviously necessary to clear large extents of jungle in the Dry Zone. Careful planning has been carried out to demarcate areas which have to be cleared and other areas which will be conserved for the future.

It is generally not known that 300,000 acres have been set apart already, in the original plan, for environmental reasons. The Government has added to this area the entire Wasgomuwa Reserve and half of the Somawathiya Reserve which were to have been cleared for human settlement in the original plan. These two land areas will now be added to the substantial jungle areas which have been set apart for wild life and forestry.

In addition, the Government has decided to demarcate a new reserve to include the immediate catchment of the Ulhitiya, Ratkinda and Maduru Oya reservoirs which jointly extends over 150 square miles. The Yala and Gal Oya National Parks are to be linked with the Maduru Oya reserve by a jungle corridor. The Wasgomuwa and the Somawathiya reserves would in turn be linked by a corridor mainly for the fauna whose habitats are the villus and the immediate riverine environment. In fact, it could be stated that we are one country where steps have been taken to preserve natural habitat for fauna giving them precedence over man. For example, a large number of Veddhas would be shifted from jungle areas of the Maduru Oya National Park and re-settled in areas where irrigation facilities are to be provided for them for settled agriculture, thus keeping the park free to fauna.

WISDOM OF OUR ANCIENTS

In this manner it is proposed to preserve our endemic Dry Zone species and riverine communities of fauna and flora to grow undisturbed and to act as a gene pool for the future, both for our country and the world at large. All precautions are to be taken to see that any industries set up conform to strict control of effluents sent down the river as otherwise the very purpose of these reserves would be negatived.

Our ancients were keen conservationists, who preserved the forest cover of the mountains areas and irrigated the plains. In this manner soil in the mountains was conserved and water held up in the hills for a longer period. This increased the base flow of our rivers and reduced their run-off rate; flash floods were thus obviated.

With the commencement of the plantation economy by the British in the mid-19th Century, and the introduction of the Crown

Lands Ordinance of 1840 and the Waste Lands Ordinance of 1897, forests in the up and mid-country were opened up for coffee and later, tea. The soil washed down in torrents, leaving bare the weathered rocks with a thin mantle of soil. Muddy waters carrying the soil in suspension silted the river-beds below. This was the heritage left behind by the Colonial administrators. We have to rectify this situation and prevent further deterioration.

The growing of flue-cured tobacco on the hill slopes is causing severe damage to the available jungle. Timber required for curing tobacco is obtained from adjacent forests. The timber required to cure one acre of tobacco is estimated at 7 tons per season; the 40,000 acres of tobacco would require the felling of 1,500 acres of medium yielding forests per year for curing tobacco. This is a very serious problem facing the nation.

Remedial measures have to be taken to prevent the destruction of our forests which are part of our national heritage.

WATERSHED MANAGEMENT

The construction of large reservoirs would bring with it changes in the natural conditions in the area by the presence of a permanent water body. This would engender changes in the hydrological conditions of the area, and in the acquatic and terrestrial life, in addition to providing new avenues of recreation for man.

The present method of land-use around the reservoir would have to be changed. For example, the immediate steep slopes of the reservoirs will have to be reforested and "chena" and tobacco cultivation banned. The forest reserves in the catchment of these reservoirs will have to be protected from further encroachment. For example, the planting of cardomons in the Knuckles Range would have to be stopped and the range kept under natural forest cover or even speedily reforested. This will be necessary as the water flowing into the reservoirs is regulated by these natural forests.

According to the latest statistics, Sri Lanka with a population of 14 million is consuming the equivalent of 11,000 GWH of energy per annum or the equivalent of 30 million barrels of oil per annum. This is used in the proportion of : hydro-elctricity – 13.3%; fossil fuel energy (oil) – 26.7%; firewood – 60.0%.

Since the cost of fossil fuel is spiralling and as hydro-electricity is limited, the natural tendency is to use more firewood as a fuel source.

In the 1956 aerial survey, a forest cover of 7.2 million acres was identified. The recent estimates of forest cover is in the region of 4 million acres. As one would see, the increasing population and the increasing cost of fuels have eaten up our national forest reserves by about 40 per cent.

The use of fuel wood and agricultural waste has been estimated to have gradually increased from 4 million tons per annum in 1960 to 5.2 million tons in 1980, while the natural regeneration of fuel wood from forest cover at present cannot exceed 1 million tons per annum. The agricultural waste from coconut, rubber plantations, paddy husks saw mills, etc., yield around 1.5 million tons per annum. That is, we have an annual yield of 2.5 million tons per annum. But we are consuming 5.2 million tons per annum. Where does the remaining 2.7 million tons of fuel wood and agricultural waste come from ? It is clear that this would naturally have to come from our forests.

Let us examine this aspect more in depth. Over 90% of our population use firewood for domestic purposes, especially for cooking food. Firewood is also used in the tobacco processing industry. Forests are also burnt down in slash and burn (chena) cultivation. Clearly therefore the burning

of forests for chena cultivation has to be curtailed or banned, while the use of firewood for industrial processing like tobacco-curing has to be either curtailed or preferably banned. In the case of tobacco, other options like sun-dried tobacco (though of low quality) could be adopted or other energy forms used for curing.

In a situation when over 90% of the people of our country sustain themselves using firewood for cooking purposes, it would be necessary to provide energy for this in some way.

At the present rate of use of firewood, in the context of the population growth, about the turn of this century, firewood would not be available for domestic use in Sri Lanka, unless alternative measures to reforest on a large scale are undertaken.

The failure to provide fuel wood for the people would not only affect the fuel requirements for the kitchen and hearth but would snowball into other areas of the economy and environment and put out of gear, the irrigation structures, including the massive Mahaweli Programme on which we are dependent for our survival.

The reason is that though the rainfall in our country would continue to be the same the run-off (stream flow) regimes of the rivers would change drastically with the denudation of the forests. Without forest-cover in the catchments, the frequency and intensity of flash floods could pose a threat to the dams.

The run-off regimes are dependent on the land-use within the catchment areas of the rivers. Any change in the land-use patterns, like denudation of the forests, will bring a different run-off regime which will bring more frequent and higher intensity flash floods.

The designing of our reservoirs both ancient and modern was based on the land-use pattern of the catchments which was in existence over the centuries.

Even the design of the dams of the Mahaweli Programme has been on the basis of the land-use pattern in the catchment that existed over a decade ago. The designs of the dams have been for (return) floods in the context of land-use pattern that existed before.

This underscores the importance of conservation measures like protection of our forests and afforestation programmes in our catchments while at the same time planning to provide for fuel wood on a large scale as an energy source for the basic human needs of cooking.

MEASURES TO CONSERVE UPPER CATCHMENTS

In the upper catchment areas, reafforestation and conservation programmes are envisaged, in the first instance, for the conservation of the immediate catchments of the reservoirs in order to prevent silting of the reservoir, whilst in the larger areas of the catchments the main objective is to increase the base flow of the rivers and prevent flash floods.

In this connection, a concerted programme for reafforesting the upper catchments is envisaged by the Forest Department, the state plantations, the villagers and voluntary organisations.

In areas which are marked out for clearing, for purposes, of reservoirs, dams, channels, agricultural crops and for settlement, careful conservation measures are to be carried out. Even during the extraction of timber, precautions are to be taken to keep narrow strips of jungle along drainage lines in order to serve as windbreaks and as a protection against erosion.

In the case of areas of jungle which will be cleared for the building of reservoirs, it is

proposed in the future to uproot the trees completely, without leaving the stumps behind. In the past, it was not the practice to remove the stumps of trees from the beds of tanks. As a result, it has not been possible to develop inland fisheries, water sports, boating and recreational facilities on these beautiful stretches of water. In addition, it has also been difficult to control water weeds, due to the presence of tree stumps.

HERITAGE CONSIDERATIONS

Concurrently a programme is underway to preserve the heritage in the areas of the Mahaweli that would be affected by the new development. The upper catchment areas, where the major reservoirs will be built have been occupied for millennia by people with specific traditions, their own folk lore, folk dances and songs. These would have to be recorded before the people are shifted. Likewise in the downstream areas, where the purana villages and the Veddha communities would be displaced, steps are being taken to record their habitat on films and tapes. These records would be of great anthropological value.

FOLK MUSEUMS

Artefacts and archaeological materials from areas that would be submerged or otherwise affected would be conserved wherever possible *in situ* or reconstructed on higher ground where necessary. In areas where inundation takes place, these artefacts would be moved to a central place and exhibited in folk museums to be constructed. A central Mahaweli Museum is to be constructed in Colombo to exhibit artefacts of our hydraulic civilisation, supplemented with working models of the Mahaweli reservoirs, so that the present and future generations would be aware of our heritage and learn to preserve it for all time.

Conservation of the environment and preservation of our heritage are matters receiving the highest priority of the Government, and the Government is taking positive measures in this direction.

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