WATER DEVELOPMENT DEPARTMENT

ANNUAL REPORT

1965/66

R. BARRETT, C.ENG., M.I.C.E., M.I.W.E.,
Director of Water Development.

The Hon. C. M. G. Argwings-Kodhek, B.A. (Law), M.P., Minister for Natural Resources, inaugurates the Butere New Water Supply in Western Province (although this new water supply was completed and commissioned within the financial year, it was not possible to arrange the opening ceremony until August 3rd 1966).

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MINISTRY OF NATURAL RESOURCES

WATER DEVELOPMENT DEPARTMENT ANNUAL REPORT 1965/1966

1. Introduction

The Establishment of the Water Development Department

1.1. The events which culminated in the establishment of the present Water Development Department in 1964 are fully described in Appendix I of this Report.

Review of the Year

1.2. In spite of many changes in the senior staff of the Department, and serious deficiencies in the ranks of the professionally qualified and technically qualified officers, the wide responsibilities of the Department were most satisfactorily maintained during the financial year under review.

1.3. Mr. O. S. Cege, B.E. (Civil), D.I.C., was appointed Acting Director in June 1965. A new Assistant Director, Mr. T. G. Davis, C.Eng., M.Sc., M.A., B.A.I., A.M.I.C.E., was appointed in July 1965, and the new substantive Director, Mr. R. Barrett, C.Eng., M.I.C.E., M.I.W.E., commenced duty on the 2nd September 1965.

1.4. In May 1966, the Department, which had previously been within the portfolio of the Hon. S.O. Ayodo, M.P., Minister for Natural Resources, Wildlife and Tourism, was transferred to the newly created Ministry of Natural Resources within the portfolio of the Minister for Natural Resources, the Hon. C. M. G. Argwings-Kodhek, M.P.

1.5. The Department's in-service training programme continued, and four refresher courses for water supply operators were held and attended by 63 operators including five officers employed by local authorities.

1.6. The recurrent and development expenditure of the Department in the financial year under review was £1,094,225 and £207,392 respectively.

1.7. The operation and maintenance of 79 township water supplies, three rural pipeline schemes, the installations of the Mombasa Pipeline Board and 45 Government institutional supplies, which are the responsibility of the Director of Water Development, and on which the health and well-being of over half a million persons depend, were efficiently maintained.

1.8. The total revenue in respect of Gazetted water supplies was £821,805, and the water consumption was 2,950 million gallons. These figures reflect an increase of 19.8 per cent and 15.7 per cent respectively compared with the previous financial year.

1.9 Expenditure on capital works for Gazetted water supplies was £95,500, including augmentation, reticulation extensions, renewals and electrification of existing supplies, and the completion of the new water supplies for Butere Township and Kinango.

1.10. The installations of the Mombasa Pipeline Board were satisfactorily operated and maintained by the Department throughout the year, and a new scheme was designed to serve the densely populated Coast Hinterland between Mazeras and Sokoke at an estimated cost of £300,000. Full details are given in the Annual Report of the Mombasa Pipeline Board for the year ending 30th June 1966.

1.11. During the period under review, the capital value of works completed in respect of rural water supplies was £13,500 on dams, £27,500 on piping schemes and £11,250 on minor works. These figures include works designed and constructed by the Department at the request of the range management division of the Ministry of Agriculture and Animal Husbandry.

1.12. An engineer of the Department together with a water bailiff and subordinate staff were seconded to the Ministry of Lands and Settlement throughout the year. Six schemes to a total value of over £64,000 were installed and eleven new projects costing over £120,000 were designed.

1.13. The Dixey Unit's heavy earth moving equipment continued its programme of de-silting and repairing existing pans and constructing new pans and airstrips. The cost of this work was £11,100. The No. I. Dam Construction Unit carried out work costing £14,700 and earned £13,495 in revenue.

1.14. The development of the hydrological network continued. Fifteen new hydrological stations were installed, and collection, analysis and publishing of data were undertaken.

1.15. The Department participated in the Kenya National Programme for the International Hydrological Decade, and the Director represented the Government of Kenya at meetings of the technical committee for the hydrometerological survey of the catchments of Lakes Victoria, Kioga and Albert and also on the East African Nile Waters Co-ordinating Committee at technical level.

1.16. The Department continued to give advice, and provided all the associated engineering services to the Ministry of Agriculture and Animal Husbandry in respect of irrigation development. The more important activities during the year were concerned with the two United Nations special fund projects, namely, the survey of the irrigation potential of the Lower Tana River Basin and the surveys and pilot Demonstration Schemes leading to the reclamation of the Yala Swamp.

1.17. The mapping of Kenya's ground water resources continued, and 44 borehole-siting investigations were carried out, nine of which were for Government projects. Under the borehole subsidy scheme £2,599 was paid out.

1.18. The Isotope investigation of the Lake Chala area continued.

1.19. The Secretariat for the Water Apportionment Board and Catchment Boards continued its work throughout the year, and 1,480 authorizations and permits for ground water and surface flow were issued. Under the dam subsidy scheme, £2,150 was paid out.

1.20. The Department continued to give advice to the Ministry of Local Government in respect of loan applications received for sewerage works from local authorities and to the Water Apportionment Board in respect of effluent standards and the treatment of trade wastes.

1.21. The survey section carried out a large amount of work including 11 water supply reticulation surveys, 80 miles of pipeline surveys, and the extensive surveys for the U.N.S.F./F.A.O. Yala Swamp reclamation project.

1.22. The workshops continued the maintenance of the Department's 220 vehicles, and the general maintenance and repair of pumping equipment and other mechanical plant was also undertaken.

The Functions of the Department

1.23. The function of the Water Development Department is to implement the Government's water policy throughout Kenya. The principal duties may be briefly stated as follows:—

(i) To advise the Water Resources Authority on the development of the water resources of Kenya within a carefully planned programme designed to enhance their contribution to the economic and social welfare of the country.

(ii) To advise the Water Resources Authority on the development of such water resources to serve the needs of the human and animal population, agriculture, including irrigation and ranching, manufacturing, hydro-electric power generation, etc., and to place as much water development as possible on a sound commercial basis.

(iii) To advise the Water Apportionment Board on the conservation of the country's water resources by the control and apportionment of such resources, including river regulation, and by the promotion of measures designed to prevent waste and pollution.

(iv) To assist in the preservation of forest reserves which cover some of the principal water catchment areas in collaboration with the Chief Conservator of Forests.

(v) To make a continuing assessment of the surface and ground water resources of the country by a co-ordinated and systematic programme for the measuring and recording of data such as rainfall, evaporation, river discharge, etc.

(vi) To operate and maintain public and Government institutional water supplies, for which the Director of Water Development is the Gazetted water undertaker, and including the installations of the Mombasa Pipeline Board. To plan, design and construct new supplies and the augmentation of existing supplies.

(vii) To advise other Government Departments, including carrying out the design and construction of civil engineering works in connexion with irrigation, flood protection, sewerage and sewage disposal, etc.

A General Assessment of Progress in Water Development

1.24. The principal aim of the Department is to ensure that water development plays its full part in the implementation of the Government's Development Plan.

1.25. An over-all assessment of the development of water supplies throughout Kenya indicates that, provided the allocation of development and recurrent funds remains at its present level, the progress being made in the operation, maintenance and augmentation of township water supplies is satisfactory, and in consonance with the natural growth of population and industrial activity.

1.26 It is the Government's stated policy that water supplies in the rural areas of Kenya shall be developed as rapidly as possible. Whilst a great deal of water development is being carried out in those areas to the extent of the funds available, progress during the last few years has lagged behind other activities in the general pattern of progress. This is especially the case in the agricultural sector where water supplies are essential for the development of smallholdings, large-scale farms and ranches. The range lands of Kenya occupy some 85 per cent of the total area of the country with an estimated population of 1.5 million pastoralists together with an immense number of livestock, and the problem of water development is a considerable challenge. Adequate financial provision and technical services and the efficient collection of revenue are essential if more rapid progress is to be made. These problems and their possible solutions are discussed in detail in a departmental memorandum "The Organization of Rural Water Supplies—A Proposed Five-Year Plan" issued in September 1965.

1.27. The potential for large-scale irrigation is being gradually exploited in collaboration with the Ministry of Agriculture and Animal Husbandry and the Interim Irrigation Board. There are numerous possibilities for minor irrigation in the marginal areas of subsistence farming where a few additional inches of water would make all the difference between famine relief and a marketable surplus production, and the Department aims to provide the engineering skills necessary for the proper development of such irrigation at the highest possible rate in close collaboration with the Ministry of Agriculture and Animal Husbandry.

1.28. The hydrological network which provides essential data for the implementation of all water development is of a very high order particularly in the high-potential areas, and in consequence of the hydrometeorological survey of the Equatorial lakes will be strengthened in the area of the Nile Basin. There is, however, considerable need for extension of the network into the arid and semi-arid areas of the country if the development of the range lands, mentioned above, is to proceed at a satisfactory rate.

1.29. Shortage of geologists has made it impossible at present to continue with regional ground water mapping of the country which is of the utmost importance in certain areas. The siting of boreholes, however, in accordance with the borehole subsidy scheme, mentioned in the main body of the Report, continues most satisfactorily.

1.30. The Department's unsatisfactory staff position at the end of the year is described in detail in the body of the Report, from which it will be seen that the main problem is the deficiencies in the ranks of professional hydraulic engineers, senior technical officers, superintendents and field officers. The department proposes to accelerate the Africanization programme at all levels in the establishment, to co-operate with the university and technical colleges and to correlate other training schemes, expanding the scope of the courses held in the Department's training school, and encouraging the study of water engineering and its associated disciplines by lectures to colleges and schools, as well as promoting other activities demonstrating and publicizing the importance of this subject in Kenya's development.

2. Organization of the Department

The Water Act

2.1. The conservation, control, apportionment and use of the water resources of Kenya is controlled under the provisions of the Water Act (Cap. 372 of the Laws of Kenya, Revised 1962).

The Water Resources Authority

2.2. The Water Resources Authority was established under the provisions of the Water Act and is charged *inter alia* "to investigate the water resources of Kenya and to advise, and make recommendations to the Minister in regard to the improvement, preservation, conservation, utilization and apportionment of such resources, and as to the provision of additional water supplies".

2.3. The authority, which has no executive or financial powers, but has wide advisory functions in relation to the policy of water development and the control and apportionment of water, is also the appeal body in respect of certain appeals provided for in the Act. The Director of Water Development is technical adviser to the Water Resources Authority.

2.4. During the period covered by this Report, some of the principal items considered by the Water Resources Authority have been:—

(i) The proposed National Water Authority, and the implementation of the recommendations of the W.H.O./F.A.O. mission for the setting up of a National Water Authority with executive powers (for details *see* Appendix I).

(ii) Co-ordination of the proposals for development of the Tana River, including hydroelectric development, the irrigation potential of the Lower Tana Basin, and the use of water in the Upper Tana catchment for irrigated agriculture and for domestic purposes, including long-term proposals for Nairobi City. A standing technical committee has been set up to keep these matters under review.

(iii) The declaration of Protected Catchment Areas:—Under powers provided by section 14 of the Water Act, the Authority has advised the Minister to exercise his powers to declare certain important water catchments protected areas. These include parts of the Lembus Forest and the Chyulu Hills.

Other matters considered include:—

(iv) Staff matters in the Water Development Department.

(v) Coast water development (North and South of Mombasa).

(vi) Reorganization of the Water Development Department to expand rural water development services.

(vii) Review of financial estimates.

(viii) Priorities for water development.

Provincial Water Advisory Committees

2.5. The establishment of seven provincial water advisory committees recommended in the W.H.O./F.A.O. mission report—"The Organization for Water Development in Kenya" (for details please *see* Appendix I) has been effected.

The Director of Water Development

2.6. The Director of Water Development is responsible to the Permanent Secretary, Ministry of Natural Resources, for the administration of a department whose permanent establishment includes 32 professional, 167 higher technical and executive and 642 lower technical, executive and general posts.

2.7. The Director is the Government's technical adviser on all matters concerning Kenya's water resources and their development, and is the statutory technical adviser to the Water Resources Authority, the Mombasa Pipeline Board and the Water Apportionment Board.

2.8. The Director is member for Kenya on the East African Nile Waters Co-ordinating Committee at technical level, the World Meteorological Organization's Commission for Hydrometeorology (East Africa), and also on the technical committee for the Hydrometeorological Survey of the Catchments of Lakes Victoria, Kioga and Albert. He is a member of the National Irrigation Board, the Tana Basin Technical Committee, the National Committee for the International Hydrological Decade and the working party for setting up a National Water Authority.

2.9. The work of the Department is carried out at headquarters by a number of specialist sections operating through five district offices and fifteen divisional and sub-divisional offices.

2.10. The Director is supported by two Assistant Directors and four senior section heads responsible for urban water supplies, hydrology, irrigation and rural water supplies. Other sections are concerned with hydrogeology, water law, sewerage and survey.

Principal Officers

2.11. The principal officers of the Department at the end of the year under review were as follows:—

Director	R. Barrett, C.Eng., M.I.C.E., M.I.W.E.
Assistant Director (1)	O.S. Cege, B.E. (Civil), D.I.C.
Assistant Director (2)	T. G. Davis, C.Eng., M.Sc., M.A., B.A.I., A.M.I.C.E.

Section Heads (Headquarters)

Superintending Engineer (Urban Water Supplies)	R. B. Pickett, C.Eng., A.M.I.Mun.E.
Superintending Engineer (Irrigation)	G. G. Manig, B.Sc. (Agr.), Dip. (Agr.), B.Sc. (Eng.), Dip. (Eng.)
Adviser, Rural Water Supplies	G. A. Classen, M.B.E., C.Eng., A.M.I.M.M., F.G.S.
Superintending Hydrologist ...	D. R. L. Prabhakar, B.A. (Hons.), M.A., D.I.C.
Geologist	R. J. Tingey, B.Sc. (Hons.) (Geology), F.G.S.
Chief Technical Assistant (Survey)	B. C. John, Inter R.I.C.S.
Registrar of Water Rights ...	W. I. T. Dewar
Administrative Assistant ...	R. O. Oloo
Officer-in-Charge (Accounts) ...	A. R. Chaudry
Chief Draughtsman	G. E. Ofula
Officer-in-Charge (Workshops)	P. W. W. Manger

District Organization

District Hydraulic Engineer, Mombasa	C. L. Abernethy, B.Sc.
Mombasa Pipeline Engineer ...	B. Grover, B.Sc. (Eng.)
Officer-in-Charge, District No. 1, Kisumu	S. D. Tomkins
Officer-in-Charge, District No. 2, Nakuru	B. Hopkins
Officer-in-Charge, District No. 3, Nairobi	R. F. Clark
District Hydraulic Engineer, District No. 4, Fort Hall ...	A. B. Braganza, Dip. of Royal College, Grad.I.C.E.

Staff Position during 1965/66

2.12. The Schedule at Appendix III shows the staff position in the G.4 Scale and upwards at the 30th June 1966. The Water Development Department is, of course, a technical department to a very large degree, and the Schedule indicates that there are serious deficiencies in the ranks of the professionally qualified and technically qualified officers. Actually the position as regards qualified hydraulic engineers is slightly worse than the Schedule indicates, because of the 17 posts necessary, ten were filled; but of those ten, four officers were out of the country on further training or Fellowship courses for the whole or a major part of the year. This means that the effective strength was six out of 17 "A" Scale hydraulic engineers.

2.13. The four engineers who were out of the country on further training are on the point of returning (July 1966) so that some improvement of the position can be expected. However, quite a few posts for qualified hydraulic engineers remain vacant, and this will be a very serious matter if water development is to be intensified.

2.14. A deficiency of one should also be noted amongst the small staff of geologists held by the Department. During the coming year it is possible that the two existing geologists may not renew their contracts, and on the other hand the establishment of geologists is being increased to five. All of these five posts may be vacant.

2.15. The other aspect of the staff position which is unsatisfactory at present is the deficiency in the ranks of superintendents, senior inspectors and senior technical officers. These officers are not, as a general rule, in possession of an academic qualification; but they do possess a vast store of knowledge gained as a result of long experience and are consequently most difficult to replace.

2.16. A considerable number of local staff have already been trained and promoted to the middle and junior grade technical posts, but it is now a matter of giving them time to acquire experience. When dealing with public water supplies it is, of course, essential that these technicans can be relied on.

2.17. In conclusion, it may be said that the shortage of professional or technical officers can to some extent be overcome by the employment of consultants; but this practice can be a most expensive one.

Training

2.18. A training school was set up in 1964 at the same time as the Water Development Department was established.

2.19. The in-service training programme now in operation provides for courses of instruction given by a superintendent of water supply, for inspectors, foremen, water supply operators and artisans.

2.20. Training continued during the year under review until the training officer proceeded on vacation leave. Four refresher courses for water supply operators were held and attended by 63 operators including five operators employed by local authorities.

2.21. The present accommodation is inadequate, and a bid for funds in the 1966/67 Estimates has been made for the construction of a new training wing incorporating sleeping quarters, classrooms, laboratory and workshop.

2.22. In accordance with Government policy, the training of indigenous personnel and the co-ordination and extension of such training within the curricula of university, polytechnic and other agencies is becoming of paramount importance, and it is proposed next year to appoint a senior training officer charged with and responsible for that specific task.

3. Finance

Accounts Organization

3.1. Details of the Department's accounts organization may be found at Appendix II.

Recurrent Estimates

3.2. The approved recurrent estimates for the financial year 1965/66 provided for expenditure of £1,118,295. The actual expenditure was £1,094,225 and details are given at Appendix IV.

3.3. A saving of nearly £14,000 on personal emoluments resulted from our inability to fill all the professional and technical posts, and an over expenditure occurred in passage and leave expenses because there were more retirements than had been anticipated. The cost of maintaining and replacing vehicles was £4,400 more than expected and miscellaneous expenditure cost nearly £3,000 more. The latter excess expenditure was due to postal charges incurred by provinces in connexion with water revenue collection, and advertisement charges abroad for vacant staff positions.

3.4. A supplementary estimate of £1,500 under "Renewals" was unfortunately received too late for expenditure, and expenditure under "Professional Fees" was £432 more than estimated. This over-expenditure reflects an increase in the cost of obtaining consultant's advice.

3.5. The cost of operating and maintaining the dam construction unit was approximately £5,000 less than expected. Two factors contributed to this, viz (i) time spent on moving this complex unit from the lake area to the Coast and (ii) heavy rainfall at the Coast limiting construction work for several weeks.

Development Estimates

3.6. The development estimates are set out in detail at Appendix V and show that while the approved estimates total £237,344 the total actual expenditure was only £207,392.

3.7. Reduction in actual expenditure under urban water supplies was due to a shortage of professional design staff and to the fact that the development of urban water supplies is largely financed by loans from Great Britain which are conditional upon a 40 per cent import content being maintained. Such import content consists largely of pipes and fittings, the delivery of which can be as long as nine months, thus making it impossible for the work to be completed in the current financial year.

3.8. An under-expenditure of nearly £15,000 under rural water supplies was due to (i) the non-arrival of materials ordered from abroad, and (ii) the non-availability of "matching contributions" from local authorities.

3.9. Less than half of the £10,000 provided for dam and borehole subsidies was utilized; but there are indications that development works which may qualifiy for subsidy will be increasing during 1966/67.

4. Urban Water Supplies

General

4.1. Urban water supplies throughout Kenya are operated under the provisions of the Water Act by Gazetted water undertakers namely, the Director of Water Development, local authorities including municipalities and urban councils (12 supplies) and private water undertakers (17 supplies).

4.2. The Director of Water Development as Gazetted water undertaker manages and operates 79 township water supplies and three rural pipeline schemes and also acts as the operating agent for the Mombasa Pipeline Board which is a quasi-Government body charged with providing a bulk supply of water to Mombasa and its environs. A Table of Gazetted water supplies operated and maintained by the Department and giving maximum operating capacities may be found at Appendix VII.

4.3. The operation and maintenance of water supplies is administered by the urban water supply section through five district headquarters which in turn control 15 divisions and subdivisions.

4.4. Designs for new works are carried out by the urban water supply section and subsequently constructed by the appropriate district.

Gazetted Water Supplies

4.5. *Revenue.*—The supplies are operated on an economic and self-accounting basis. Water is distributed by pipe, and metered to each consumer. Consumers are billed each month and pay for water according to consumption, subject to a minimum charge.

4.6. Revenue is collected for the greater part by provincial revenue officers although in some cases, including Mombasa, it is collected by the Water Development Department.

4.7. The total revenue for 1965/66 was £821,805 and the water consumption 2,950 million gallons. These figures reflect an increase of 19.8 per cent and 15.7 per cent respectively compared with the previous year.

4.8. The growth in consumption and revenue over the last ten years for Gazetted supplies operated by the Director of Water Development is shown on the graph at Appendix VI.

4.9. *Operation and Maintenance.*—Operation and maintenance costs for the year were £145,676. This excludes the cost of purchase of water in the case of Mombasa and personal emoluments of permanent and pensionable staff.

4.10. Expenditure on renewals amounted to £4,446.

4.11. *Capital Works.*—One new water supply for Butere Township was completed.

4.12. The development of a new source for Kinango water supply to replace the old saline boreholes was also completed together with the reticulation extensions to Bondo water supply.

4.13. Expenditure of £34,900 was incurred on minor extensions which consisted mainly of extensions to the various distribution systems.

4.14. The total expenditure for the year on capital works was £95,550 made up as follows:—

(*a*) *Minor extensions*—Minor works at various supplies mainly in extension of the distribution systems	Expenditure £34,900
(*b*) *Kajiado water supply*—Part renewal of the 32-mile-long gravity pipeline	Expenditure £11,400
(*c*) *Kericho water supply*—Staff housing and preliminary work in connexion with the proposed new treatment plant ...	Expenditure £1,200
(*d*) *Kakamega water supply*—Electrification of pumping station, construction of 250,000-gallon reservoir as the first phase of augmentation of the supply	Expenditure £10,000
(*e*) *Embu water supply*—Completion of two 100,000-gallon reservoirs and electrification works	Expenditure £1,000
(*f*) *Limuru water supply*—Drilling of a new borehole to a depth of 850 feet	Expenditure £2,700
(*g*) *Mombasa South Mainland*—Part construction of new wells and main pipeline and reservoirs	Expenditure £10,400

(*h*) *Kilifi water supply*—Part renewal of the five miles of main pipelines and reservoirs ... ... Expenditure £9,100

(*i*) *Bondo water supply*—Completion of pumping station storage reservoirs and pipelines in extension of the existing supply ... ... Expenditure £1,400

(*j*) *Busia water supply*—Drilling of a new borehole in augmentation of the supply ... ... Expenditure £3,250

(*k*) *Homa Bay water supply*—Augmentation of existing treatment plant and an additional 50,000-gallon reservoir ... Expenditure £4,600

(*l*) *Butere water supply*—Completion of boreholes, pumping equipment, generator station, reservoirs and distribution system of the new water supply ... ... Expenditure £2,300

(*m*) *Kinango water supply*—Completion of ten miles of main pipeline and pumping station as a new water source superseding the existing boreholes ... ... Expenditure £3,300

The Mombasa Pipeline Board

4.15. Installations operated by the Department on behalf of the Board are principally:—

(*a*) The Mzima/Mombasa Pipeline with a maximum operating capacity of 8,000,000 gallons per day supplying Mombasa by gravity flow from Mzima Springs 140 miles to the north-west.

(*b*) The Mrere/Mombasa Pipeline, 27 miles long, with a maximum operating capacity of 2,000,000 gallons per day.

(*c*) The North Mainland Pipeline with a capacity of 750,000 gallons per day.

4.16. The activities of the Board are fully described in the Mombasa Pipeline Board's Report and Accounts for the year ended 30th June 1966. The total consumption increased from 2,060 to 2,090 million gallons. Work was started on a rehabilitation programme at a total estimated cost of £57,000.

4.17. The system as designed was found to be unstable in operation producing surge and water hammer. The principal contributory factor was found to be a malfunction of the control valves at the ten break-pressure tanks. In order to effect an improvement, it is necessary for the valves to be modified and provided with new float linkages so as to produce stable operation at all rates of flow and thus permit maximum carrying capacity of the pipeline.

4.18. It is further proposed to install pressure-relief valves of the spring-disc type at break-pressure tanks and at other selected points along the pipeline, as an additional safety measure against the occurrence of water hammer.

4.19. The cathodic protection system of the pipeline using sacrificial anodes was found to have deteriorated and a major programme of rehabilitation at an estimated cost of £5,000 per annum over a period of three years was initiated.

4.20. Major improvements to the Mrere pipeline access road at a cost of £17,500 were also undertaken.

4.21. *New Developments.*—Whilst, during the year under review, there was no major change in the installations of the Board, the Board, nevertheless, discussed and agreed an extension of its supplies from the Mzima pipeline to Sokoke just north of Kilifi.

4.22. This scheme, at an estimated cost of £300,000, has been designed by the Director of Water Development to provide water to the densely populated Coast Hinterland between Mazeras and Sokoke, to the Sokoke, Roka and other settlement areas, and also to replace the existing unsatisfactory water supply to Kilifi Township. The locations of Rabai, Ruruma, Kaloleni and Chonyi will also be amongst those commanded by the proposed new system. The installation of the supply will bring much benefit to the area concerned, as at present, the populace rely on springs, streams, wells, dams and rainwater for their requirements. All the present sources of supply are untreated, and diseases such as gastro-enteritis are rife. The installation of a good-quality water supply will not only benefit the existing population, but will encourage further development, including the development of such tourist potential as the area may have.

4.23. At the end of the year, negotiations were in hand to secure the necessary finance.

Non-Gazetted Water Supplies

4.24. (i) Four non-Gazetted water supplies for small townships namely, Lodwar, Olokurto, Wanguru and Mandera, and which are non-revenue-earning, are operated by the Department. The total expenditure on operation and maintenance was £3,171.

(ii) A new water supply for Lodwar was completed at a total cost of £6,500. The plant comprised portable electric pumping units to pump from temporary wells in the Turkwell River bed during periods of no flow. Provision has been made for pumping to take place from wells over a 1,000 feet stretch of river. The raw water is pumped to the treatment works consisting of detritus channels, coagulation basins and rapid gravity filters. After chlorination, the treated water is pumped to the township. Power is provided by electricity generators.

Institutional Water Supplies

4.25. In addition to Gazetted water supplies, the Director of Water Development is responsible for the design and operation of water supplies for Government institutions such as schools, hospitals, military cantonments and police establishments; funds for this purpose being provided by the respective Ministries. Some supplies are operated on behalf of county councils.

4.26. The number of institutional supplies so operated and/or maintained was 45, and the cost of operation and maintenance was £19,146.

4.27. The total expenditure of £23,958 was incurred on new works which included £6,827 for the first-phase drilling of boreholes on behalf of the new Chemilil Sugar Company factory and £7,730 for drilling and equipping of boreholes on behalf of the Ministry of Works for the Nairobi to Mombasa Road project.

4.28. Investigations were carried out on behalf of the Ministry of Education in connexion with the water supply to 92 schools.

4.29. *North Samburu Boreholes.*—Nine boreholes in the North Samburu area are operated to serve as watering points for cattle in times of drought. The cost of operation and maintenance of these boreholes was £12,061.

4.30. *Subdivision of Lands.*—Under the Land Planning Regulations, no subdivision of land may take place without the guarantee of an adequate water supply. After investigation the Department gave advice and recommendations to the central authority in respect of 46 applications.

5. Rural Water Supplies

General

5.1. In the period under review, the capital value of works completed by the rural water supplies section was as follows:—

Dams—£13,500, Piping Schemes—£27,500, Minor Works—£11,250.

5.2. The cost of operating the No. 1 Dam Construction Unit in the construction of 11 dams to a value of £13,500 was £14,700.

5.3. The cost of operating the Dixey Unit in desilting existing pans and dams for a period of nine months was £11,100. The unit earned £1,760 in revenue for new works.

5.4. The Department, through its rural water supplies section, works very closely with the range management division of the Ministry of Agriculture and Animal Husbandry on water development projects in the semi-arid areas where ranching is the basis of the local economy. Surveys and designs followed by construction are carried out by the Department at the request of the range management division who also provide the funds.

Coast Province

5.5. Early in the period under review a technical officer together with subordinate staff was posted to Mombasa, to work under the direction of the district hydraulic engineer, Coast Province, for surveying and designing dams and pipelines in the rural areas of the province.

Taita District

5.6. *Josa Scheme.*—Phase II of this scheme has now been completed. The work was carried out by the district health inspector using materials supplied by the W.H.O. and money supplied by the county council to a design prepared by the Department. It is expected that Phase III of the scheme will be started shortly at a cost of £1,328, to be supplied by the county council.

5.7. *Lualeni Grazing Scheme.*—Two new boreholes were sited and drilled for the range management division. One proved a failure, while the second proved to be successful, giving a yield of over 2,000 gallons of water per hour. A schedule of machinery to extract this water has been prepared, and it is intended that the equipping will commence as soon as the range management division make the necessary money (£1,500) available. The deepening of the existing borehole proved unsuccessful as it did not produce the anticipated increased yield.

5.8. *Oza Pipeline.*—The survey and design for a 12-mile pipeline, to water 6,000 head of cattle, to the south-west from Taita Hills was completed for the range management division. The estimated cost of the installation is £11,750.

5.9. *Kajire Pipeline.*—A five-mile extension to the existing Kajire Pipeline near the Sagalla Hills was surveyed and designed for the range management division. The estimated cost of this extension is £3,000.

5.10. *Mwanda Market.*—The survey and design for an improved water supply for Mwanda Market in the Taita Hills was carried out for the district health department.

5.11. *Mwatate Trading Centre.*—The survey and design of a water supply to the trading centre was completed. The installation of the supply will cost £4,100.

Kwale District

5.12. *Shimba Hills.*—The survey and design of the Majimboni-Jilore water supply was finalized. It is hoped that the Central Agricultural Board will make the necessary funds (£9,100) available to enable installation to commence early in the 1966-67 financial year.

5.13. *Kurase Triangle.*—During the latter half of June 1966 the dam construction unit moved into the Kurase Triangle to construct experimental tank-dams for the range management division. A trial borehole was sited near Kurase Rock and drilling will begin early in July with £4,000 provided by the Ministry of Agriculture.

Kilifi District

5.14. *Kilifi Settlement Scheme.*—The survey and design of a 22-mile pipeline from Gede to Roka settlement area was completed. Funds to the value of £12,500 are available and work will commence on the installation of the Gede-Penda Kula section early in the 1966/67 financial year.

5.15. *Kilifi Hinterland.*—Eleven earth dams, with capacities between two and 12 million gallons, were constructed by the dam construction unit. These were financed from funds made available by the Ministry of Agriculture and the Kilifi County Council. In addition, the Department constructed a mass concrete weir at Mwembekati which will contain approximately two million gallons of water. The capital value of this work was approximately £13,500.

Eastern Province

Marsabit District

5.16. The Department has a senior inspector of water supplies stationed in the district who, in addition to maintaining the various existing water supplies, advises and assists the county council on the installation of new supplies.

Kitui District

5.17. *Mbitini Pipeline.*—Two wells dug by county council staff near the Nzeo River were test-pumped by the Department. These wells will be the source for the Mbitini Pipeline which was also surveyed and designed. The full scheme which ends at Mbitini School, is expected to cost £14,000.

Embu District

5.18. *West Mvuria Grazing Scheme.*—The installation of a ram and pipeline together with the construction of a 10,000-gallon storage tank and 30-foot-long cattle troughs were completed at a cost of £1,500 for the range management division. Funds for the scheme were made available by the county council.

5.19. *Ngandori Reticulation Scheme.*—The design of this major scheme was completed. It is estimated that the cost of supplying piped water to the 5,100 small-holdings in the area would be about £217,000.

Machakos District

5.20. *Chai Irrigation.*—The aqueduct on the Chai Furrow was destroyed for the fourth time in five years by the irresponsible actions of some of the local people. The irrigators have agreed to finance the construction of a new structure designed by the Department which will be carried out with help from the staff and management of Dwa Plantations Ltd., who are providing an artizan and equipment.

5.21. *Mulala Valley.*—The Department gave technical advice to a self-help group of residents of Mulala Valley in Mbitini Location on how the dry river-bed in the valley could be used to store flood waters, by the construction of a series of concrete weirs. This has the long-term possibility of turning the present dry river into a permanent stream.

Central Province

Kirinyaga District

5.22. *South Ngariama Grazing Scheme.*—The work on extending this supply to the centre of a four-block rotational grazing scheme was completed. The work was carried out on behalf of the range management division, at a cost of £1,800.

Kiambu District

5.23. *Uthiru Township.*—A survey and design was completed to supply water to Uthiru Township, at a cost of £7,250. This is one of the fast-developing dormitory towns on the outskirts of Nairobi. Loan funds will be available to the county council in the 1966/67 financial year, and subject to the loan being taken up, the Department will install the supply.

Rift Valley Province

Kajiado District

5.24. A senior inspector of water supplies has been working full time in the district since January, assisting the county council to re-organize their water supplies. He has inspected all the boreholes in the district and supervised the necessary maintenance and repairs.

5.25. *Sultan Hamud Area.*—The pipeline from the railway tank east of Emali Township to a storage tank and cattle trough in the eastern section of the Poka Group Ranch was installed for the range management division at a cost of £600.

5.26. A half-mile long pipeline was installed at a cost of £500 to carry water to the south-west of the Sultan Hamud—Loitokitok Road about three miles from Sultan Hamud. This will stop infiltration into the Masai ranches, north-east of the road, by outsiders in search of water and will greatly help to reduce the risk of disease.

5.27. Borehole No. C.3339 at Manone was fully equipped and is working successfully. The petrol engine on borehole C.3 was changed for a more reliable diesel unit.

5.28. Boreholes C.1061 and C.3338 remain undeveloped; the money to equip them is still awaited from the range management division.

5.29. *Matapatu.*—Work was completed early in the year on the nine-mile pipeline from a spring in the Mabarasha Hills to a storage tank at the Ilbisil Trading Centre. En route the pipeline serves 11 individual ranches. The cost of this installation was £9,250.

5.30. *Meto.*—Meto is a small trading centre on the Tanzania border west of Namanga. The design was completed to pipe water from a spring two miles within Tanzania to Meto. The installation of the supply is estimated to cost £4,500. An application to extract the water has been made to the Tanzania authorities. Work will start on the installation as soon as the permit has been received. Financial assistance is being provided by the Olkejuado County Council and the United States Agency for International Development.

5.31. *Turoka Boreholes.*—The Magadi Soda Company Ltd., handed over the three boreholes at Turoka to the Olkejuado County Council. The boreholes are capable of producing large quantities of water but the machinery had fallen into disrepair. The machinery was repaired at a cost of over Sh. 2,500.

5.32. *Chief Maora's Borehole.*—A borehole was drilled at a cost of £8,150 for the Chief and two other ranchers to supply water to their ranches. Funds for drilling were provided by the Agricultural Finance Corporation. The borehole was successful. The work on equipping and the laying of the distribution pipelines is in progress.

5.33. *Ngong Area.*—Two small water supplies were designed for individual farmers. A survey is in hand to appraise the water potential of the country between the Ngong Hills and the Mbagathi River.

5.34. *Kajiado Area.*—A number of springs were inspected and gauged to the south-east of Oldonararu, and to the north-west of El Donyo-Narok Hill. The information was required by the range management division for the proposed ranching schemes in the area.

5.35. *Magadi Area-Nguruman.*—The gabion weir, necessary to divert water into the new irrigation furrow, was constructed by the Department. The digging of the furrow and the irrigation generally are being carried out by the Soil Conservation Service and the Department of Agriculture.

5.36. *Irrigation at Loitokitok.*—A further investigation and survey of the dam site for the proposed Rombo irrigation scheme was carried out and a design prepared. The diversion weir for the Kimana irrigation scheme was completed and the excavation of the main canal is progressing satisfactorily. This work is being carried out on behalf of the Agricultural Department.

Narok District

5.37. A number of streams and springs were gauged in the Kilgoris area with a view to using their waters to augment the existing township supply.

5.38. *Cis Mara.*—The water supply to the Lemek Trading Centre was redesigned to give an adequate and permanent supply, at an estimated cost of £1,350.

Uasin Gishu District

5.39. *Tinderet.*—A survey was carried out at the request of the Central Agricultural Board for a proposed pipeline from a borehole to the police station, school, and a group of farms in the Burnt Forest area 3½ miles away.

5.40. *Turkana District.*—Six wells on the Khayekhorongole irrigation scheme were test pumped at about 2,000 gallons per hour each. Experiments are continuing on perfecting an animal-driven type of pump. Two types are at present being tested with varying degrees of success. A windmill has also been erected for trial purposes.

5.41. In January a mobile drilling rig, generously donated by Oxfam, was sent to the district. Two boreholes were drilled one at Lorogumu Mission and the other at Lorengippe. The former gave a yield of 700 g.p.h. while trouble was experienced with running sand at the latter.

5.42. The reorganization of a district team for water development outside the special schemes was started in May and a considerable amount of equipment purchased.

Western Province

Kakamega District

5.43. *Kiboswa.*—Two piping schemes were surveyed and designed, one to supply the fast-developing Kiboswa Market and Nyangoro Mission Boarding School, and the other, the high-density farming area of the Tigoi Ridge, at a combined cost of £6,500. An additional amount of £750 will be required to distribute water within the market area. It is estimated that the annual operating cost of the scheme will be approximately £700.

Nyanza Province

Kisii District

5.44. A pipeline was designed to supply water to a mission boarding school and a new soapstone co-operative at Tabaka at an estimated cost of £1,950. The water will be pumped from a spring to the mission and then reticulated to the co-operative's factory.

South Nyanza District

5.45. *West Karachuonyo Location.*—With the sum of £4.500 provided as a free grant from Government, two boreholes were sited and drilling started on the eastern flank of Homa Mountain. The first, at Pala, was completed and produces 1,100 gallons per hour. The boreholes will be equipped by the Department.

Central Nyanza District

5.46. *Karadolo Sublocation.*—The survey of a proposed pipeline to supply water to 1,500 people and 500 head of stock from Mauna Dam was completed. The design and costing is now being compiled.

5.47. *Kibigori.*—A reticulated water supply for the Kibigori sugar settlement area was surveyed and designed. The estimated cost of the scheme is £12,000.

General

5.48. During the period under review the Dixey Unit completed the following works in the province:—

New pans constructed ...	3	Pan repaired	5
Pans de-silted	6	Airstrips constructed or repaired ...	5

5.49. As a result of special visits to the province with officers of other Ministries, a paper (reference ALD/NE/72/53 of 1st April 1966) was prepared putting forward proposals for a concerted water development programme for the province. This includes basic water supplies for the grazing areas, water supplies to expanding townships and trading centres, and water supplies for the provincial stock route which will have an important bearing on the province's main source of income, i.e. the stock trade. The implementation of these proposals will depend on the availability of funds, staff, and improvement of the security situation.

5.50. Detailed proposals were made for the following:—

Mandera District

(*a*) Mandera Township water supply from wells on the Daua Palma River.

(*b*) Water supply at Takaba.

(*c*) Irrigation investigations on the Daua Palma at Ramu.

(*d*) The installation of an experimental mechanical pump on one of the wells at El Wak.

Wajir District

(*a*) Improvement of the wells at Buna.

(*b*) Proposals for additional pans and tanks to serve the Stock Route between Wajir and Garissa.

Settlement Schemes

5.51. An officer seconded to the Ministry of Lands and Settlement has been fully employed throughout the period, and was assisted from time to time by additional survey staff provided by the Department.

5.52. The following schemes were completed or were nearing completion at the end of June 1966:—

1. Lessos, Keben and Koylat schemes (Eldoret area).
2. Waraza scheme (Nyeri area).
3. Leitego scheme (Sotik area).
4. Mua Hills Complex (Machakos).
5. Webber's Farm (Machakos).
6. Passenga (Dundori).

5.53. Surveys and designs for six new schemes were completed as follows:—

1. Suwerwa (Kitale).
2. Uaso Nyiro (Mweiga).
3. Gelegele (Sotik).
4. Shamata, Pesi, Simbara, Kanyaigia, Ndaragwa (930 farms in Thomson's Falls area).
5. Lari (Uplands).
6. Nyairoko (Dundori).

5.54. The following schemes are now at the design stage:—

1. Central Nyanza Schemes.
2. Maragua Ridge.
3. Koyet.
4. Western Region Schemes (covering 8,000 farms).

Dixey Unit

5.55. The Dixey Unit is the Department's unit of heavy earth-moving equipment which works primarily in the North-Eastern Province. Due to the security situation in the province over the last few years the unit was not fully employed and was closed down throughout 1964-65. With the continued need to keep pans in good repair and to press on with development, the unit was reorganized and was fully employed in the 1965/66 financial year. A special force of security guards (two platoons), has had to be employed on a full-time basis.

5.56. The unit took the field on the 6th August 1965, since then it has been continuously employed in the Wajir District, except for a short period in the Moyale area of Marsabit district.

5.57. The unit's primary commitment is the de-silting of existing pans and dams that were built earlier under the original Dixey scheme, but in the interests of efficiency the construction of new pans which may lie along the unit's route is also undertaken in order to provide the best possible coverage of water supplies within the area of operations.

5.58. In the Wajir District the unit built three large pans in the Lak Bogal drainage way for the North-Eastern Province stock route, the cost of which (£1,760) was paid by the Veterinary Department. The largest of these pans will act as a silt trap, and hence will reduce the need for cleaning the other two at frequent intervals.

5.59. A new pan was also dug at Yago to replace one which could not be cleaned out; and a small new pan was constructed at Garissa.

5.60. The following pans were de-silted:—

Dobel (Moyale).	Halati (Buna).
Bunana.	Dela.
Gersiaki (Buna).	Dugis (Garissa).

5.61. The pans listed below, which contained water when the unit was in the area, had their drains and approaches cleaned and repaired:—

Bamba Gurar.	Dadacha.
Karandusi.	Mudo.
Wapagasi.	

5.62. Due to the security situation and the need to improve communications, the unit also constructed two airstrips in the vicinity of Gurar, one to the north of the police post and a 1,000-yard strip near the pan at Bamba Gurar, as well as clearing four miles of track. The unit also levelled and cleared the airstrips at Moyale and Buna, built a new airstrip at Ijara, and carried out some bush clearing near Garissa.

5.63 *Summary of Work Done*:—

New pans constructed ...	3	Pans repaired	5
Pans de-silted	6	Airstrips constructed or improved ...	5

Expenditure

5.64. Expenditure for the year amounted to Sh. 385,100 of which Sh. 132,000 was the payment for the two platoons of police escort attached to the unit for the full financial year. This means that the actual operating expenditure was Sh. 253,100.

5.65. The number of tractor hours performed by the machines was 3,850 which included 430 hours of travelling time.

5.66. The estimated quantity of earth moved was 130,000 cubic yards.

5.67. From the operating figures for the first nine months the following costings are calculated:—

Cost per tractor hour	Sh. 72
Cubic yards moved per hour (excl. travelling time)	Sh. 47
Cost per cubic yard (inc. travelling time)	Sh. 2/02

5.68. The records for the period 1954 to 1964 show that the unit was able to attend to an average of only six pans per annum, with the best year in 1962 when six pans were desilted and two new pans constructed.

5.69. It is to be noted that the annual expenditure for that period was about £25,000 excluding security guard costs which did not then apply. Compared with this record, the performance as described for the first nine months of 1965/66 can be said to be satisfactory.

No. 1 Dam Construction Unit

5.70. Unlike the Dixey Unit, this unit works on an appropriation in aid basis and is expected to recover its running costs by charging a fee which is at present Sh. 75 per tractor hour.

5.71. In August 1965 the dam unit moved from Nyanza, where it had been building a protective bund for the Yala Swamp project, to Kilifi District in the Coast Province. From the period September 1965 to May 1966 the unit built eleven dams of varying capacities of between two and 12 million gallons, five of which were financed by the county council of Kilifi at a cost of Sh. 137,729/50, and the other six by the Agricultural Department at a cost of Sh. 132,175 making up a total cost of Sh. 269,904/50 for the 11 dams.

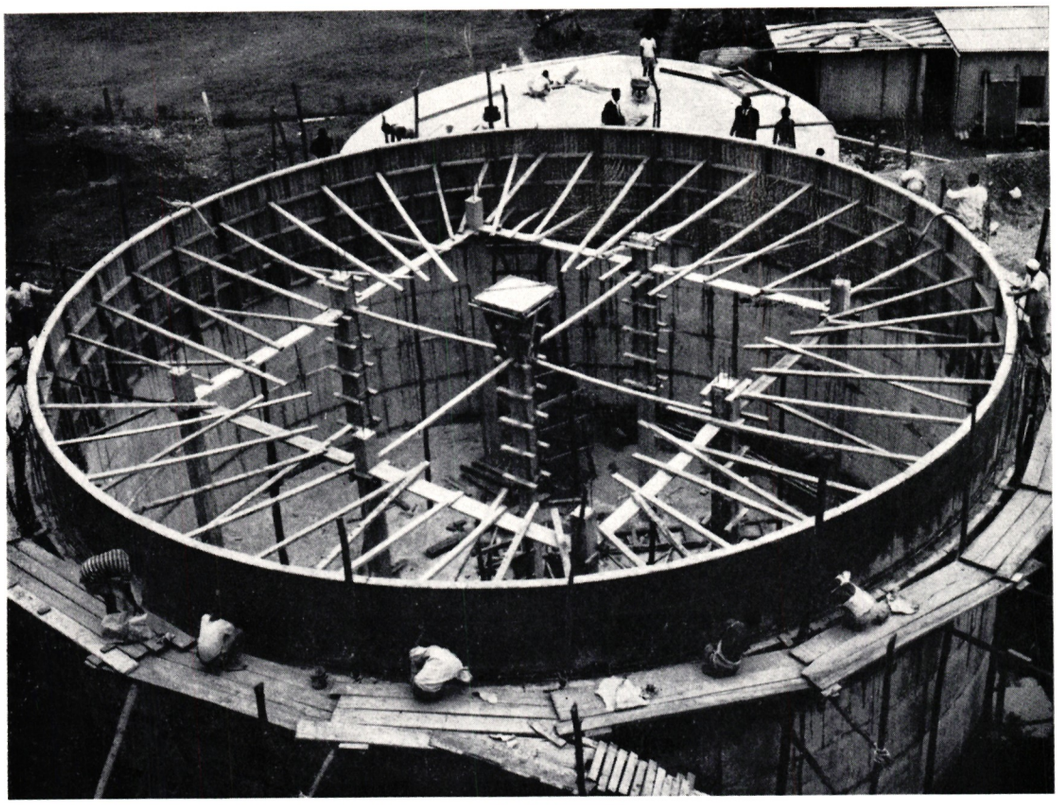


Fig. 1.—AUGMENTATION OF KAKAMEGA WATER SUPPLY.—Work in progress on the construction of one of the two quarter million gallon storage reservoirs being built as the first phase of this scheme.

Fig. 2.—A typical installation of borehole pumping equipment for an individual ranching project.

Fig. 3.—A typical mass gravity weir constructed with the Departments' advice and assistance for water conservation in a normally dry stream bed with cattle trough in foreground.

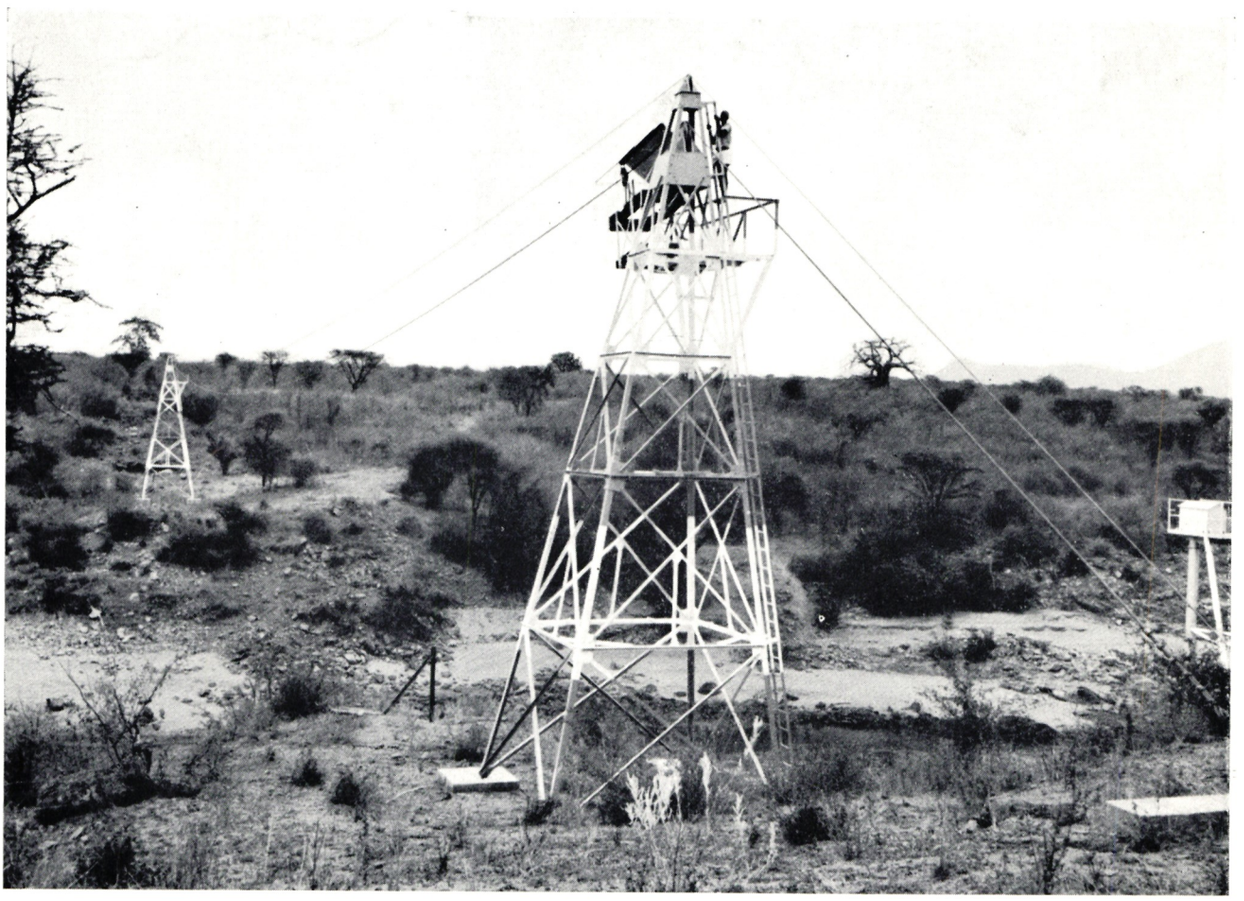


Fig. 4.—The Regular Gauging Station at Grand Falls on the Tana River showing Recorder and Cable Way.

Fig. 5.—The Regular Gauging Station on Lake Chala showing the Water Level Recorder.

Fig. 6.—ISOTOPE INVESTIGATION OF THE HYDROLOGY OF LAKE CHAKA. Sampling the lake water for Tritium Concentration.

Fig. 7.—MWEA IRRIGATION SCHEME.—Long Crest "Horseshoe" Weir giving Minimum Level Variation with Full Flow Range.
(Flow Range 0–150 cusecs: level variation 0.45 feet.)

Fig. 8.—PERKERRA IRRIGATION SCHEME.—Infiltration tests and furrow application trials in progress.

5.72. In the course of construction 62,000 cubic yards of earth were moved, at an average cost of Sh. 4 per cubic yard.

5.73. The unit's lorry transport travelled 4,198 miles, carrying water, stores, etc., and earned in revenue Sh. 20,990, at the rate of Sh. 5 per mile.

5.74. The total expenditure for the unit's operations for the financial year 1965/66 was:—

	Sh.	*cts.*
Recurrent expenditure	173,118	25
Capital expenditure	120,960	00
Total expenditure	294,078	25
Total revenue earned	269,904	50

6. Hydrology

General

6.1. The main emphasis of the work during the year has been on the improvement of gauging facilities and installation of water-level recorders at the existing stations to ensure reliability of collected data, and on the rating of these stations. Twelve new stations were opened during the year and six of these were equipped with automatic water-level recorders. Three full hydrometeorological stations were also opened.

The Hydrological Network

6.2. Hydrological stations in operation in each drainage area at the end of the year were as follows:—

Table A

Type	Drainage Area					
	1	2	3	4	5	Total
Regular gauging stations ..	107	57	75	96	45	380
Water-level recorders ..	10	2	6	19	8	45
Standard rain gauges* ..	30	18	39	56	41	184
Autographic rain gauges ..	13	2	4	12	3	34
Storage rain gauges† ..	—	—	1	21	20	42
Evaporation pans	18	13	20	15	8	74
Full hydro-meteorological ..	1	1	4	4	2	12

Drainage areas referred to in the Hydrological network are shown on the map at Appendix VIII.
* These are additional to those operated by the East African Meteorological Department.
† Read infrequently.

6.3. In addition to the collection of daily observations at the stations listed in Table A, the following field gaugings and observations were carried out:—

TABLE B

Item	Drainage Area					
	1	2	3	4	5	Total
Current meter gaugings ..	330	152	117	230	134	963
Silt samples	12	18	8	223	77	338
Cross-sections	9	—	—	5	8	22
Water samples	14	6	64	6	3	93

6.4. Routine computations were made for all stations given in Table A. 963 current meter gaugings were checked and plotted on discharge curves. Based on these, and previous gaugings, rating tables were compiled for 13 regular gauging stations and discharge entries for these were brought up-to-date. Twelve current meter rating tables were also prepared. Hydrographs were drawn for 39 stations. Rainfall intensity charts were analysed for 348 station years.

6.5. *Mt. Kenya Rainfall.*—Annual totals of rainfall were calculated for 26 storage rain gauges which are located along various tracks leading to the peak. Based on these, as well as on data from other standard rain gauges down the slopes in the area, isohyetal maps were prepared for the years 1962, 1963 and 1964.

6.6. *Rainfall Probability.*—Preliminary probability analysis was carried out of monthly rainfall at Ahero station in connexion with the Kano pilot irrigation scheme.

6.7. *Design Floods for Road Bridges.*—At the request of the Ministry of Works, flood studies were carried out for 70 proposed bridge sites in Kenya, and recommendations on design floods for these were made to the Chief Engineer (Roads).

6.8. *Hydropower Potential.*—Records of flow at 26 regular gauging stations were analysed, tabulated and sent to the Chief Engineer, Ministry of Works to enable him to complete an assessment of hydropower potential of Kenya.

The Hydrometeorological Survey of the Equatorial Lakes

6.9. This five-year project is being undertaken with the assistance of the United Nations development programme, the World Meteorological Organization being designated the executing agency.

6.10. The project concerns the hydrometeorological survey of the catchments of lakes Victoria, Kioga and Albert and the five participating countries are the Republics of Kenya, Tanzania, Uganda, United Arab Republic and Sudan.

6.11. Data on the Equatorial lakes of the Nile have considerable international significance. With a surface area of 67,000 sq. km. (26,000 square miles) Lake Victoria is the second largest freshwater lake in the world. The area of the catchments as a whole is approximately 325,000 sq. km. (126,000 square miles). The White Nile, fed and regulated by these lakes flows out of Uganda into the Sudan and thence, after being joined by the Blue Nile, into the United Arab Republic. The areal scope of the survey is shown at Appendix XXI.

6.12. The purpose of the survey is to collect hydrometeorological data to enable study of the water balance of the lakes; to enable planning of water conservation and development and to assist the participating countries in future negotiations on Nile water storage and control of the lakes.

6.13. The first meeting of the technical committee, on which the Government of Kenya is represented by the Director of Water Development, took place in Entebbe in April 1966 when terms of reference and rules of procedure were drawn up.

6.14. A project manager will be shortly appointed and a detailed plan of operation can then be prepared.

The Nile Waters

6.15. The East African Nile Waters Co-ordinating Committee at technical level, on which Kenya is represented by the Director of Water Development, is concerned with the control and allocation of the Nile waters and liaises with the Permanent Joint Technical Commission for the Nile representing the Sudan and the United Arab Republic.

6.16. One matter with which the committee is vitally concerned is the high level of Lake Victoria.

6.17. The level of Lake Victoria rose by one metre (39 inches) in three months as a result of extremely heavy rainfall over the catchment in 1961 and caused extensive flooding of lake-shore areas. The level continued to rise due to the above-average rainfall totals during the subsequent years, and the lake reached its peak level in May 1964. It was then 1.43 m. (56 inches) above the maximum level attained prior to 1961, and since records were commenced in 1899. At its peak level, the lake was 0.07 m. (approximately 3 inches) above the design maximum water level of Owen Falls Dam.

6.18. The level has fallen gradually since May 1964. The actual readings at Entebbe show a fall of 0.55 m. (22 inches) between the maximum recorded levels in 1964 and 1966. This means that, despite the fall, the present level is 0.88 m. (34 inches) higher than the maximum level recorded on the Entebbe gauge prior to the construction of the Owen Falls Dam. A graph showing Lake Victoria levels may be found at Appendix XX.

6.19. A technical standing subcommittee was set up in 1964 to consider practical ways and means of dealing with existing and future high lake levels. Some trial regulations have been carried out by computer processing designed to avoid the recurrence of excessively high or low lake levels.

6.20. The present system of regulation is based on run-of-the-river.

The International Hydrological Decade

6.21. A national committee for the decade was formed during the year, and the Department was represented by the following officers:—

Mr. R. Barrett	... ...	Director
Mr. T. G. Davis	... ...	Assistant Director (Secretary)
Mr. D. R. L. Prabhakar	... ...	Superintending Hydrologist

6.22. The Department submitted its programme for the decade to U.N.E.S.C.O. through the national committee. The decade stations and representative basins selected as part of the decade programme are shown in Table C.

Hydrological Research

6.23. The two experimental basins set up by E.A.A.F.R.O. at Kimakia and Kericho with the assistance of the Water Development Department are being continued. The hydrological effects of changes in land use are being studied.

TABLE C—THE INTERNATIONAL HYDROLOGICAL DECADE
(*Decade Stations and Representative Basins*)

Drainage Area	Regular Gauging Station	River	Catchment Area (*Sq. Miles*)	Hydro-Met. Station
No. 1 ..	1.BG.7	Ewaso Rongai	264	Eldoret.
	1.DA.2	Nzoia	3,250	
	1.EE.1	Nzoia	4,576	
	1.FG.2	Yala	1,106	Kericho.
	1.JG.1	Sondu	1,269	
No. 2 ..	2.GB.1	Melawa	601	
	*2.GC.4	Turasha	280	Naivasha.
No. 3 ..	*3.AA.4	Mbagathi	105	Muguga.
	3.DA.2	Athi	2,210	Machakos.
	3.J.15C	Lumi	178	Oloitokitok.
	3.MH.10	Manolo	246	Mombasa.
No. 4 ..	*4.AA.5	Sagana	195	Mwea Tebere
	4.BC.2	Tana Sagana	913	Garissa.
	4.ED.3	Tana Kamburu	3,500	Wayu.
	4.F.13	Tana Grand Falls	6,553	Galole.
	*4.H.1	Kalundu	12	Kitui.
No. 5 ..	5.AA.1	Ewaso Narok	215	Rumuruti.
	5.BC.8	Ngobit	100	
	5.BE.20	Nanyuki	332	Lamuria.
	5.D.5	Ewaso Ng'iro	1,761	
	5.E.3	Ewaso Ng'iro	5,800	

*Representative Basin.

6.24. Other research projects have been initiated on the following subjects:—

(i) Areal evaporation patterns.

(ii) Rainfall depth duration frequencies.

(iii) Swamp transpiration.

(iv) Drought frequencies and distribution patterns.

Investigations

6.25. The following investigations were undertaken during the year:—

(*a*) *Oloitokitok Area.*—Further studies of the water resources of the area were made and collated with the previous information and a report was prepared.

(*b*) *Taveta Area.*— A further investigation into the flow of the Lumi River and springs was undertaken and notes were prepared on the present state of the channels.

(*c*) *Tana River.*—The Department took over the responsibility for the hydrology of the Middle and Lower Tana Catchment in December 1965, from the U.N.S.F./F.A.O. project. Early in 1966, sites were selected and automatic water-level recorders were installed on the following rivers—

(i) Mutonga River.

(ii) Kazita River.

(iii) Thiba River.

(iv) Thika River.

6.26. Intensive gauging and silt sampling programmes were carried out at all the newly established stations.

Publications

6.27. Bi-annual publication of stream flow records at selected regular gauging stations and circulation thereof was continued during the year.

Guide to Hydrometeorological Practices

6.28. Comprehensive instuction notes on hydrometeorological instruments and their field layout were prepared and issued to all hydrological staff.

7. Irrigation

General

7.1. Although the policy for irrigation development is the responsibility of the Ministry of Agriculture and Animal Husbandry, the Department gives technical advice and provides all the associated engineering services, and there is a continuing programme for the extension of existing schemes and development of new projects.

7.2. The more important activities during the year were largely concerned with the two United Nations special fund projects, namely, the survey of the irrigation potential of the Lower Tana River Basin and the survey and pilot demonstration schemes leading to the reclamation of the Yala Swamp. The Superintending Engineer (Irrigation) was appointed co-manager to both these projects.

7.3. Other activities included advising the Ministry of Agriculture and Animal Husbandry on several schemes and carrying out special investigations for other sections and Departments.

The Survey of the Irrigation Potential of the Lower Tana River Basin

7.4. The survey of the irrigation potential of the Lower Tana River Basin, which was undertaken with the assistance of the United Nations special fund and with the Food and Agriculture Organization acting as the executing agency, was completed towards the end of 1965. An interim report was published in 1965, and the final report is expected to be released by the middle of 1967.

7.5. The purpose of the survey is to assess the potential for irrigated agriculture of some 200,000 acres (312 square miles) of land in the Galole area where virtually no development has so far taken place.

7.6. The Department provided the co-manager, hydrological assistance, surveys and other essential services for the investigations.

The Surveys and Pilot Demonstration Schemes Leading to the Reclamation of the Yala Swamp

7.7. This project is being undertaken with the assistance of the United Nations Development Programme/Food and Agriculture Organization.

7.8. The Yala Swamp is an area of about 84 square miles flooded permanently by the Yala River which ends in it, and exceptionally by the Nzoia River which runs round its northern edge. The level of the swamp is 12 feet above the highest level of Lake Victoria, from which it is separated by a narrow strip of land, less than one mile in width. The swamp is covered by a dense growth of papyrus.

7.9. The first project to be completed by 1968, envisages:—

(i) the detailed surveys and planning for the diversion of the Yala River before it enters the swamp and Lake Victoria.

(ii) the establishment of a pilot demonstration area of 500 acres to investigate the agricultural potential of the drained swamp and the adaptation of crops for irrigated agriculture, including the economic aspects of farming; and

(iii) the establishment of a separate pilot scheme of 500 acres in Bunyala with pumped irrigation from the Nzoia River.

7.10. If the results of the first project are promising, a second follow-up project will be prepared and submitted to the United Nations Development Programme for the implementation of surface drainage of the total area of the swamp, detailed topographic and soil surveys and the preparation of detailed plans for drainage, irrigation settlement and infra structure of the area. The net area will be about 62 square miles.

7.11. The project commenced in January 1966, and the Department has provided the co-manager, the resident irrigation engineer, surveys and other essential services. The main activity during the year under review has been the preparation of hydrographical and topographical surveys.

Mwea Irrigation Extensions

7.12. The work comprised the survey, planning and construction of fields, distribution system and drainage for extensions to Blocks 2A and 4. The total number of acres completed was 440; but work on an additional 850 acres reached various stages of completion. The work was carried out under the supervision of the Department partly by direct and convict labour and partly by earth-moving and petty contracts. Funds expended totalled £21,000.

Perkerra Irrigation Extension

7.13. Work comprised the planning, setting out and supervision of construction of fields, distribution system and drainage for a 250-acre extension. The work completed was equivalent to 100 acres. The actual operations were financed, manned and equipped by the Department of Agriculture through the scheme manager. The total expenditure was £3,500 of which £200 was spent by this Department.

Minor Activities

7.14. The following minor activities were undertaken by the section:—

(*a*) *Yatta Furrow Irrigation.*—The section assisted in the drafting of proposals for two 20-acre pilot areas and arranged for surveys, prepared layouts and structural designs and advised on engineering matters generally.

(*b*) *Taveta Irrigation.*—A report was prepared on the present situation and future possibilities on this high-potential area.

(*c*) *Tebere Red Soils.*—Tentative plans and estimates for overhead irrigation of these extremely porous soils were prepared.

(*d*) *Kano Plains Pilot Scheme.*—The compilation of hydrological and irrigation data and a study of the general problems were initiated towards the end of the period under review.

(*e*) *Dam Design.*—The section continued its function as engineering adviser to the Water Apportionment Board on dam construction applications.

(*f*) *General.*—Assistance and advice was rendered to H.E. the President, the National Parks and other Government Departments and individuals.

Scientific Research and Documentation

7.15. Much work was done on the following aspects of irrigation science:—

(*a*) Crop-water use (particularly with regard to rice at Mwea).

(*b*) Soil-moisture characteristics (infiltration, availability).

(*c*) Design features of overhead systems.

7.16. Documentation and cataloguing of local irrigation practices and specifications were commenced.

8. Hydrogeology

General

8.1. Kenya is fortunate in that it possesses extensive ground water resources which with the exception of the Nairobi area, where conservation measures have been implemented, are under-developed. The mean water table is about 260 ft. below surface, which is considerably deeper than that generally obtaining in the remainder of the African Continent.

8.2. The drilling of boreholes in Kenya commenced in 1927 and to the end of June 1966, 3,391 boreholes have been drilled and 75 per cent of these were successful.

Drilling Contractors

8.3. Legislation was enacted at an early date which provided for the licensing of drilling contractors and for the submission of records and strata samples for every borehole drilled. Such records have proved invaluable.

Borehole Subsidy Scheme

8.4. The development of ground water sources is encouraged by a borehole subsidy scheme under which, if a borehole sited for a farmer by a geologist of the hydrogeology section is a complete failure, Government pays 75 per cent of the cost of the borehole.

The Work of the Hydrogeology Section

8.5. The hydrogeology section is responsible for the keeping of all records relating to ground water development, and has from time to time and according to availability of staff, undertaken regional ground water surveys and geological mapping in selected areas of the country. Some of the reports have been published and are available to the public, others of a less important nature are filed in the Department's archives.

8.6. In the Nairobi ground water conservation area there exists the risk of ground water depletion because of the large number of boreholes that were drilled in the past. Abstraction from all boreholes is now controlled and the section has the responsibility of carrying out regular measurements and inspections on selected boreholes to record fluctuations in the water table, so that should it become necessary, further restrictions can be imposed without delay.

8.7. In addition to normal geological mapping and interpretation, geophysical surveys are carried out using the resistivity and magnetic methods and considerable use is made of the excellent aerial photographs of the country, available from the Survey of Kenya, in the interpretation of structure and recharge.

8.8. In early 1965, the section suffered a serious loss due to the departure of the senior geologist, leaving only two men out of an establishment of four to deal with an increasing volume of work. Despite this, nearly all requests from the public and from Government Departments were dealt with expeditiously, and the essential records were maintained though there was inevitably a set-back in the classification, processing and recording of geological data as it became available.

Borehole Siting in 1965/66

8.9. Applications for borehole siting under the subsidy scheme are frequently made in ignorance of alternative sources of water for a farming or ranching project, and in many instances the geologist was able to indicate such alternative sources as being much more economical than the drilling of a borehole. The following table shows the volume of work carried out. A considerable number of investigations were unproductive in that, having applied for a borehole to be sited, the farmer concerned was unable to raise the necessary funds to carry out the work. At the present time, the average cost of drilling and equipping a borehole is £2,000.

Table D—Borehole Siting Application 1965/66

	Applications	Investigations	Aprovals	Drilled
(i) Subsidy Scheme ..	39	27	22	9
(ii) Non-subsidy	8	8	—	3
(iii) Official	12	9	—	8

TABLE E—BOREHOLE SUBSIDY SCHEME 1965/66

	Successful	Unsuccessful
Boreholes drilled on sites approved (27)	4	5 (1 was a low yielder)

Amount of subsidy paid during the year was £2,599.

8.10. A number of boreholes were drilled during the year for which investigations had been carried out earlier. The following Table, therefore, does not reflect the preceding Tables, but does show the actual number of boreholes drilled, arranged in their several categories.

TABLE F.—BOREHOLES DRILLED 1965/66

(i) Agriculture and ranching	20
(ii) Townships	4
(iii) Road construction	2
(iv) National Parks (water for wildlife)	4
(v) Oil exploration	4
(vi) Missions and schools	5
(vii) Industrial	3
(viii) Development Corporation	1
(ix) Government settlement projects	2
(x) Police posts	1
TOTAL	46

Of this total, six holes were unsuccessful and two yielded less than 100 g.p.h.

8.11. It is to be noted that, while the siting of boreholes is the sole responsibility of the Department, through the hydrogeology section, actual drilling is carried out by private contractors. The Government does not operate its own drilling machinery, except for purposes of investigation. Equipment is also a matter for private enterprise, except where a Government water supply is involved. When possible, the Department, through the rural water supplies section, assists individual farmers and local authorities in the rural areas with the design and installation of the equipment.

Hydrogeological Reports

8.12. During the year, two reports were received from the printers and became available to the public:—

(i) Technical Report No. 1.—*Hydrogeology of the Nairobi Area* by E. A. L. Gevaerts.

(ii) Technical Report No. 2.—*Geology and Groundwater Conditions in Central Laikipia* by C. M. Bristow and B. N. Temperley.

8.13. A detailed investigation into the ground water conditions, geology, water table contours and water quality of the coastal strip between Gazi and Mtwapa was undertaken by the section. The detailed maps have been completed; but the final report was not available at the close of the year.

Isotope Investigation of the Hydrology of the Lake Chala Area

8.14. The investigation was initiated with the help of the International Atomic Energy Agency in February 1964 when Lake Chala was dosed with tritiated water. Sampling and analysis, of waters from Lake Chala and surrounding springs and boreholes were continued during 1965/66, on the basis of which the International Atomic Energy Agency issued a technical report on the isotope investigation.

8.15. From the progress made so far it may be concluded that:—

(*a*) The turnover time of Lake Chala (Volume 3×10^8 cubic metres) water is of the order of four years.

(*b*) The filtration velocity of the Chala ground water is about 0.5 to 0.7 metres per day, as calculated from the appearance of tritiated water in the Little Lumi Spring.

(*c*) Lake Chala water does not make a significant contribution to the discharge of the Njoro Kubwa Springs, the latter being a group of major springs in the area.

9. Water Law

Water Apportionment Board

9.1. The original water board was established in 1935 under the provisions of Ordinance No. XXXV of 1929 "to make provision for the employment and conservation of water and to regulate water supply, irrigation and drainage".

9.2. Under the provisions of Ordinance No. 56 of 1951, the title of the water board was changed to Water Apportionment Board.

9.3. Under the provisions of the present water Act, the Water Apportionment Board is charged with "the control of the conservation, apportionment and utilization of the water resources of Kenya". Thus, all proposals for the diversion or conservation of water in any watercourse containing either normal or flood flow, and, in certain cases, the construction and abstraction of water from boreholes, must receive the approval of the Board before construction can commence.

9.4. The Director of Water Development is technical adviser to the Water Apportionment Board and the Water Development Department maintains the secretariat for the Water Apportionment Board and Catchment Boards headed by the Registrar of Water Rights. Field control of water abstractions is enforced by a staff of Water Bailiffs.

Catchment Boards

9.5. The original Ordinance No. XXXV of 1929 made provision for the setting up of district water boards to be "advisory to the Water Board on matters pertaining to applications for water rights or the alteration thereof in any part of its area".

9.6. The Water Ordinance No. 56 of 1951 enacted a change in the name of these Boards to read "Regional Water Boards" with powers to advise the Water Resources Authority on certain matters, and to advise the Water Apportionment Board on the apportionment of existing and potential water supplies, etc.

9.7. The Water (Amendment) Bill 1964 changed the name of regional water boards to read "Catchment Boards" and made provision for such changes to be enacted by notice in the Gazette, at the same time revoking the powers of the regional water boards which were still in operation.

9.8. The Catchment Boards are as follows:—

The Athi Catchment Water Board.
The Tana Catchment Water Board.
The North Ewaso Ngiro Catchment Water Board.
The Rift Valley Catchment Water Board.
The Lake Victoria Catchment Water Board (North).
The Lake Victoria Catchment Water Board (South).

Dam Subsidies

9.9. By notice in the Gazette in 1959, the Government of Kenya notified for general information, conditions of a scheme with the object of encouraging the development of the water resources of Kenya for agricultural purposes of all kinds by the construction of storage dams.

9.10. This scheme, subject to the conditions laid down, provided for payment of subsidies of 40 per cent of the assessed cost of a dam in low-rainfall zones, where the annual rainfall is less than 30 inches, or 25 per cent of the assessed cost of a dam in the higher-rainfall zones. These subsidies are subject to a maximum of £1,900 in low-rainfall zones, and £1,200 in high-rainfall zones.

9.11. When it is the intention to construct a dam in which the maximum depth of water impounded is 16 feet or more, the Water Apportionment Board has ruled that a qualified engineer registered under the water act must undertake the design and prepare the plans.

9.12. The design of all dams is subject to the approval of the Director of Water Development.

Subsidies for Unsuccesful Boreholes

9.13. By notice in the Gazette in 1959, the Government of Kenya published conditions granting the payment of subsidies for unsuccessful boreholes drilled by registered borehole contractors, and sited by a geologist employed by the Water Development Department.

9.14. This grant was made with the object of encouraging the development of the ground water resources of Kenya for agricultural purposes of all kinds, including the domestic and stock watering requirements of the farmer.

9.15. Subject to the conditions covering this grant, the maximum subsidy payable on an unsuccessful borehole is £900 or 75 per cent of the cost of the borehole, whichever is the less.

Water Apportionment Board Statistics

9.16. During the year under review:—

Water Apportionment Board meetings held		12
Applications for ground water permits received ...		84
Applications for surface flow permits received		1,806
Authorizations and permits issued		1,480
Water Apportionment Board fees collected ...	Sh.	92,260
Dam subsidy fees collected	Sh.	800
Dam subsidies paid out	Sh.	42,995

10. Drainage

10.1. Due to lack of staff, drainage activities were severely curtailed. Advice to the Local Government Loans Authority was given, however, in respect of a large number of sewerage and sewage disposal schemes.

10.2. Advice on sewerage and sewage treatment was given to the town planning adviser in connexion with planning proposals for nine townships.

10.3. The advisory services given to the Water Apportionment Board in respect of the pollution of rivers and water sources were maintained.

11. Survey

General

11.1. The most important activities of the section were concerned with carrying out surveys for projects initiated by the irrigation and urban water supply sections.

Water Supply Reticulation Surveys

11.2. Water supply reticulation and treatment plant surveys were made of the following eleven townships:—

(i) Gatundu.
(ii) Machakos.
(iii) Kiambu.
(iv) Githunguri.
(v) Kajiado.
(vi) Ngong.
(vii) Malindi.
(viii) Kakamega.
(ix) Homa Bay.
(x) Kisii.
(xi) Changamwe (Mombasa).

11.3. In some cases, no township plans existed, and base plans had to be made before the position of the pipelines could be plotted. However, in future, it is hoped to produce the base plans from enlarged aerial photographs.

11.4. The Rank Cintel pipe and cable tracer, purchased at the beginning of 1966, proved to be a great asset in pipe location. Prior to the purchase of this equipment, the exact location of pipelines could only be ascertained by exposing them for most of their length.

Pipeline Surveys

11.5. Approximately 80 miles of pipeline surveys were made, the most important being for the proposed Mazeras-Sokoke pipeline in the Coast Division. Other pipeline surveys included those for the Shimo la Tewa extension, the Carn Hill to Kajiado renewal, the Limuru extension and also levelling for proposed pipelines in the Likoni area.

Yala Swamp Reclamation Project

11.6. One of the major activities of the section was in connexion with the U.N.S.F./F.A.O. Yala Swamp reclamation project. During the first part of 1966 the main survey control was completed. For this, a total of 50 points were fixed at approximately one-mile intervals round the perimeter of the swamp. On completion of the control, detailed surveys were made. A number of tracer lines totalling nine miles were cut through the papyrus swamp and surveyed. This proved a particularly arduous operation, as in places the papyrus is growing and floating in as much as eight feet of water. At the end of the year a further four miles of trace lines were being cut and surveyed in the north-east corner of the swamp for the location of the pilot scheme.

11.7. Other work completed for the Yala Swamp project included two surveys for the proposed diversion of the Yala River, a survey for the route of the feeder canal from the Yala River to Lake Kanyaboli and the demarcation surveys for both the Bunyala and the Kadenge (swamp) irrigation pilot schemes.

Other Activities

11.8. A detailed survey was also made of part of the main canal of the Galole irrigation scheme in connexion with the development of the pilot irrigation scheme for the Tana Basin survey.

11.9. For most of the year, three of the section's levellers have been helping the Irrigation Section with the setting out on the Mwea/Tebere and Perkerra irrigation schemes.

12. Workshops

General

12.1. The central workshops of the Water Development Department which are situated at Eastleigh, were first brought into use in November 1964. The workshops are divided into two sections. The first, and major section, deals with the repair of vehicles and the other deals with the repair of pumps ,etc.

Vehicle Repair Section

12.2. This section deals with the repair of the Department's vehicles and the day-to-day maintenance and servicing of vehicles stationed in the Nairobi area. Vehicles from outlying districts are usually only sent in to the workshop when they require a general or major overhaul. Repairs of all kinds are carried out with the exception of such jobs as crankshaft regrinding and cylinder reboring which are carried out by private firms.

Departmental Vehicles

12.3. The following Table shows the principal types and numbers of vehicles in use by the Department:—

Table G.—Departmental Vehicles

Type of Vehicle	No.
Staff cars	2
Ford vans	2
Morris 5 cwt. P.U.	1
Mini moke (light P.U.)	1
Land-Rovers and pick-ups	85
Lorries over 3 tons	60
Tractors, earthmoving equipment, compressors, trenchers, drilling rigs	37
Water trailers and caravans	30
Electricity generator trailers	2
Total	220

12.4. During the year under review, the following jobs were carried out by this section:—

345 Minor repairs and servicing.
49 General overhauls (cost over £100).
26 Major overhauls.
7 Major accident repairs.

12.5. £49,901 was expended on the maintenance and replacement of vehicles.

Workshop Premises

12.6. A certain number of structural improvements to the workshop premises were carried out. These included the erection of a perimeter fence, and the construction of a separate compound for vehicles awaiting boarding, etc., a battery-charging room, an engine-repair shop and a store for spare wheels, etc. A separate oil store is under construction.

Plant Repair Workshop

12.7. This workshop is operated under the supervision of a senior inspector of water supply. It is equipped with an adequate complement of stationary plant such as a lathe, drills, grinders, etc., as well as being capable of carrying out welding jobs, both oxy-acetylene and electric.

12.8. During the year the workshop was kept fully occupied and assisted the vehicle repair section by carrying out reconstruction and repairs of vehicle bodies, modifications to towing hitches and the like.

12.9. In addition to the above, which consumed a very considerable proportion of the time, the workshop also carried out maintenance and repairs to field plant such as concrete mixers, vibrators, etc.; overhauled and made ready for safaris, tractors, drilling equipment, compressors and caravans.

12.10. When time permitted, certain improvements to the workshop premises were also undertaken. Some of the more unusual tasks that were required of the workshop may be listed:—

(i) Modifications to an experimental animal-driven pump.

(ii) Overhauling of a large stationary lighting plant engine for the Mwea-Tebere irrigation scheme.

(iii) Repairing a cement-block machine for District No. 3; cutting and threading drop-piping for borehole installations and making additional fittings for pump installations; making a diving platform; repairing an aluminium boat for the F.A.O. project.

(iv) Making up the fittings for the Department's display at the Agricultural Show in Nairobi.

13. Acknowledgement

13.1. Acknowledgement is made to the staff of the Department at all levels whose earnest endeavour and dedication to duty has made possible the progress and achievements recorded in this Report.

13.2. Acknowledgement is made also to the following Ministries, Government Departments and other agencies whose assistance and collaboration has been greatly appreciated by the Department during the year under review:—

Ministry of Agriculture and Animal Husbandry particularly, the Director of Agriculture, the Chief Agriculturist, the Head of the Range Management Division and the Central Agricultural Board.

The United Nations Development Programme (U.N.D.P.).

The United Nations Educational, Scientific and Cultural Organization (U.N.E.S.C.O.).

The International Bank for Reconstruction and Development (I.B.R.D.).

The United Nations Food and Agriculture Organization (F.A.O.).

The World Health Organization (W.H.O.).

The Oxford Committee for Famine Relief (O.X.F.A.M.).

The United States Agency for International Development (U.S.A.I.D.).

The British Council.

The East African Meteorological Department.

The Government Chemist.

Nairobi,
March, 1967.

R. BARRETT, C.Eng., M.I.C.E., M.I.W.E.,
Director of Water Development.

THE ORGANIZATION FOR WATER DEVELOPMENT IN KENYA

1.1. This appendix describes the events which culminated in the establishment of the present Water Development Department, and mentions the new pattern of organization envisaged in the W.H.O./F.A.O. report.

1.2. In 1962, the Government of Kenya requested the World Health Organization with the assistance of the Food and Agriculture Organization of the United Nations to provide a consultant team "to review the organization of water development in Kenya".

1.3. In 1963, the W.H.O./F.A.O. mission submitted its report "The Organization for Water Development in Kenya".

1.4. The principal recommendations made by the mission were the setting up of a National Water Authority, a statutory body responsible to Parliament through the responsible Minister, and a unification of the technical services dealing with water supplies of all kinds.

1.5. A working party called at that time, recommended that the mission's proposals be implemented in two stages as follows:—

Stage I

The setting up of a separate technical department of water development under the Ministry of Natural Resources to be composed of the former Hydraulic Branch of the Ministry of Works and the ALDEV technical branch.

Stage II

When the Department of Water Development was functioning, further consideration be given to the establishment of a National Water Authority, of which the Water Development would form an integral part.

1.6. These recommendations were accepted by the Cabinet, *vide* Cabinet Minute No. 160 of 1964.

1.7. Stage I was effected when the Water Development Department was established on 1st July 1964.

Provincial Water Advisory Committees

1.8. The establishment of seven provincial water advisory committees, also recommended in the W.H.O./F.A.O. report, has been effected.

The Proposed National Water Authority

1.9. In September 1965, the Ministry of Natural Resources and Wildlife, the Ministry responsible at that time for water development, appointed a working party to examine the recommendations of the W.H.O./F.A.O. mission and submit a report to the Minister. The working party included representatives of the Treasury, and the Ministries for Natural Resources; Agriculture; Economic Planning and Development; Health and Local Government; the Chairman of the Central Agricultural Board, the Chairman of the Water Resources Authority and the Director of Water Development.

1.10. The working party reported to the then Ministry of Natural Resources, Wildlife and Tourism. The majority report recommended that the proposals of the W.H.O./F.A.O. mission for setting up a National Water Authority, with statutory powers be adopted. The Treasury was unable to support the recommendations of the majority report and submitted a minority report, which recommended that the decision should be deferred until the reports of the Government working party on statutory organizations, and the commission of inquiry on local government had been presented to Government.

1.11. In April 1966, the Ministry of Natural Resources, Wildlife and Tourism decided to defer a decision on the proposal for a National Water Authority until the reports of the above-mentioned inquiries were available.

APPENDIX II

THE ACCOUNTS ORGANIZATION

2.1. The accounts section of the Water Development Department is responsible to the Director for the accounting of all finances of the Department in accordance with Government regulations, and is principally subdivided into the following sections:—

(i) *Control of Funds.*—Compiling and submission to the Permanent Secretary, Ministry of Natural Resources, recurrent and development estimates of the Department, in consultation with the Director, section heads, officers-in-charge districts, and ultimate call-up of funds held on behalf of the Department in the Ministry of Natural Resources, and their subsequent reissue to the various district offices throughout Kenya.

In addition to departmental estimates, this office issues funds to all district headquarters for the maintenance and operation of institutional water supplies on behalf of other Government Departments, county councils and private bodies on an agency basis.

(ii) *Revenue Section* is responsible for monthly preparations, collection and accounting of a substantial sum of revenue for three public water supplies in the Nairobi area involving 400 consumers. Apart from the main function of collecting revenue of the public water supplies, this office also collects and accounts for other revenue items, i.e. Water Board fees, fees of engineer geologists for dams and borehole constructions and other miscellaneous revenue items. It is worth mentioning that during the year 1965/66, a sum of £43,891 was collected by this office for the above revenue items.

This office also keeps and distributes stationery requirements to the entire country for collection of water supply revenue.

(iii) *Expenditure Section* maintains all accounting books and ledgers for expenditure items controlled by the Director, checking and processing of merchants' accounts, staff claims, and monthly preparation and payment of wages to 141 non-established staff.

The officer-in-charge accounts section is also responsible for advising on accounting procedures and regulations to all the officers-in-charge district headquarters on behalf of the Director of Water Development.

APPENDIX III

WATER DEVELOPMENT DEPARTMENT—ESTABLISHMENT (SCALES G4 AND ABOVE) AS AT 30TH JUNE 1966

Post	No. of Posts in Establishment	No. of Posts Filled	No. of Posts Vacant
Director	1	1	—
Assistant Directors	2	2	—
Superintending Engineers	3	2	1
Adviser, Rural Water Supply	1	1	—
Engineers (Hydraulic)	17	10	7
Senior Technical Officers	5	3	2
Superintendents, Water Supply	12	9	3
Senior Inspectors, Water Supply	18	6	12
Technical Officers	8	5	3
Staff Surveyor	1	—	1
Inspectors, Water Supply	30	24	6
Hydrologists	4	4	—
Geologists	3	2	1
Registrar of Water Rights	1	1	—
Assistant Registrar of Water Rights	1	1	—
Senior Water Bailiffs	5	5	—
Water Bailiffs	13	12	1
Senior Hydrological Assistants	2	1	1
Senior Computing Assistant	1	1	—
Hydrological Assistants	6	6	—
Computing Assistants G4	4	3	1
Chief Technical Assistant (Survey)	1	1	—
Technical Assistants (Survey)	3	3	—
Works Supervisors	2	2	—
Chief Draughtsman	1	1	—
Executive Officer G2	1	1	—
Executive Officer G3	1	1	—
Personal Secretary II	1	1	—
Accountant G2	1	1	—

APPENDIX IV

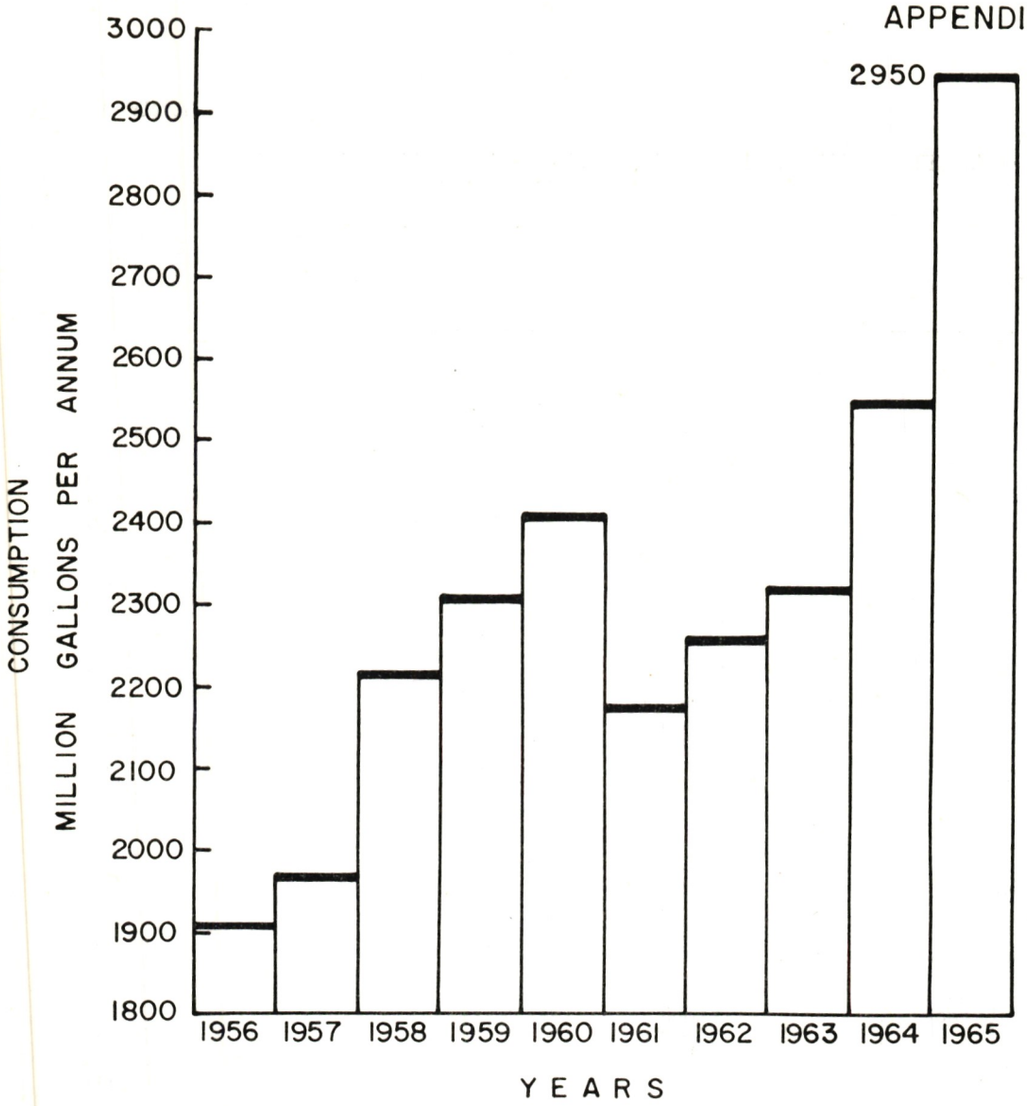
WATER DEVELOPMENT DEPARTMENT—RECURRENT EXPENDITURE 1965/66

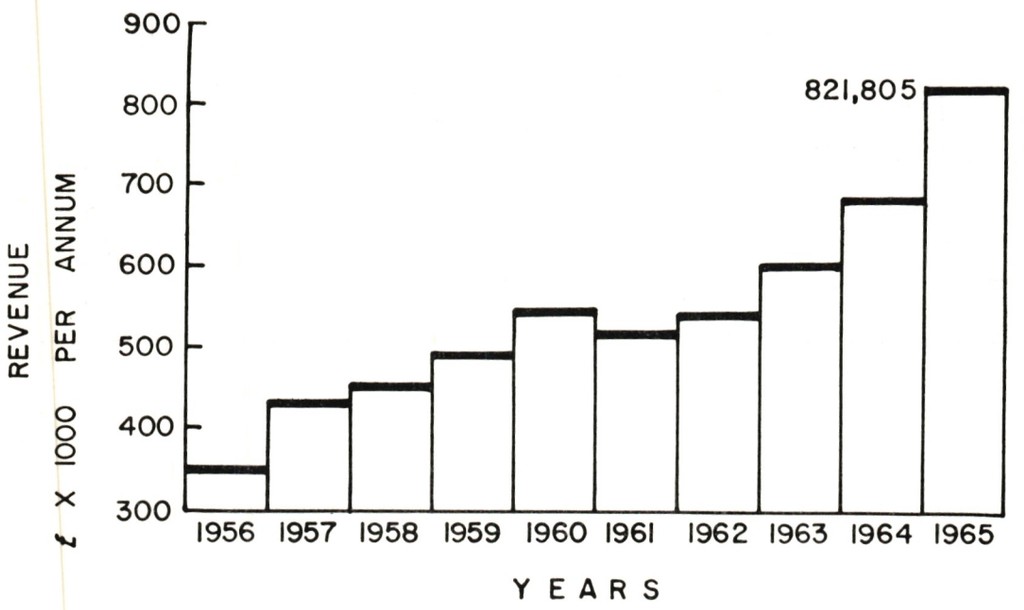
	Approved Estimates	Actual Expenditure
	£	£
Personal Emoluments	310,000	296,465
House Allowances	22,000	20,523
Passage and Leave Expenses	5,000	7,398
Travelling and Subsistence Expenses on Duty	30,000	25,880
Replacement, Maintenance and Running Expenses of Vehicles	45,500	49,901
Purchase and Maintenance of Tools, Plant, Equipment, Stores and Instruments	8,300	7,670
Miscellaneous Other Charges	9,850	12,721
Subsidization of Unsuccessful Boreholes	1,500	NIL
Renewals from Appropriated Funds (£1,500 Supplementary Estimate)	6,500	4,446
Water Supplies, Maintenance, Operation, Investigations, Coast Protective Works and Works Expenditure) (£10,000 Supplementary Estimate)	217,000	216,214
Professional Fees	1,000	1,432
Operation and Maintenance of Dam Construction Unit	20,000	14,760
Sub-Total £	676,650	657,410
MOMBASA WATER SUPPLY		
Personal Emoluments	37,095	33,736
House Allowances	3,500	2,342
Passage and Leave Expenses	600	674
Travelling and Subsistence Expenses on Duty	2,500	2,282
Miscellaneous Other Charges	4,150	3,954
Operation Maintenance Expenses	45,700	45,105
Renewals from Appropriated Funds (£2,100 Supplementary Estimate)	3,100	3,072
Purchase of Water from Mombasa Pipeline Board	345,000	345,650
GRAND TOTAL £	1,118,295	1,094,225

APPENDIX V

DEVELOPMENT EXPENDITURE 1965/66

		Approved Estimates	Actual Expenditure
		£	£
Urban Water Supplies		133,000	124,293
Rural Water Supplies		45,010	30,640
Buildings for Divisional Offices and Yards		2,000	1,918
Water Resources Survey		14,000	12,458
Dam and Borehole Subsidies		10,000	4,749
Loan to Mombasa Pipeline Board:	£		
Original Estimate	10		
Supplementary Estimate	33,324		
		33,334	33,334
TOTAL £		237,344	207,392





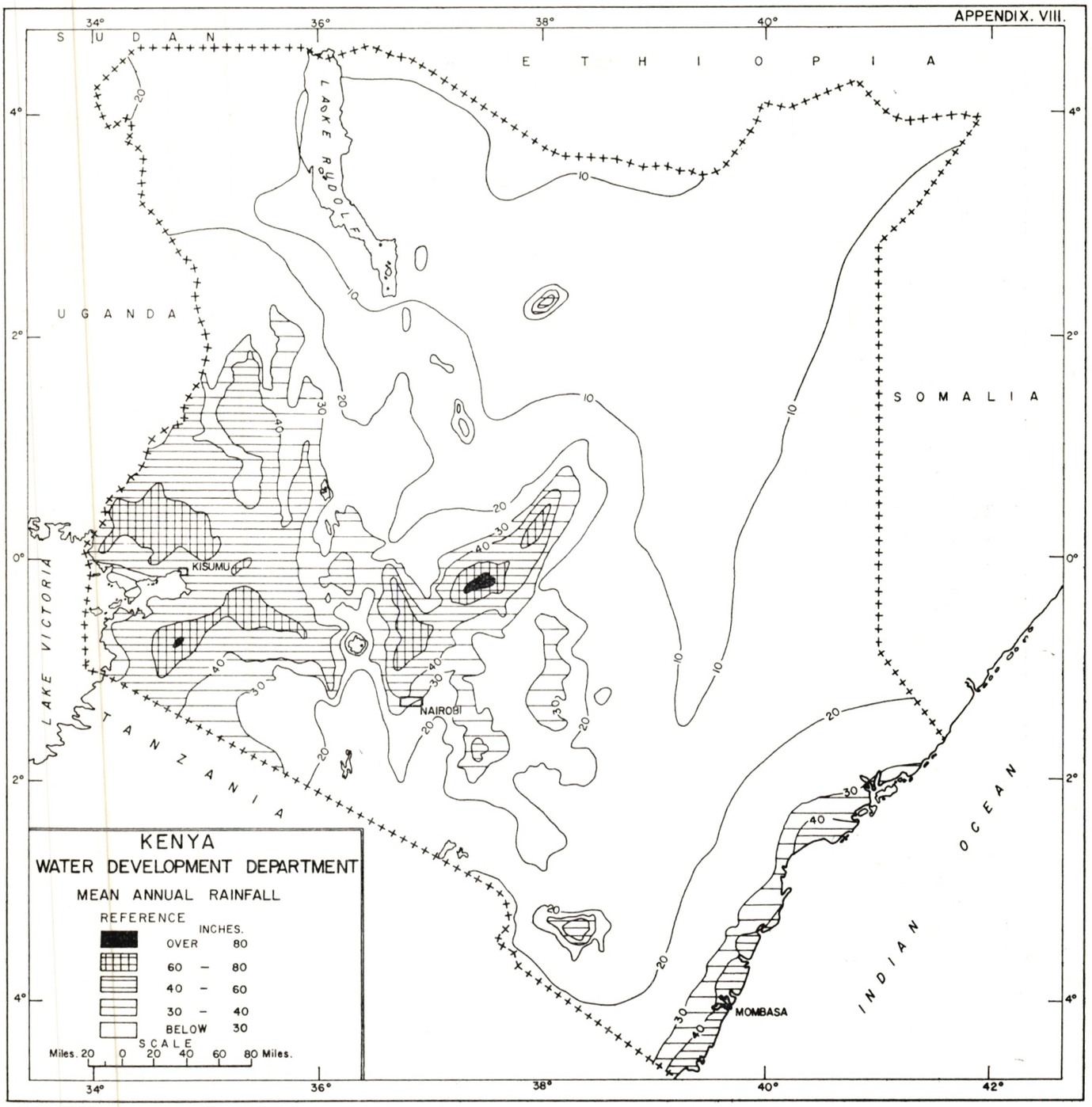
GRAPHS OF CONSUMPTION AND REVENUE FOR GAZETTED WATER SUPPLIES OPERATED AND MAINTAINED BY THE WATER DEVELOPMENT DEPARTMENT

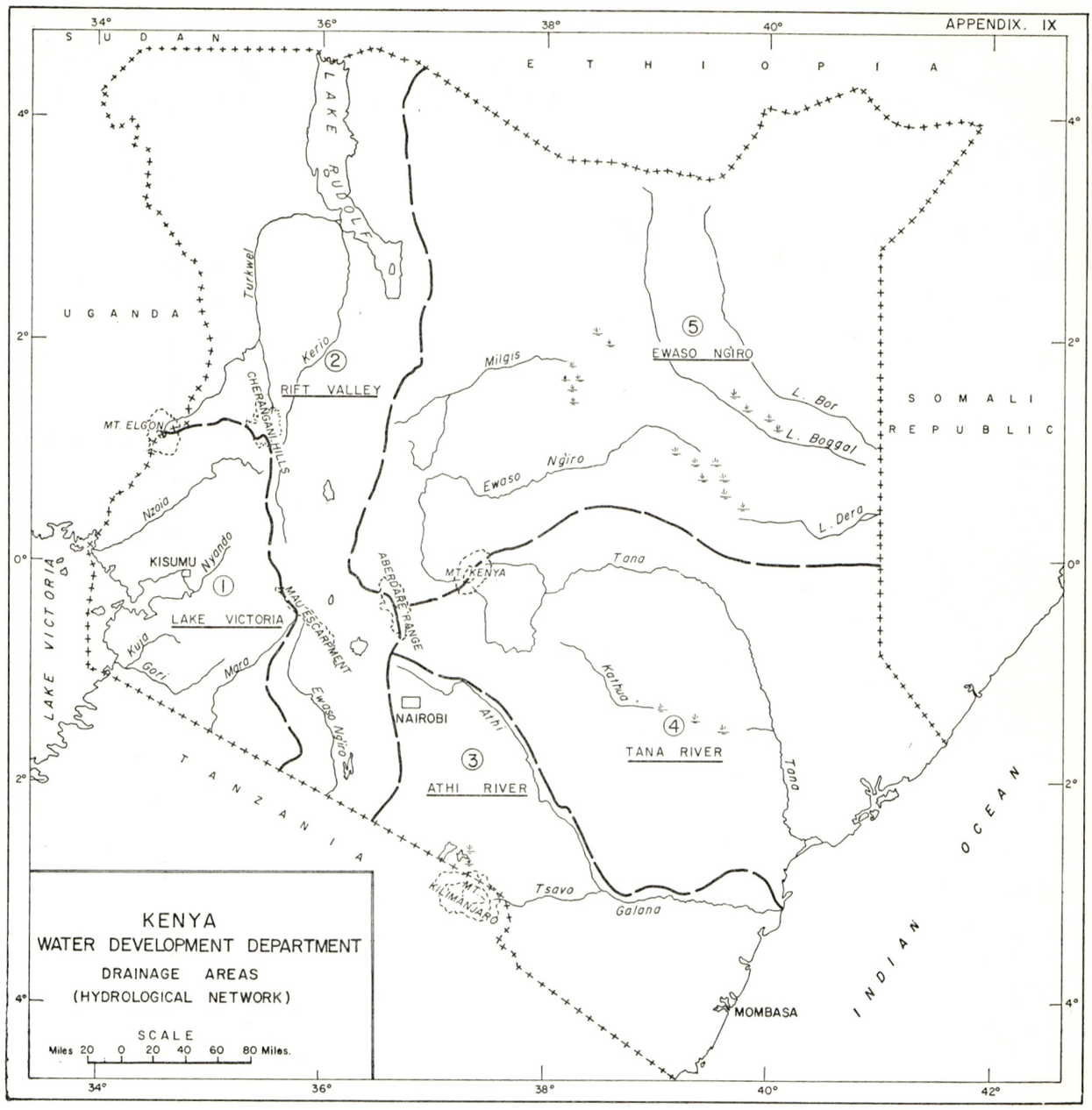
W.D.D. DRG. No. G12/6

APPENDIX VII

GAZETTED WATER SUPPLIES OPERATED AND MAINTAINED BY THE WATER DEVELOPMENT DEPARTMENT

Water Supply	Maximum Operating Capacity (*Gallons per day*)
District No. 1.—H.Q. Kisumu	
1. Maseno	80,000
2. Ukwala	12,000
3. Bondo	15,000
4. Vihiga	14,000
5. Busia	9,000
6. Kericho	200,000
7. Kapkatet	8,000
8. Lumbwa	20,000
9. Londiani	18,000
10. Sotik	36,000
11. Bomet	18,000
12. Kisii	120,000
13. Migori	14,000
14. Nyamira	10,000
15. Homa Bay	50,000
16. Kakamega	130,000
17. Bungoma	100,000
18. Kimilili	25,000
19. Kapenguria	15,000
20. Tambach	8,000
21. Kapsabet	60,000
22. Nandi Hills	16,000
23. Butere	25,000
District No. 2.—H.Q. Nakuru	
24. Molo	160,000
25. Eldama Ravine	13,000
26. Elburgon	22,000
27. Kabarnet	13,000
28. Rongai Pipeline	433,000
29. Elburgon Pipeline	30,000
30. Maralal	10,000
31. Naivasha	200,000
32. Gilgil	50,000
33. Kijabe	2,000
34. Narok	32,000
35. Kinangop Ring Main	450,000
District No. 3.—H.Q. Nairobi	
36. Kiambu	80,000
37. Kikuyu	36,000
38. Ruiru	48,000
39. Gatundu	20,000
40. Githunguri	20,000
41. Limuru	14,000
42. Kabete	200,000
43. Kajiado	50,000
44. Ngong	30,000
45. Wilson Airport	50,000
46. Nairobi Airport	116,000
47. Machakos	200,000
District No. 4.—H.Q. Fort Hall	
48. Fort Hall	150,000
49. Karatina	250,000
50. Kerugoya	96,000
51. Saba Saba	25,000
52. Kandara	20,000
53. Kangema	15,000
54. Kianyaga	15,000
55. Kigumu	15,000
56. Mukuruweini	15,000
57. Othaya	10,000
58. Embu	160,000
59. Chuka	6,900
60. Kitui	70,000
61. Mwingi	10,000
62. Garissa	40,000
63. Nyeri	400,000
64. Kiganjo	250,000
65. Isiolo	50,000
66. Marsabit	20,000
67. Meru	120,000
68. Nkubu	30,000
69. Maua	12,000
Coast District.—H.Q. Mombasa	
70. Mombasa	8,000,000
71. Kwale	50,000
72. Mazeras	50,000
73. Mariakani	50,000
74. Kinango	10,000
75. Mombasa South Mainland	30,000
76. Mombasa North Mainland	750,000
77. Malindi	240,000
78. Kilifi	30,000
79. Lamu	60,000
80. Voi	150,000
81. Taveta	10,000
82. Wundanyi	20,000


APPENDIX. VIII.
S U D A N
E T H I O P I A
U G A N D A
S O M A L I A
T A N Z A N I A
LAKE RUDOLF
LAKE VICTORIA
INDIAN OCEAN
KISUMU
NAIROBI
MOMBASA
34°
36°
38°
40°
42°
4°
2°
0°
KENYA
WATER DEVELOPMENT DEPARTMENT
MEAN ANNUAL RAINFALL
REFERENCE
INCHES.
OVER 80
60 – 80
40 – 60
30 – 40
BELOW 30
SCALE
Miles. 20 0 20 40 60 80 Miles.


APPENDIX. IX
SUDAN
ETHIOPIA
UGANDA
SOMALI REPUBLIC
TANZANIA
INDIAN OCEAN
LAKE VICTORIA
LAKE RUDOLF
Turkwel
Kerio
RIFT VALLEY
CHERANGANI HILLS
MT. ELGON
Nzoia
KISUMU
Nyando
LAKE VICTORIA
Kuja
Gori
Mara
MAU ESCARPMENT
Ewaso Ngiro
ABERDARE RANGE
MT. KENYA
NAIROBI
Athi
ATHI RIVER
Tana
Kathua
TANA RIVER
EWASO NGIRO
Milgis
L. Bor
L. Boggal
Ewaso Ngiro
L. Dera
MT. KILIMANJARO
Tsavo
Galana
MOMBASA
KENYA
WATER DEVELOPMENT DEPARTMENT
DRAINAGE AREAS
(HYDROLOGICAL NETWORK)
SCALE
Miles 20 0 20 40 60 80 Miles.

APPENDIX X

RAINFALL AND PAN EVAPORATION IN INCHES—1965
DRAINAGE AREA No. 1.—LAKE VICTORIA

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Eldoret—													
Rainfall ..	3·52	0·80	2·51	5·98	1·14	2·92	4·38	3·72	0·15	4·45	3·68	1·45	34·70
Evaporation ..	6·04	6·22	7·31	5·84	6·04	5·20	4·56	4·02	5·19	5·19	5·16	5·67	66·44
Kisumu—													
Rainfall ..	3·41	0·87	7·24	10·45	8·92	1·46	2·21	0·15	6·11	5·50	4·65	4·22	55·19
Evaporation ..	7·95	8·17	9·34	7·25	6·82	6·74	6·67	7·43	8·67	7·56	6·53	7·56	90·69
Kericho—													
Rainfall ..	1·89	0·38	6·98	9·25	5·07	5·05	4·54	6·14	4·35	7·42	6·52	4·62	62·21
Evaporation ..	6·05	6·12	6·56	4·54	4·65	4·92	4·07	4·60	5·00	4·13	3·79	5·07	59·50
Kitale—													
Rainfall ..	0·54	1·36	2·86	5·32	4·74	1·13	3·37	5·90	1·94	7·81	3·79	1·08	39·84
Evaporation ..	6·32	6·96	7·30	5·10	5·02	4·73	4·47	4·86	5·42	5·79	5·39	5·90	67·26

APPENDIX XI

DRAINAGE AREA No. 2.—RIFT VALLEY

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Naivasha—													
Rainfall ..	1·82	0·84	2·14	4·70	2·08	1·33	1·91	1·03	0·59	1·58*	2·85	1·32	22·19*
Evaporation ..	7·60	7·92	8·98	7·06	5·76	6·85	6·02	7·41	7·51	7·93*	5·37	5·92	84·33*
Nakuru—													
Rainfall ..	0·73	0·11	1·34	4·23	3·13	1·53	2·60	3·24	1·00	2·06	2·44	2·15	24·56
Evaporation ..	N.R.	N.R.	N.R.	N.R.	N.R.	5·93	5·94	6·16	6·76	6·20	4·60	7·15	Incomplete
Lodwar—													
Rainfall ..	0·01	0·70	1·98	4·01	Nil	Nil	Nil	Nil	Nil	0·03	0·52	Nil	7·25
Evaporation ..	12·59	11·68	13·42	11·15	12·26	11·66	12·86	14·12	15·40	15·39	12·24	14·06	156·83

Note.—N.R.—No Records. *—Estimated.

APPENDIX XII

DRAINAGE AREA No. 3.—ATHI RIVER

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mombasa—													
Rainfall ..	2·09	0·01	0·21	4·25	4·89	3·93	1·21	1·39	4·26	3·47	9·96	0·08	35·75
Evaporation ..	7·45	8·13	8·95	7·45	Pan Leaking	5·57	5·67	6·31	6·36	6·11	6·10	8·00	Incomplete
Machakos—													
Rainfall ..	3·21	0·60	1·68	7·43	0·68	Nil	0·02	0·04	0·16	7·83	5·24	0·73	27·62
Evaporation ..	6·35	7·74	8·30	6·45	5·38	4·64	4·30	4·86	7·42	7·23	5·70	6·87	75·24
Nairobi—													
Rainfall ..	3·95	0·03	1·88	9·62	4·06	3·46	0·62	0·48	Nil	2·83	5·14	5·45	37·52
Evaporation ..	8·31	10·09	10·50	7·12	6·06	6·46	4·84	5·32	7·80	5·67	4·20	6·63	83·00

APPENDIX XIII

DRAINAGE AREA No. 4.—TANA RIVER

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Garissa—													
Rainfall ..	0·90	Nil	1·66	1·04	0·10	0·53	0·06	0·14	0·77	2·81	4·11	0·19	12·31
Evaporation ..	Pan Leaking	Pan Leaking	9·40	9·66	11·62	9·85	9·72	10·68	10·03	8·47	6·61	7·47	Incomplete
Kitui—													
Rainfall ..	2·20	Nil	1·60	9·87	0·80	0·18	0·03	0·10	0·15	4·89	13·90	0·82	34·54
Evaporation ..	5·88	6·96	7·90	6·69	6·08	5·24	5·21	6·72	7·83	7·29	5·48	6·34	77·62
Nyeri—													
Rainfall ..	2·03	0·64	1·71	2·47	4·32	0·62	1·08	1·14	0·61	3·53	7·80	3·30	29·25
Evaporation ..	4·89	6·08	6·15	5·25	5·58	5·10	3·92	3·84	6·39	6·25	4·36	4·98	62·79

APPENDIX XIV

DRAINAGE AREA No. 5.—EWASO NGIRO RIVER

Rainfall	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Archer's Post—													
Rainfall ..	0·14	Nil	Nil	3·30	0·47	Nil	Nil	Nil	Nil	1·36	1·81	0·35	7·43
Evaporation ..	9·98	11·90	13·80	10·40	10·95	11·18	11·86	13·76	13·84	11·50	7·85	10·53	137·55
Lamuria—													
Rainfall ..	3·33	0·58	2·72	3·82	0·47	2·45	0·27	0·21	0·37	1·10	3·45	0·67	19·44
Evaporation ..	5·43	7·10	6·36	5·22	6·21	6·73	6·27	6·83	8·03	7·50	4·99	6·67	77·34
Rumuruti—													
Rainfall ..	2·98	Nil	0·13	5·46	2·59	1·82	0·52	1·08	0·38	1·85	2·62	1·99	21·42
Evaporation ..	6·52	7·48	8·63	6·66	6·01	6·78	5·90	6·60	8·10	7·17	5·24	7·41	82·50

APPENDIX XV

MEAN MONTHLY RIVER DISCHARGES IN CUSECS—1965

DRAINAGE AREA No. 1—LAKE VICTORIA

River	Regular Gauging Station	Catchment Areas	Period of Record	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total Cusec Days	Mean	Max.	Min.
		Sq. Mls.	*Years*																
Rongai	1 BG 7	264	5	76·8	54·4	48·7	62·3	78·2	46·1	56·8	69·4	48·0	104·0	15·5	53·0	25,972	71·2	277	11·4
Nzoia	1 DA 2	3,250	17	821	542	453	617	826	504	651	688	517	758	955	484	238,106	652	1,649	332
Nzoia	1 EE 1	4,575	3	1,822	1,164	877	1,436	2,627	1,380	1,449	1,527	1,076	1,619	2,755	1,786	594,529	1,629	4,620	660
Yala	1 FG 1	922	18	524	326	308	594	829	416	488	425	378	470	746	497	182,925	501	1,547	193
Nyando	1 GD 4	997	10	224	159	158	228	237	133	177	213	173	139	216	158	67,462	185	1,081	86
Kibos	1 HA 4	26	32	37·35	21·71	36·91	45·03	64·50	28·09	25·40	26·91	32·48	36·88	92·31	54·53	15,302	41·92	222·40	10·65
Sondu	1 JG 1	1,269	19	404	245	152	1,162	2,625	911	618	657	680	475	1,195	872	305,188	836	4,314	118
Gori	1 KC 3	1,176	15	276	113	57	200	816	207	65	58	49	48	93	682	81,723	224	1,883	32·2

APPENDIX XVI

DRAINAGE AREA No. 2.—RIFT VALLEY

River	Regular Gauging Station	Catchment Area	Period of Record	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total Cusec Days	Mean	Max.	Min.
		Sq. Mls.	*Years*																
Molo	2 EG 1	256	34	22·96	15·44	11·18	12·61	12·93*	8·54	11·72	9·26	6·70	6·70	11·63	7·04	4,135*	11·33*	34·20	4·99
Melawa	2 GB 1	610	34	105·49	46·26	38·76	77·02	271·33	61·59	110·02	92·57	85·91	70·18	150·15	76·44	36,246	99·30	657·33	34·50
Turasha	2 GC 4	280	15	55·30	23·63	24·99	56·54	195·69	46·12	76·30	52·19	55·76	40·58	83·53	46·14	23,147	63·41	448·90	18·26

NOTE.—*Estimated.

APPENDIX XVII

DRAINAGE AREA No. 3.—ATHI RIVER

River	Regular Gauging Station	Catchment Area	Period of Record	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total Cusec Days	Mean	Max.	Min.
		Sq. Mls.	*Years*																
Mbagathi	3 AA 4	105	15	15·31	4·64	4·20	35·49*	35·4	6·70	5·99	4·98	3·66	6·78	7·19	12·56*	4,364*	11·96*	381·40	3·50
Thiririka	3 BD 8	18	4	21·7	14·7	10·7	8·9	54	41	17	12·2	8·1	8·3	75	40	9,493	26·01	291	6·1
Ndarugu	3 CB 5	100	9	76·7	43·2	28·1	55·9	122·2	91·3	48·6	33·4	22·2	23·0	118·5	98·3	23,188	63·53	312·2	15·9
Athi..	3 DA 2	2,210	9	300	156	124	406	538	288	198	159	108	133	437	312	96,036	263	2,683	80
Manolo	3 MH 10	246	34	20·70	0·67	0·64	1·71	5·70	5·26	1·67	1·69	1·54	10·02	62·6	3·49	3,514	9·63	487·81	0·50

NOTE.—*Estimated.

APPENDIX XVIII

DRAINAGE AREA No. 4.—TANA RIVER

River	Regular Gauging Station	Catchment Area	Period of Record	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total Cusec Days	Mean	Max.	Min.
		Sq. Mls.	*Years*																
Sagana	4 AA 1	37	18	33·50	18·70	20·30	54·70	66·20	24·80	18·50	12·60	13·55	26·43	61·30	49·40	12,183	33·4	606	9·53
Sagana	4 AC 3	109	17	283	130	116	243	453	170	111	96	91	22	791	345	92,959	255	1,513	63
Sagana	4 BC 2	913	17	1,040	592	497	939	1,798	748	574	484	380	706	3,000	1,350	368,437	1,009	4,694	282
Thika	4 CB 4	122	20	183	102	78	220	587	268	142	99	64	70	567	258	80,329	220	848	46
Chania	4 CA 2	200	44	227	159	121	276	735†	363	228	161	117	139	517	268	100,836†	276†	1,093	98
Thiba	4 DD 1	738	18	561	384	339	692	709	675	351	470	286	559	1,291	842	217,813	597	2,180	242
Tana Kamburu ..	4 ED 3	3,500	14	2,979	1,718	1,348	2,939	5,979	2,880	1,775	1,432	1,132	1,788	7,202	3,950	1,069,517	2,930	10,543	905
Tana Garissa ..	4 G 1	16,300	32	7,063	3,684	2,563	4,616	8,948	4,557	2,881	2,401	1,747	2,449	11,614	Missing	—	—	—	1,351

NOTE.—†In excess of.

APPENDIX XIX

DRAINAGE AREA No. 5.—EWASO NG'IRO RIVER

River	Regular Gauging Station	Catchment Area	Period of Record	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total Cusec Days	Mean	Max.	Min.
		Sq. Mls.	*Years*																
Narok	5 AA 1	215	20	59·3	36·5	30·7	35·7	28·3	24·0	26·0	30·2	28·3	28·5	45·4	32·3	12,320	33·8	93·1	22·2
Ewaso Ng'iro ..	5 BB 2	155	18	55·9	25·0	18·7	24·2	40·2	17·0	15·9	13·4	11·7	17·9	35·9	27·8	9,248	25·3	188·1	9·18
Naro Moru ..	5 BC 2	35	34	23·9	10·1	12·0	26·6	33·8	13·5	9·4	7·2	14·1*	35·2	62·2	30·1	8,486*	23·25*	141·5	6·0
Ewaso Ng'iro ..	5 E 3	5,800	16	736	335	217	660	528	210	188	149	168	602	1,078	392	160,051	439	3,015	124

NOTE.—*Estimated.

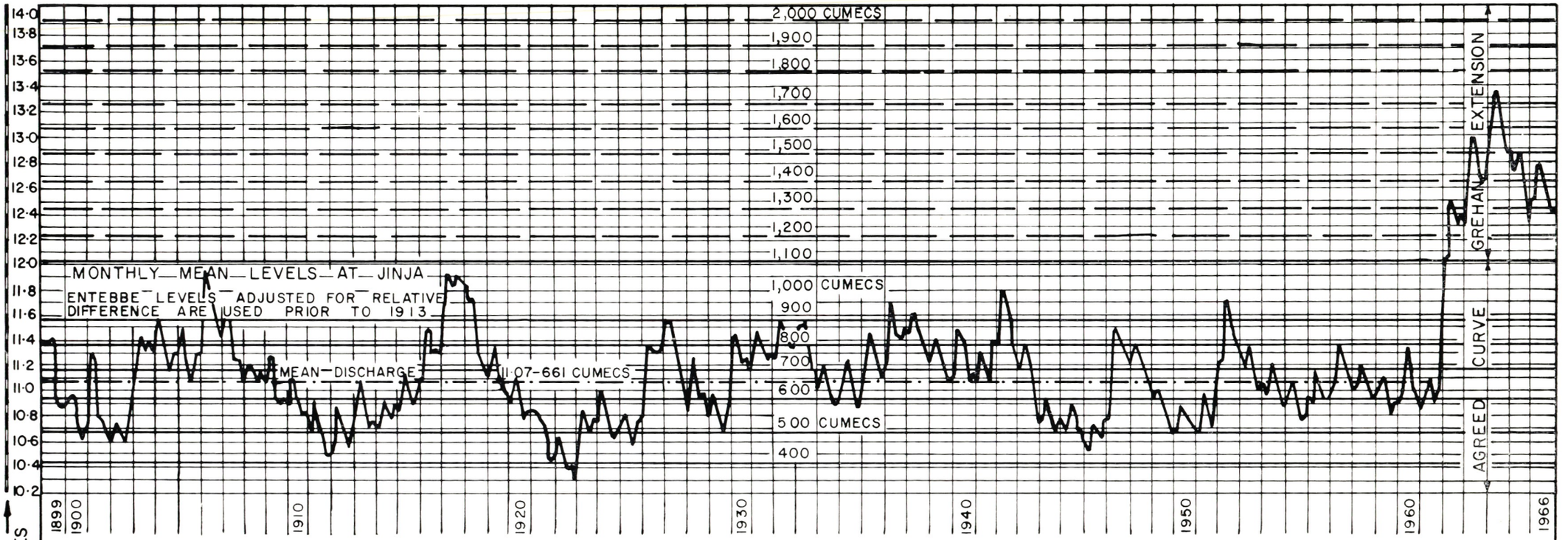


Fig. 1.

BASED ON ORIGINAL DRAWING PRODUCED BY WATER DEVELOPMENT DEPARTMENT, ENTEBBE. OCTOBER, 1961.

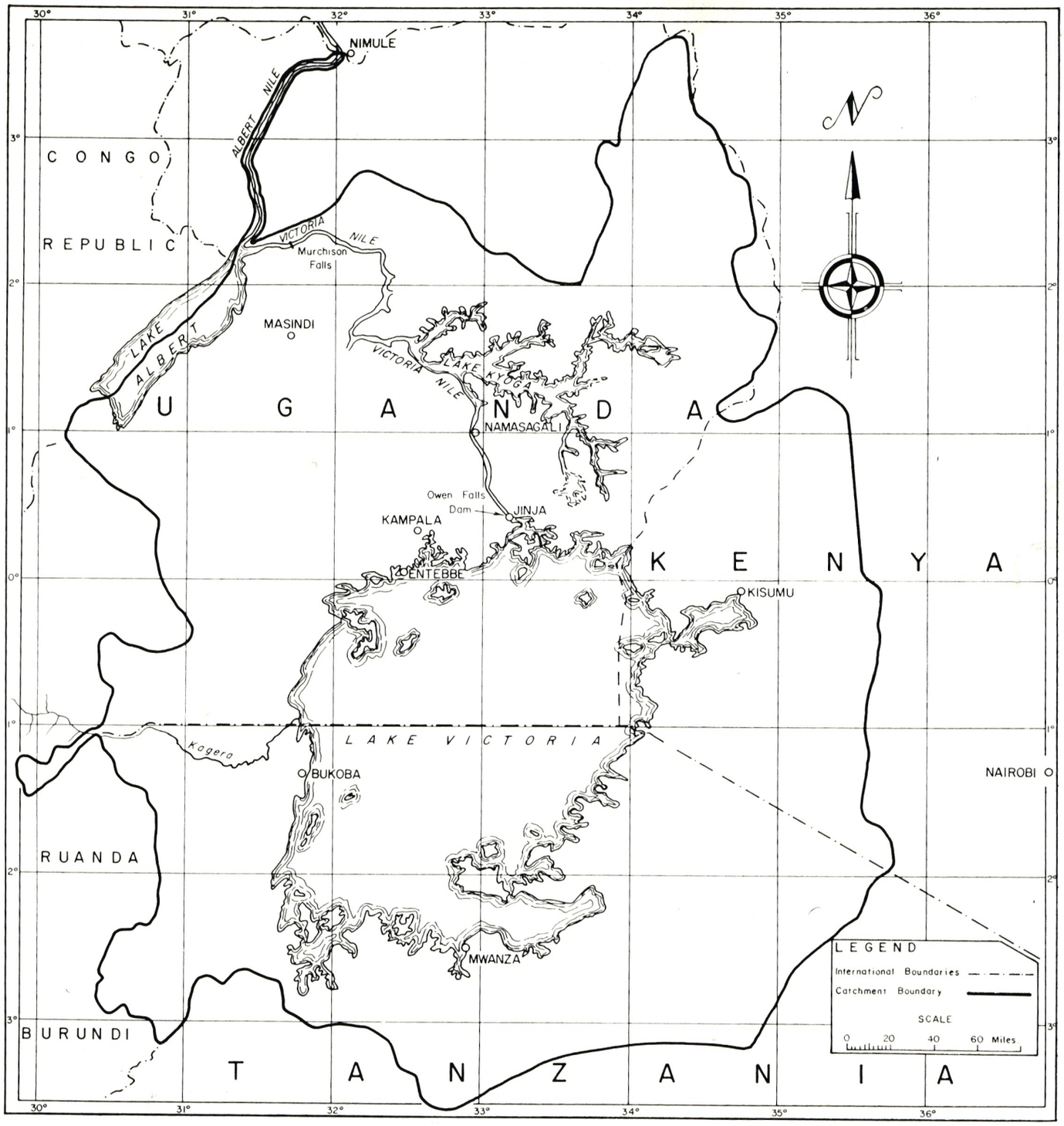
MINISTRY OF NATURAL RESOURCES	
WATER DEVELOPMENT DEPARTMENT HEAD OFFICE	
DRAFT BY	C. B. P. FARIA.
CHECKED BY	G. OFULA.
DRG. No.	L 2/1/1

LAKE VICTORIA

LEVEL VARIATIONS SINCE 1899
JINJA GAUGE

D Grabalan
SECTION HEAD

R. Barnes
DIRECTOR
WATER DEVELOPMENT DEPARTMENT



AREAL SCOPE OF THE HYDROMETEOROLOGICAL SURVEY OF THE EQUATORIAL LAKES

GPK 5313—600—3/67