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DEPARTMENT OF WATER DEVELOPMENT

ANNUAL REPORT FOR 1958

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The engineering and geological side of all Government water development work is in the hands of the Department of Water Development whose duties include the search for new sources, the conservation and development of supplies for irrigation, domestic and industrial use, and the problems connected with river training, flood protection and land drainage. The administration of village Irrigation Divisions and Associations and domestic Water Commissions is supervised by the District Commissioners. Disputes over water rights are handled chiefly by the Commissioners in consultation with the Law Officers, and the Departments of Land Registration and Water Development. Soil conservation and the agricultural problems involved in the economic use of water are responsibilities of the Department of Agriculture.

2. In 1958 the works programme of the Department of Water Development suffered because of shortage of money arising out of the disturbed political conditions in the island and also because of sabotage to plant by terrorists. The chief works under construction were the final stages of the £850,000 Greater Nicosia water supply scheme, which was virtually complete at the end of the year, and the 105 foot high Trimiklini irrigation dam which was finished in time to provide water for the 1958 summer irrigation season. About 66% of an £80,000 scheme for lining irrigation channels at Kythrea was carried out during the year. Terrorist action caused work to be suspended on several schemes, including a 65 foot high dam at Pyrgos and a large village water supply tank at Yialousa. The drilling programme was reduced for the same reason, only 157 boreholes being drilled in 1958 as against 293 in 1957. Pipes and machinery costing £478,000 were delivered for the Morphou Bay Scheme for Nicosia water supply which will pump two million gallons of water per day in the first instance and four million gallons later through a 24 mile pumping main. The total expenditure amounted to £1,049,125 as compared with £1,064,000 in 1957.

3. The rainfall of 1957/58 averaged about 18" inches over the whole island or about 95% of normal. It was above average in the western and southern valleys of the Troodos mountains but below average to the east and north of the island. No special demands were made upon the department

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for either drought relief or flood damage.

4. The department is divided into seven technical services dealing respectively with:-

(a) Irrigation and drainage
(b) Investigations for major irrigation projects
(c) Town water supplies
(d) Village domestic water supplies
(e) Hydro-geology and drilling
(f) Hydrology
(g) Workshops

Other sections dealing with accounts, administration and clerical matters together comprise a head office which serves all the above technical services. There is continuous liaison between all branches so that their work is co-ordinated in the best interests of the over-all water supply problems of the island. Thus a source of water may be developed for domestic water supplies in excess of the requirements of a particular village and the surplus may be utilised for irrigation; where gravity water supplies are not available geological investigations may locate underground sources from which water can be pumped for irrigation or domestic use.

IRRIGATION AND DRAINAGE

5. As in previous years the majority of the irrigation and drainage works carried out by the department were small in size. They may be classified in the following groups.

(a) Excavation of springs to increase yield
(b) Diversion of stream flow
(c) Lining channels with concrete
(d) Construction of concrete or masonry storage tanks
(e) Construction of infiltration galleries
(f) Construction of concrete and earth dams
(g) Installation of pumping plant on wells and boreholes
(h) Flood protection and river training
(i) Land drainage

6. The total number of irrigation and drainage schemes completed during the year was 26, providing sufficient water to irrigate 1131 donums, of which 214 donums can be irrigated perennially. Five more schemes were in progress at the end of the year and a further 107 have been planned in detail and are ready to be carried out as opportunity occurs. These figures are not inclusive of

many small works carried out by landowners following the drilling of boreholes by Government or by private contractors.

7. The rate of progress in irrigation in the period of development since the 1946 census is shown in the following table:-

	Gravity Irrigation		Pumped Irrigation	Total
	Perennial Donums	Seasonal Donums	Donums	Donums
1946 Census	59,409 say 59,500	284,977 say 285,000	53,131 say 53,000	397,517 say 397,000
Estimated at end of 1957	89,000	358,500	138,500	586,000
New Irrigation in 1958 (say)	214	917	10,500@	11,631
Estimated total at end of 1958	say 89,000	say 359,500	149,000*	say 597,500
Percentage increase since 1946 census	50%	26%	180%	50%

@ Includes 2,000 donums resulting from private drilling.
* Includes 5,500 donums resulting from private drilling.

8. The total area of arable land in Cyprus amounts to about 3,900,000 donums of which 80% to 85% is cultivated; 15% is now irrigated in an average winter and 6.1% in an average summer. It is estimated that new irrigation works are causing the value of agricultural production in Cyprus to increase by about £750,000 each year.

9. In 1958, 18 miles of channels were lined in reinforced concrete. These were chiefly at Kythrea (11 miles) and at Trimiklini (one mile). The former are part of an £80,000 scheme of improvements to the old channels distributing water from the Kythrea spring, which is the largest in the island. The works are being carried out entirely at Government expense as compensation for the compulsory acquisition of 5% of the water in 1956 for the domestic supply of the dry villages of the Eastern Messaoria. It is anticipated that the saving in water resulting from lining the channels will be some five times greater than the quantity acquired. The Trimiklini channels form part

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of the distribution system delivering water from the new 105 foot high dam described in the 1957 Annual Report. They bring new perennial irrigation to some 800 donums.

10. The new Trimiklini reservoir was filled for the first time in 1958. Extensions to the channels and a pipe distribution system to cover the steeper parts of the irrigated area were under construction at the end of the year. The successful example of this project at once led to requests from neighbouring villages for three more dams of the same type on the same river.

11. Construction of a 65 feet high concrete dam at Pyrgos proceeded until 26th March when the dam was about 50% complete. Some of the construction plant was then badly damaged by sabotage and work was stopped. The reinforced concrete distribution channels, 5 miles in length were already complete at the time of the incident.

12. At Ay. Marina, in the Paphos District, a stream intake was made and 4 miles of distribution pipe were laid at a cost of £13,000 to convey water to some 550 donums of cereal crops. This is the first stage of a larger scheme which will include a 60 feet high dam to store 28 million gallons of water for 1400 donums of winter and early summer irrigation. A somewhat similar arrangement was made at Lefka where 6,280 feet of distribution pipe was laid as a start for a large scheme the chief item of which will be the 85 feet high Marathassa dam to impound 80 million gallons.

13. A river training scheme on the Xeros River, Paphos was in progress at the end of the year. It consists of 8 gabion groynes and 5550 feet of wired reinforced concrete staking of a type first used experimentally at Kapilio in the Limassol District.

14. Works were carried out or started with funds provided by other departments. These include the installation of four borehole pumps at Morphou, three for the Government Experimental Farm and one for the Education Department, and some channelling at the Akhelia Chiflik in Paphos for the Department of Agriculture. A request from the latter department for a pumping installation to extract water from a recently completed gallery under the river bed at Akhelia will be attended to in 1959 as soon as some land acquisition difficulties have been solved. Pumping plant previously installed for the Departments of Agriculture and Forests suffered considerably from sabotage during the

year, no less than 9 installations being badly damaged.

15. Irrigation schemes that have been planned and are ready for construction but not yet started include the Argaka - Magounda dam and channels (£35,000), Syrianokhori irrigation channels (£26,000), Kato Lakatamia channels (£26,000), Pano Zodhia and Angolemi channels (£17,000) Polis channels (£14,000), Phinikas infiltration works and channels (£13,000), Kyra pumped irrigation scheme (£10,000) and Elea pumped irrigation scheme (£8,000). A complete list of 106 schemes awaiting execution is given in Appendix 9. Preliminary investigations have been made for proposed dams at Aradhippou, Ay. Theodoros, Psevdas, Petra, Livadhia and Limnitis. These will require further examination and preparation by the Projects Section before they are ready for construction.

16. Some interesting measurements of the quantity of water per donum used for irrigation in actual practice on 10 plots of land are given at the end of Appendix 5. If better irrigation methods and practices were used there is no doubt that very much less water could have been made to produce equal crops.

INVESTIGATIONS FOR MAJOR IRRIGATION PROJECTS

17. The Projects Section of the department was established in June 1958 under a Senior Engineer for the purpose of carrying out detailed field and office investigations and the preparation of plans for the larger irrigation projects after preliminary investigations have been made by the Irrigation Section. In 1958 the schemes described in the following paragraphs were examined.

18. The Akaki Catchment Storage Scheme in the form now being planned consists of three large mass concrete irrigation dams on the Akaki River upstream of Malounda village, and a lined conveyor channel to deliver the water to the lands of Meniko and Akaki villages.

Dam	Height above river bed ft.	Storage capacity m.g.	Approx. cost £
Malounda	80	420	150,000
Saittas	80	355	240,000
Spithia-tous-Papadhes	112	370	220,000

These dams can be built one at a time in any order as money becomes available. The conveyor channel, 5 miles long of 21 cusec capacity, will cost about £40,000 and should be built with the first dam.

19. The proposed Sklidros dam is part of a scheme on the Maroulena River which is one of the two chief tributaries of the Akaki River upstream of the works described in the previous paragraph. It is required to provide summer water for the Palekhori Irrigation Division for which channels costing £13,000 were built in 1951-1953. The dam is to be curved in plan and of the mass concrete gravity type. In the first instance it is to be 75 feet high above the river bed but provision is made for future heightening to 90 feet by means of prestressed cables anchored in the bed rock under the dam. The storage capacity before heightening will be 150 million gallons and after heightening 250 million. The cost of the first stage will be about £100,000.

20. A smaller dam 43 feet high above the river bed to impound 17 million gallons is proposed on the Pharmakas River which is the second of the two chief tributaries of the Akaki River. This dam is to supplement the works of the Kalokhorio Irrigation Division which already possesses a dam 37 feet high together with 2½ miles of lined channels. The cost of the new dam which is 3,200 feet upstream of the first, will be about £30,000.

21. Detailed surveys and drawings were completed for the proposed Marathassa Dam near Lefka. This is to be a concrete gravity dam 85 feet high above the river bed of storage capacity 80 million gallons. The cost is estimated at £90,000. A pipe line and temporary intake for this scheme was constructed in 1958 as described in paragraph 12.

22. The inhabitants of the villages near Trimiklini in the Limassol District, having seen the advantages of the

recently completed dam (105 feet high) have asked for three more similar dams on the same river. It is unlikely that all three will be feasible but surveys are in progress for two at sites near Saittas, upstream of the completed dam. These are both likely to be about 100 feet high and the cost will be of the order of £150,000 and £175,000 respectively exclusive of distribution channels. A single main distribution channel 5 miles long to serve both proposed dams is under study and may cost a further £50,000.

23. The cost of dams built in Cyprus is usually high in relation to storage capacity because of unfavourable topography, the valleys being for the most part too steep and narrow to hold much water without a disproportionately high dam. Because of the extremely high value of water for early and late summer irrigation, however, there are many places where the construction of dams up to about 100 feet high such as those mentioned above will be economically sound. A preliminary assessment of the possibilities made on the basis of information available in 1958 indicates that under present conditions some 25 or 30 additional dams are likely to be sound economically and feasible in practice.

24. The Akaki River Training Scheme is being planned with a view to reclaiming waste land in the lower reaches of the river between Meniko and Morphou. Under present conditions the dry river bed occupies a width of up to 2,000 feet whereas a waterway of only about 250 or 300 feet is sufficient to pass all except the very highest floods. Much of this land could be made suitable for agriculture if the river were confined to a narrow channel. A detailed survey has been made of the twelve miles of river bed involved and a scheme is being prepared using a combination of reinforced concrete wired staking and gabion groynes. The average cost of this type of work is likely to be about £6,000 per mile. Since it is somewhat experimental it will be advisable to carry out one or two miles only in the first instance in order that results may be observed and the nature of the works modified or changed as necessary.

TOWN WATER SUPPLIES

24. Under present conditions the Water Boards of Nicosia, Limassol and Famagusta are responsible for the supply of most of the water to their respective towns. The members are nominated half by Government and half by the Municipal Council and the Chairman is appointed from among these six by the Governor. In Larnaca the water authority is the Evcaf Department while in both Paphos and Kyrenia it is the Municipality. The Department of Water Development advises all the above authorities on the technical aspects of their water supplies. In the case of Nicosia the Department itself now supplies a large proportion of the water.

26. In 1958 the Town Water Supply section of the Department was occupied chiefly with the construction of the final stages of the £850,000 Greater Nicosia Scheme, which is now virtually complete. It was also engaged in planning extensions to the water supplies of Nicosia, Famagusta and Limassol and in miscellaneous minor construction work. Details regarding town water supplies, including consumption figures, are given in Appendices 10, 11 and 12.

27. Restrictions in summer were required as usual in the part of Nicosia which lies within the old town walls, where there is still no pressure water supply, and at Limassol and Larnaca. Because of the rapidly increasing population, rising standards, and the continued deterioration of many of the sources it will be necessary to spend large sums of money on town water development in the next few years. This will be seen from the following paragraphs which describe the position briefly as regards each of the chief towns.

28. In Nicosia the completion of the Greater Nicosia scheme removed temporarily the overall shortage of water but the inadequacy of the pipe system within the walls caused the usual restrictions in that part of the town. The Greater Nicosia Scheme is a Government project which supplies water in bulk to the Water Board of Nicosia and to individual consumers in suburban areas. It is designed for eventual integration with the Boards works and with the Morphou Bay Scheme which will follow in the next phase of development. In 1958 it supplied a summer average of some

1.50 million gallons per day to Nicosia of which 1.00 m.g. was from its own sources and 0.50 m.g. from privately owned sources brought to Nicosia in the new supply mains. The total consumption in the whole of Nicosia in the summer amounted on the average to about 3.00 m.g.d. The August consumption per person was roughly as shown below:-

	Population (approx.)	Consumption Gallons per person per day
Nicosia within walls (Restrictions in force)	25,000	20
Water Board Area outside walls (No restrictions)	39,000	58
Suburbs (only part of future consumers yet connected to the new scheme)	23,000	17
Total and Average	87,000	36

29. Because of the steady deterioration of one of the main pumping grounds, Kokkini Trimithia, it is unlikely that the present supply of 3.00 million gallons per day can be maintained in future without extensions to the present works. Meanwhile the population of Nicosia is increasing rapidly, by 53% in the ten years 1946-56, and living standards are rising. It is very clear, therefore that more water is wanted.

30. The next phase of development has been planned and consists of pumping four million gallons per day to Nicosia through a 24 mile twin rising main from Morphou Bay against a total pressure head of 800 feet. The first stage of construction of this phase will consist of the pumping station and a single pipe line to deliver 2.00 m.g.d. and the second stage of extra pumps and another pipe to deliver a second 2.00 m.g.d. The pipes and most of the machinery for the first stage were ordered and delivered in 1958 but money for construction is not yet available. The Westminster firm of Messrs. Howard Humphreys and Sons are consulting engineers for the main pumping station and pipe lines.

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31. The present system of administering the Nicosia water supply has given cause for considerable anxiety both on the technical and financial sides. Water is now sold, directly or indirectly, by three chief authorities namely Government, the Water Board and the Water Administration and in the case of the Board the current charges are not sufficient to recover expenses including such matters as loan charges and adequate maintenance costs. With a view to improving the organisation and to safeguarding its investments Government has proposed that a new Board should be set up to control water supplies to the whole of Nicosia including the suburban villages. At the end of the year this proposal was under consideration by the municipal members of the present Board.

32. In Famagusta, although no restrictions were imposed in 1958, the water supply is in a dangerous state because the water levels in the Phrenaros boreholes, from which most of the water is drawn, is declining from year to year with very little recovery after the winter rains. It is unlikely that the present output from these boreholes will be maintained for many more years.

33. In the summer of 1958 the total consumption was slightly over 1.00 million gallons per day, or approximately 35 gallons per person per day for a population of 30,000. In the ten years 1946-56 the number of inhabitants increased by 65.4%, the highest rate of any town in Cyprus. This rapid expansion, and the improbability of maintaining the supply at even its present level, indicate clearly the very urgent need for additional water.

34. A scheme has been prepared for supplying an additional one million gallons per day in the first instance, from near Xylophagou, through a main pipe line designed for a future flow of 2.2 m.g.d. The sources are ten boreholes that have been tested at various rates from 9,000 to 16,000 gallons per hour per borehole. The proposed main pipe line is of asbestos cement, 15" diameter and 10 miles long. A one-million gallons covered service reservoir that can be enlarged in future is included in the scheme, and from this reservoir separate pipes will deliver the water to the

existing Stavros reservoir, to the northern part of the town, and to the military camps at Karaolis and Ay. Nicolaos. No street distribution pipes are included. The scheme is estimated to cost about £350,000. It would be possible to carry out part of this scheme only in the first instance at a cost of £200,000 in which case the water delivered would be about 700,000 gallons per day. Some of the pumps and materials required for this scheme have been ordered as described in Appendix 10.

35. Although the Limassol Water Board had minor difficulties in keeping up its supply of water due to temporary breakdowns of the pumps at Chiflikoudhia it was able to carry on through the summer with only relatively minor restrictions as described in Appendix 10. The total consumption rose to over 1.50 million gallons per day or approximately 37 gallons per person for a population of 41,000. The population increased by 60.1% in the ten year period 1946-56, which is the second highest rate of all the towns in Cyprus.

36. As Limassol grows more difficulties are to be expected each summer in finding sufficient water. As a short term measure it will no doubt be possible to make greater use of the re-charged ground water area at Chiftlikoudhia but new sources outside the town will be needed before many years. Preliminary plans have been prepared for pumping water from boreholes in the Kolossi-Phassouri area into the existing steel main from Khalassa, which now runs at less than half capacity in summer when the springs are low. It is planned to pump 0.80 million gallons per day into the Khalassa pipe line which, with the water from the springs, will then be enabled to discharge 1.40 million gallons per day at the Limassol reservoir throughout the summer. The cost of these proposed works will be about £45,000. In addition a new service reservoir of about one million gallons capacity costing about £40,000 will be needed before many years, and improvements will be advisable at Chiftlikoudhia pumping station. The total cost of all the above works is likely to be of the order of £110,000.

37. The Larnaca supply this summer amounted to about 850,000 gallons per day or 45 gallons per person for a population of 19,000 and minor restrictions were imposed as

described in Appendix 10. In a very dry year the only source, the Bekir Pasha chain-of-wells may yield only 500,000 gallons per day or 26 gallons per person. The increase in population in the ten years 1946-56 was 20.9%. Additional sources for Larnaca are not so necessary as for the other chief towns because usually the total water available is reasonably sufficient. Improvements to the existing works are however required to provide an equitable distribution of the water throughout the town. Proposals include the duplication of the existing 15" main from the tunnels to the town, the construction of an 800,000 gallon service reservoir, the division of the distribution system into 6 independent areas, and the introduction of more meters to replace the existing saccoraphi system of distribution.

38. In the smaller district towns and municipalities works have also been planned. For Paphos, a 24 mile pipe line is to convey 300,000 gallons per day from the Trozena springs near Yerovasa a distance of 24 miles. When the springs diminish in summer the supply will be made up by pumping from the Dhiorios river bed. For Morphou a new scheme includes new boreholes from which the water will be drawn, a 300,000 gallon service reservoir, and a new distribution system. Kyrenia needs additional water. Efforts spread over many years to find sufficient from boreholes have met with only partial success and there now appears to be no alternative but to pipe the water from the Karavas and Lapithos springs. A scheme has accordingly been drawn up to include supply pipe lines from the springs, a 200,000 gallon service reservoir and improvements to the distribution system.

VILLAGE WATER SUPPLIES

39. The work of the Village Domestic Water Section is confined mostly to water supplies for villages and rural municipalities but it also includes the towns of Paphos, Kyrenia and Morphou which are mentioned in the preceding paragraph. Sources of water are examined, measured, and where suitable, developed. Supply and distribution pipe lines are laid and storage tanks and public "fountains" constructed. A "fountain" is a combined public standpipe, trough and drainage soak pit. House connections are not normally made but there is a growing demand for this convenience. The sources of a village water supply may be springs, infiltration galleries, boreholes or wells.

40. During the year 40 village water supply works were completed and 53 miles of pipes were laid. Six of these schemes were new or complete replacements and the remainder were improvements to existing supplies that were formerly unsatisfactory or inadequate. Work on one scheme was stopped and not restarted because of sabotage to machinery. This was at Yialousa where a 100,000 gallons circular tank was under construction and about half finished.

41. It is now estimated that of the total of 627 villages named in the census of 1946, the number with piped supplies is 517 or 83%. 366 (58%) may be considered satisfactory and 151 (24%) need fundamental repairs or replacements. Because of rising standards a number of village water supplies that were formerly considered satisfactory are now inadequate and require improvements. The 110 villages still without piped supplies are on the whole situated far from reliable sources, and the cost and difficulty of supplying them with piped water will, in most cases, be greater than in past schemes.

42. In addition to the 40 schemes completed in 1958 a further 9 schemes were under construction but incomplete at the end of the year. Plans have been prepared for a further 140 schemes and, although some need modification in view of changing circumstances, most are ready for starting as soon as money becomes available. The following table indicates the work done on village water supplies during the year under review:-

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VILLAGE WATER SUPPLIES

LENGTH OF PIPE LAID IN 1958

(All pipes are of galvanised steel)

Size	¾"	1"	1¼"	1½"	2"	2½"	3"	4"	Total
Miles	2.23	7.22	7.77	5.70	16.95	2.00	3.07	7.87	52.87 miles

Elevated tanks: 4, Ground Level Tanks: 20, Pumphouses: 3
Fountains: 138, Distribution Boxes: 5

43. The schemes completed may be classified as shown below. "Village Standard" means that the distribution of the water is effected by street fountains only, not by house connections.

(a)	New schemes to village standard where previously there was no piped water	3
(b)	Total replacement of an absolete scheme	3
(c)	Improvements to village standard only	24
(d)	Improvements including house connections	3
(e)	Water supplies to schools and police stations	7
		40

Of the above 40 schemes, 27 obtain their water from spring and 13 from wells or boreholes by pumping.

44. The largest village domestic waterworks under construction during the year was a combined scheme in the Karpas for Ayia Symeon, Korovia and Galinoporni with provision for future extensions to Nata, Vathylakas, Lythrangomi and Leonarisso. The source of the water is a pair of boreholes near Ayios Andronikos and the works comprise, in the present phase, a pumphouse with a 30,000 gallons storage tank, 6,500 feet of 6" rising main, a 100,000 gallons circular storage tank, some 11½ miles of supply and distribution pipe, 3 village storage tanks and 42 fountains. Work on this scheme was started on 30th October.

45. Water supplies were installed in two detention camps that were erected as emergency measures and were required quickly. Both involved pumping installations and reinforced concrete elevated tan s. At Mammari a 30,000 gallons circular tank was built on a 20 foot concrete trestle and at Pyla a similar 20,000 gallons tank was built on a trestle of the same height. The time

occupied in construction, including the preparation of difficult foundations, was 104 days at Mammari and 57 at Pyla where high alumina cement was used in parts of the tank to speed up the hardening of the concrete.

DRILLING FOR WATER

46. The activities of the Drilling Section in finding and developing new sources of underground water may be assessed by the fact that during the period 1946-1958 a total of 2,591 new boreholes was sunk with an aggregate of 487,505 feet of drilling. Two-thirds of these boreholes were successful and the tested total quantity of water pumped therefrom was 11.4 million gallons per hour. It is estimated that, as a result of the drillings, the total additional volume of water now available for irrigation, domestic, and industrial purposes is of the order of 132 million gallons per day. The agricultural development which has taken place as a result of the perennial irrigation from borehole pumping is clearly visible in many areas throughout the island, such as in the Western Mesaoria, the Akrotiri Peninsula and around Xylophagou and Liopetri. Where previously the summer landscape was bare and arid, citrus groves and vegetable gardens are being extended year by year and the agricultural economy of these districts greatly enhanced.

47. Water for the towns of Nicosia and Famagusta and for most of the villages of the plains is derived from boreholes located and sunk by the Department of Water Development. Schemes for additional supplies for these towns and for other villages from new boreholes are under construction and in course of preparation.

48. In 1958 most boreholes were sunk on a full cost basis for private individuals, public bodies and commercial companies for irrigation, domestic supply and industrial purposes. Boreholes have also been sunk for military camps and installations and each year Government has drilled at its own cost a considerable number of prospecting boreholes to test the potential resources of new areas. A scheme for subsidizing the drilling of boreholes for private persons was discontinued in August 1957 since when no further applications were accepted although where deposits had been previously made the boreholes were drilled as

opportunity occurred. Applications for drilling continue steadily although at a slightly reduced rate and at the end of the year there was a waiting list of 140.

49. Sixteen drilling rigs were available for use during most of the year but because of the danger of sabotage the actual number working at any one time varied between 15 and 3, and the average was 9. Two drilling rigs were damaged by terrorists near Morphou and one near Limassol and as a result all drilling was stopped in these two areas. The three damaged machines were all repaired. At the end of the year only four machines were in operation and 12 were standing idle in the workshops.

50. All the department's drilling rigs are of the percussion drilling type and with one exception have a normal capacity range of 8" to 10" diameter holes to a depth of about 500 feet. One other rig, a Ruston-Bucyrus 60 R.L., is a heavier type, capable of drilling to over 1000 feet or shallower large-diameter boreholes. One machine has a rotary attachment which enables core samples to be taken. In 1958 the average drilling depth of boreholes sunk for water was 225 feet and the greatest depth 1,020 feet.

51. The number of boreholes sunk by the department during the year was 157. Of these, 99 were for irrigation, 11 for domestic water, 26 for prospecting for water and 5 for industrial supplies. In addition one observation borehole was drilled and a further 15 for technical and engineering purposes. Of the 141 boreholes for water, 115 produced more than 1000 gallons per hour on test and are classified as successful. The tested outputs show that, if pumped together, these boreholes are capable of a total output rate of 1,031,000 gallons per hour.

52. In addition to the above Government work, a considerable amount of drilling for water was carried out by registered contractors. Twenty privately owned percussion drilling rigs operated during 1958 most of them of a light, locally built, type which is suitable for drilling only in favourable rock strata. Private drillers have sunk 180 new boreholes for water during 1958, of an average depth of 117 feet and a total estimated (but not tested) output rate of 700,000 gallons per hour.

53. The widespread and intensive drilling operations which have been carried out in recent years have undoubtedly discovered and demarcated most of the island's aquifers so that it is unlikely that any extensive new areas of underground water remain untapped. During 1958 Government prospecting drilling was mainly devoted to finding domestic water for Nicosia at Morphou Bay and for rural communities throughout the island and although no extensive new ground-water areas were located the results were on the whole most satisfactory.

SEISMIC GEOPHYSICAL SURVEY

54. A team from the Directorate of Overseas Geological Surveys, London, carried out a successful seismic geophysical survey of 14 "dry" river beds. This survey which was of a preliminary nature, was carried out to determine the approximate depth to the bedrock and hence to provide information concerning the quantity of water held in the overlying gravels and the best means of extracting it. The survey and its results are described in Appendix 4.

HYDROLOGY

55. The hydrological service continued and increased its work of collecting and recording information on the following subjects:-

(a) Changes in ground water levels
(b) Quantity of water pumped from wells and boreholes
(c) Annual re-charge of aquifers
(d) Flood run-off in rivers
(e) Summer discharges of streams
(f) Discharges of springs
(g) Run-off from different types of catchments
(h) Chemical and bacteriological analyses of water.

Special intensive studies are being made of groundwater conditions in the Phrenaros area which is the chief source of the Famagusta town water supply and in the Kokkini Trimithia and Morphou Bay areas which are of special importance to Nicosia water supply. Hydrological information is summarised regularly by the Engineer-Hydrologist in monthly and annual reports.

56. A comprehensive report on the water resources of

Cyprus was prepared in 1958 by the Engineer-Hydrologist summarising the results of hydrological surveys and studies made since the inception of the hydrological service in 1954, taking into consideration other information collected by the department during the past decade and earlier. The report describes the hydrological conditions of each catchment area and gives estimates of run-off, and of the replenishment and yield of groundwater areas.

57. Among the results obtained from hydrological surveys and research one of the most useful is the information concerning the effect of the recent expansion of borehole pumping upon the underground water resources of the island. The increased agricultural production resulting from irrigation with pumped groundwater is of great economic value to the island and it is very important that the present pumping output should not only be maintained but that it should be increased from year to year where possible. The reservoirs of underground water, however, are not unlimited and so in developing irrigation from wells and boreholes, one must take care not to exhaust the aquifers by drawing off more water than can be replaced naturally from the rainfall or in some cases artificially by re-charge works.

58. In order to study the effect of the recent developments it is necessary to keep a careful watch upon changes of ground water level in pumped areas. For this purpose a total of 55 special observation or control boreholes has been drilled at key points, and within the special study areas some 2,000 privately owned wells and boreholes are observed at regular intervals. The chemical quality of the water is also checked periodically so that any increase in salinity can be detected at an early stage. The information obtained from these observation boreholes is showing beyond doubt that in certain areas such as Phrenaros, Famagusta, Kokkini Trimithia, Laxia, Morphou Bay and elsewhere new drilling must be rigidly controlled if existing public and private interests are to be protected and if further groundwater development is to proceed on sound lines.

59. A summary of the water levels over the past six years is given in Appendix 6. This shows, among other

things, that the minimum ground water level at Kokkini Trimithia, which is still the chief source of the Nicosia town water supply, fell by more than 12 feet in the past 7 years. At Phrenaros West, one of the two chief sources for Famagusta, it fell by 14 feet in 7 years and at Phrenaros North, the other source for Famagusta, by 14 feet in 6 years. This rapid and continuous decline in water levels has now reached the stage where it indicates clearly that both the Kokkini Trimithia, and the Phrenaros groundwater areas are becoming seriously depleted and that unless the rate of pumping is greatly reduced or unless artificial recharge is found possible, it is only a matter of time before disaster overtakes the sources used in these areas for the town water supplies of Nicosia and Famagusta. It is therefore imperative that these two towns should develop alternative sources.

60. In groundwater areas near to the sea the fall in levels is usually less marked. Along the Morphou Bay Coast the observation boreholes a few hundred feet from the shore showed a decline of 2 feet in the past 3 years while at 1½ miles inland the decline over the same period was nearly 8 feet. This represents a flattening of the groundwater gradient to the sea from 0.15% to 0.08% within 3 years. At Xylophagou, where the observation boreholes are on an average about one mile from the sea the fall over the past two years was about 2.0 feet. Around Famagusta, the groundwater level has remained substantially constant since 1953 when re-charge operations began both directly by means of the first stage of the Famagusta Recharge Scheme and indirectly from the water of the new town supply.

61. In the hydrological year 1957/58 (1st October to 30th September) only about 12½ million gallons of water passed into the Famagusta Recharge Tunnel from the Ay.Lucas end and 65 million from Paralimni Lake. At the end of the calendar year of 1958, however, there was good rainfall in the Famagusta district and about 7" fell in Famagusta in December. It is estimated that in this month some 28 million gallons entered the recharge tunnel from Ay.Lucas Lake and about 5 from Paralimni. In addition some 25 millions entered the aquifers through the bed of the Ayios Lucas reservoir. The total artificial recharge for the month of December at Famagusta is therefore estimated at about 58 million gallons. At the end of the year there

were still some 25 m.g. stored in the Ayios Lucas lake and probably an equal quantity in the Ayios Nicolaos valley, all available for recharge. It may be said, therefore, that the month's rainfall brought in not less than 100 m.g. for artificial recharge.

62. At Limassol, in the season 1957/58 the total recharge made by the Limassol Water Board into the Chiflikoudhia chain-of-wells was 102 million gallons and the total extraction by the Board was 57 millions. Privately owned wells in the vicinity no doubt benefited from this recharge operation because the ground water in the area is now sweet although before the recharge operations began the common salt (NaCl) content was around 1,000 parts per million.

63. No exceptional floods occurred in the winter of 1957/58 although the early rains caused a number of fairly high discharges in the Paphos district among which was a short flood of 4,700 cusecs on the Stavros River at the Evretou recorder and 3,400 cusecs on the Khrysokhou River at the Skoulli Recorder. The percentage run-off over the whole hydrological year was generally less than average ranging from nil at sea level on some of the longer rivers such as the Pedieos to up to about 30% at the higher measuring stations. At Trimiklini (1900 ft. above the sea) the average percentage run-off was 22% and on the Peristerona at Panayia (1450 ft.) it was 32%.

64. The measurement of spring discharges was continued at regular intervals as part of the normal hydrological survey and also, in special cases, for proposed village water supplies. A total of 266 springs or small streams was measured regularly, involving 1508 measurements.

65. Totals of 1171 samples of water for chemical analysis and 381 samples for bacteriological analysis were collected during 1957-58 and submitted to the Government analyst and the Government pathologist respectively. The samples were taken mainly from domestic water supplies all over the island during periodic checks and from control boreholes to test ground-water quality. Samples were also taken from all new boreholes during pumping tests and from various springs, streams and rivers used, or intended to be

used, for irrigation purposes.

66. Notes on the work of the Hydrological Section for the year 1957-58 together with summarised information are given in Appendices 5 and 6.

WORKSHOPS

67. Changing labour conditions, rising costs, and the increased use of pumping both for irrigation and domestic water have made it necessary for the department to operate and maintain additional mechanical plant, and the workshops have accordingly been enlarged so as to be capable of undertaking their increased responsibilities.

68. The workshop section of the department attends to the maintenance of all departmental plant and in addition serves all the other sections of the department in respect of such matters as the building of forms for concrete work, carpentry, the supply of precast concrete products, the installation of pumping plant, the fabrication of special pipe connections and steel sluice gates, the cutting and bending of steel reinforcement, the slotting and perforation of pipes and drilling casing, etc. etc.

69. The workshops and store accommodation of the department include workshop office, garage, fitters shop, plant maintenance bay, precast concrete yard, welders shop, smithy, a small moulding shop, a water-meter testing room and three store buildings. In addition there are two open storage sites one of 1½ donums, used mostly for interchangeable timber formwork, and one of 12 donums for pipes.

70. A list of the chief items of plant now on charge is given in Appendix 17. Other plant is hired from contractors or borrowed from other departments as required. Heavy lorry transport is all hired from contractors but some departmental Rovers and light "Countryman" vans are used for the transport of personnel, light tools, etc.

71. A considerable quantity of plant was damaged by sabotage while engaged on construction work in different parts of the island. In only a few cases however, was the damage so great that repairs were not possible and much additional damage was no doubt prevented by the withdrawal of plant and the stoppage of work at most sites where

attacks were made. Damage costing about £6,000 in all for repairs or replacement was caused to 1 loading shovel, 1 builder's hoist, 5 concrete mixers, 2 concrete vibrators, 3 drilling rigs, 1 compressor, 1 landrover, 1 van and 1 pumphouse.

MISCELLANEOUS ACTIVITIES

72. Technical advice is frequently given to public bodies including the military and to private individuals on their water supply problems. The department is often asked to provide expert opinion on water disputes. Flood discharge estimates are sometimes required by public authorities. A total of 27 prolonged pump tests of wells and boreholes was made during the year for Government, the Military, public bodies and private individuals. The security of water supplies throughout the island has this year caused the department a certain amount of extra work. Miscellaneous activities such as the above, and the necessity for the department to be represented at numerous committee meetings on a wide range of subjects, absorb a very large proportion of the time of the technical staff.

73. A technical paper on "Hydrology and Water Development in Cyprus" was prepared in the department and presented to the Institution of Civil Engineers jointly by the Director, Assistant Director and Engineer-Hydrologist.

LEGISLATION

74. No new laws concerned directly with water development were enacted in 1958 and there were no noteworthy amendments to existing laws. Considerable attention has been given to proposed amendments of the Wells Law, the Water Supply (Municipal and other areas) Law and to a new Land Drainage and Reclamation Law. One order was issued under the Wells Law and a second is in the course of preparation.

75. The present Wells Law needs considerable revision in order to provide for the control of the repair and replacement of old wells within conservation areas, for the inspection of drilling works carried out by private drillers, and for miscellaneous matters concerning the rules for licensing drillers and their equipment.

76. It is proposed to alter the water supply (Municipal and Other Areas) Law, or to introduce a new supplementary law, in order to bring the whole of Nicosia, including the large suburban area, under the control of one large Water Board instead of under three separate authorities as at present.

77. The original bill for a Land Drainage Law was amended to provide for land reclamation at the request of the Director of Agriculture. The objects of the proposed law, as regards drainage, are to facilitate the maintenance and improvement of rivers and streams, the execution of river training works and the prevention of pollution.

78. A new order under the Wells Law issued on 15/5/58 to bring under control all new well-sinking in the Western Mesaoria from Kokkini Trimithia to Morphou Bay. A similar order is being prepared to protect the water-bearing area north of the Kyrenia Range between the mountains and the sea, to both the east and west of Kyrenia town.

FINANCE

79. The following is a summarised statement of the expenditure of the Department of Water Development in 1958:-

	Government funds	Contribution from Beneficiaries	Total
1. Irrigation & Drainage	£ 66,775	£ 28,500	£ 95,275
2. Village Water Supplies	46,525	40,700	87,225
3. Subsidized Drilling	4,800	1,000	5,800
4. Prospecting for water	8,150	-	8,150
5. Drilling upon repayment	-	21,875	21,875
6. Greater Nicosia water supply scheme	129,800	-	129,800
7. Morphou Bay Scheme	485,000	-	485,000
8. Town Water Supplies upon repayment	-	33,550	33,550
9. Hydrological Research	4,450	-	4,450
10. Purchase of Plant	15,950	-	15,950
11. Miscellaneous works for Government Authorities	35,800	-	35,800
12. Departmental and Maintenance	126,250	-	126,250
	£923,500	£125,625	£1,049,125

80. Included in the above statement are:-

1.	Personal emoluments	£ 76,556
2.	Wages for labour (approx.)	247,500
3.	Travelling	18,700
4.	Govt. controlled irrigation works	10,333
5.	Pump testing wells and boreholes	1,050
6.	Value of casing pipes fixed in boreholes	5,049
7.	Total cost of drilling and cleaning boreholes excluding items 5 and 6	39,725
8.	Maintenance of Govt. water supplies and purchase of water	9,200
9.	Water supplies for detention camps	25,451
10.	Expenditure under 1956/61 Development Programme including funds provided by other departments	908,254

81. The average cost of a new borehole in 1958 was £228, and the cost per foot of drilling £1.090 mils. A sum of £3,600 was collected as departmental charges for works carried out for water boards upon repayment and for other miscellaneous works.

82. Water Development works are usually assisted by Government grants or loans, or by both grants and loans. Towards the cost of gravity irrigation works the village contribution varies from 20% to 60% according to the type of work and the nature of the ownership of the water. Where the water is owned collectively as by the members of an Irrigation Division, the usual rate is 20% for spate irrigation and 33.3% for perennial irrigation. In Irrigation Associations there is private ownership of water and the village share is usually higher than for a Division; each case is considered on its merits with the result that the average village contribution over the past year was about 47%. The village share of the cost of a scheme is usually raised by a loan from the Government Loan Commissioners at a low rate of interest but occasionally it is paid partly or wholly in cash or in free labour. A borehole under the former subsidized drilling scheme is carried out for a private person at a fixed price to him of £32.500 mils and the balance of the cost which, in 1958 has on the average amounted to about £156, is paid by Government. No applications have been accepted under this scheme since August 1957 but some arrears of drilling

/25.

still remain and are being attended to as opportunity occurs. Private individuals are now charged the actual cost including 20% departmental charges on works and 25% on the cost of casing pipe. Municipal Corporations, companies, etc., also usually pay the full cost and departmental charges at the rate of 20% on labour and 25% on materials. Town water supply works are paid for in full by the respective authorities including departmental charges at the rate of 6% on labour and 10% on materials. The new Greater Nicosia scheme and the Morphou Bay Scheme are, for the time being, financed wholly by Government Domestic water schemes for rural municipalities and villages are paid for half by Government and half by the village if no house connections are wanted. If there are house connections the extra cost is borne entirely by the village.

STAFF AND LABOUR

83. No noteworthy additions or changes to the strength of the staff occurred during the year. On 31st December it was as follows:-

Director	1
Assistant Director	1
Senior Engineers	3
Executive Engineers	6
Geologist	1
Superintendents of Works	3
Senior Inspectors of Works	7
Inspectors of Works	9
Technical Assistants	26
Foremen	79
Clerical, Accounts and Miscellaneous	40
	176

84. The former Engineer-Hydrologist Mr. M. Grehan left the department in August upon transfer to Uganda where he was appointed Director of Water Development. Mr. O.J.E. Gething was seconded from the Public Works Department to the post of Senior Engineer and took charge of the newly

established Projects Section. Two new Executive Engineers Messrs. A.J.B. Staveley and C.F. Sayer arrived from the United Kingdom. At the end of the year vacancies existed for 1 Engineer-Hydrologist, 1 Senior Geologist, 2 Senior Inspectors of Works, 9 Inspectors of Works and 10 Technical Assistants but because of adverse changes in the financial position no recruitment was attempted. Six scholars are studying in the United Kingdom for university degrees under Government scholarships.

85. The average number of labourers employed during the year was 929 as compared with 1453 in 1957 and the number in December was only 733 as compared with 1454 in December 1957. About 45% were classed as skilled labourers of Special Grade or Grades I, II & III and 35% were regular. The approximate monthly averages were as shown below:-

Month	Paid Labour	Free Labour	Total
January	1439	-	1439
February	1509	-	1509
March	1397	-	1397
April	986	-	986
May	893	-	893
June	687	-	687
July	639	-	639
August	720	-	720
September	687	-	687
October	742	25	767
November	692	-	692
December	698	35	733
Average	924	5	929

86. There were no serious labour disputes or strikes but many minor problems arose whenever work was interrupted by the frequent disturbances and curfews. Cost-of-Living and Field Allowance increases caused wages to rise by about 3% between 1st January and 31st December.

87. The disturbed political conditions made 1958 a very trying year for all the staff of the department, particularly for the travelling officers whose work was frequently interrupted both by terrorist sabotage and by the necessary searches and curfews imposed by the security authorities. In spite of these difficulties, which were endured cheerfully, a very praiseworthy record of progress was achieved and for this the staff deserves great credit.

CONCLUDING NOTE

88. In Cyprus the population and the living standards are both rising fast, particularly in the towns. Most of the increase of population is taking place within the six district towns where it amounted to 50% in the 10 years 1946-56. In the smaller towns and villages over the same period, it was only 6% and over the island as a whole 17.5%. These changes produce a threefold need for water development which may be summarised thus:-

(a) more irrigation works are needed to grow food crops.

(b) more piped water is wanted in the villages to improve living standards, which are well below those of the towns.

(c) more water is needed in the towns to which it has to be piped long distances at great expense.

Although limitations of money and technical knowledge make it unlikely that the island's water resources can be fully developed or utilised for some considerable time the urgent need and pressing demand are such that no effort should be spared to provide for a steady programme of works and investigations at the highest possible level of expenditure.

I.L. Ward
Director of Water Development.

APPENDIX 1
DRILLING FOR WATER

by D.P. McGregor B.Sc., A.M.I.M.M., Assistant Director and R.D.I. Morris B.Sc., Geologist.

During 1958 the department's drilling plant consisted of 16 rigs but owing to difficult security conditions they were seldom all in operation together, and the average number working was only 9. At the beginning of the year there were one Ruston-Bucyrus 60 R.L., eleven Ruston-Bucyrus 22-Ws, one Bucyrus-Erie 33 W and three Edecos. Three of the Bucyrus rigs were on loan from the Army but operated and maintained by the department. One of the Edecos was kept at head-quarters to be used as a standby. All these rigs are of the percussion type but one 22-W is fitted with a rotary attachment enabling the rig to be used for either percussion or rotary (shot crown or tungstem-carbide crown) core drilling. The normal capacity range of the rigs is 8" to 10" diameter boreholes to depths of up to 500 feet but the 60 R.L. is a much heavier duty rig. Under normal conditions it can drill an 8" diameter borehole to a depth of over 1,000 feet or, alternatively, can be used to drill 18" diameter holes to over 250 feet depth.

The department has also a number of transportable deep-well pumping units for long, continuous test-pumpings of wells and boreholes. In addition to several old reciprocating pumping units, there are two diesel-driven turbine pumps of 5,000 and 15,000 g.p.h. capacity respectively, at 100 feet head and two 25 K.V.A. mobile diesel-electric generating sets which are used in conjunction with $7\frac{1}{2}$" diameter electro-submersible pumps. With these units borehole test-pumping may be carried out in the capacity-head range of 18,000 gallons per hour from 100 feet to 8,000 gallons from 400 feet. In all eight long test pumpings, from 48 to 192 hours continuous duration, were carried out, involving a total pumping time of 823 hours and a total volume of six million gallons of water. Experience has proved how essential are these exhaustive test pumpings for proving the reliability of the aquifers.

/29.

The number of boreholes sunk during 1958 was 157 with an aggregate footage of 32,842 and an average depth of 209 feet. These figures do not compare very favourably with those of 1957 and reflect the unsettled political conditions existing during the year. Three Ruston rigs were sabotaged during 1958. The loss of these drilling rigs and the withdrawal of others to prevent their destruction resulted in the loss of 1,797 drilling days out of a possible total of 4,440. This is a loss of 40.5% of productive labour which is equivalent to 115 new boreholes. One rig was extensively damaged at Kato Kopia in April and another was superficially damaged at Ayia Phyla in September. After a third rig was severely damaged at Dhenia in November, very little work was possible for the remainder of the year and the number of rigs in the field was reduced to 4 all working in protected or safe areas. All the three damaged rigs have since been repaired in the department's workshops. Due to the risk of sabotage there was also a considerable drop in the number of wells and boreholes receiving long test pumpings in 1958.

On hundred and forty-one boreholes with a total footage of 31,701 were drilled for water. The average drilling depth for water was 225 feet. The average time taken to complete a borehole, including the time taken to lay casing and to carry out an 8 hour test-pumping of a successful borehole was 15.6 days. The average footage drilled per day was 13.4 feet. The total tested yield of boreholes drilled for water in 1958 was 24,744,000 gallons per day. In addition to new drillings 40 old boreholes were cleaned and renovated, involving 191 drilling days, equivalent to the average time taken to drill twelve new boreholes. Ninty-nine boreholes were sunk for irrigation, of these 82 or 82.8% produced on test an aggregate of 19.69 million gallons per day, a quantity which is considered sufficient to irrigate 9,800 donums in summer.

The number of successful irrigation boreholes drilled by Government since 1946 is now 1,056 with a tested output of 198 million gallons per day, sufficient to irrigate 99,000 donums of summer crops.

The actual area now being irrigated as a result of these drillings is conservatively estimated to be of

/30.

the order of 90,500 donums. The census of 1946 estimated that at the time some 53,000 donums of land were being irrigated perennially by pumped water. By the end of 1958 as a result of Water Development Department drilling alone this has been increased by 171% to 143,500 donums.

Apart from the necessity of meeting the continual heavy demand for new boreholes from the highly productive Mesaoria, drilling for water has been fairly evenly distributed throughout Cyprus in 1958. By districts, the borehole distribution was as follows:-

Nicosia & Kyrenia	72
Famagusta	25
Larnaca	16
Limassol	16
Paphos	12

and it is interesting to note quite a large increase in the percentage of successful drillings, 81.5% in 1958 compared with 75.5% in 1957 and 73.3% in 1956.

The 26 prospecting boreholes sunk during 1958 were mostly for domestic water supply, especially in Morphou Bay for Nicosia Water Supply. On one of these, near Syrianokhori, the Bucyrus 60 R.L. drilling rig penetrated to a depth of 1,020 feet. The first 71 feet was drilled with 24" diameter and the next 94 feet with 21" diameter casing. At greater depth 65 feet of 18" diameter, 245 feet of 12" diameter and 205 feet of 10" diameter were used. The remaining 340 feet was sunk with 8" diameter casing. Two new aquifers were discovered, one from 328-338 feet and the other from 632-670 feet, and valuable geological information was obtained. Samples of rock, including core samples, were collected and a study of the micro-fauna was made by the Geological Survey Department. Its report indicates that the samples of marl occuring from 440-1,020 feet are of Pliocene age. A similar study of rock samples from a borehole at Avgorou showed a geological correlation with the upper strata at Syrianokhori.

Although all the major underground sources of water must by now be known several prospecting and subsidized boreholes have produced interesting new discoveries of water. A borehole at Pergamos struck water

from 230-300 feet in the Lapithos formation which, in this locality, underlies more recent sands and marls. This is a particularly useful find of good quality water in an area where the groundwater level is falling. The quantity of water in the Lapithos rocks may not be very large however and recharge may be small, so water from an aquifer such as this must not be over relied upon.

Under very similar conditions, water has been found between bedding planes and along joints in the Lapithos marls and limestones of the Paphos District. Several prospecting boreholes were drilled near Ktima in 1958 and one is being developed for the domestic water supply of the town. Drilling here has shown how very localised the supply from this type of aquifer can be. Only a few hundred feet from the borehole being developed is one which is unsuccessful although it penetrated similar strata. Sufficient boreholes have now been drilled in the vicinity for a general trend of flow to become apparent.

A prospecting borehole drilled for Trakhoni village domestic water supply in the Limassol District proved very satisfactory in quality and quantity. The borehole is situated on high ground north of the village where there had been no previous drilling. Water was struck in sands and sandstone to a depth of nearly 200 feet. Although water was known to be present in gravels on low ground south of the village, the higher ground was not expected to yield large quantities of water.

Only one observation borehole was drilled in 1958. This was originally intended to check seismic survey results in the Kouris river at Khalassa, but is being utilised for observation purposes. Another borehole designed to check seismic survey results was started at Phinikari near the Yermasoyia river, but, due to the political situation at the time, it was never completed. It did prove the presence of water bearing gravels to a depth of 56 feet. Geophysical results and the geomorphology indicate that there is about one square mile of these gravels, lying upstream of a narrow gorge which forms a good natural barrier. The borehole was test-pumped only for one hour, producing 7,000 gallons, which indicates that there may will be quite a large undeveloped supply of ground water which could be used for irrigation.

In the Xeropotamos valley, north west of Mandria, a row of four boreholes was drilled to obtain a cross-sectional profile of the base of the river gravels. From the results it is hoped to be able to develop this source for irrigation using a shaft on the bank of the river and a gallery under the river as at Akhelia. It is interesting to note that the depths to bedrock compared very closely with results of the recent seismic survey, the average error being less than 10 feet.

An extensive programme of prospecting drilling has been carried out for the Army during 1958 in an area to the north of the Nicosia - Famagusta road at Ayios Nikolaos. Out of nine boreholes eight are successful, their yield increasing progressively northward. Only one is being developed at present, but others are being held in reserve to meet any increased requirements in the district.

There were twenty privately owned drilling rigs, licensed to drill for water, operating in Cyprus at the end of 1958, showing an increase in number of 6 rigs compared with 1957. Altogether they drilled 184 new boreholes, all for water, with an aggregate footage of 21,020. Of these boreholes 81% were successful and gave an estimated total output of 715,000 gallons per hour. Seventeen of these rigs are locally made, some of them quite well constructed, but they are of a rather light type generally only suitable for drilling in favourable rock conditions. There has been a tendency towards the use of imported drilling rigs by private contractors. In 1957 all rigs were locally made, but during 1958 three Ruston - Bucyrus rigs were brought into use. As in previous years the majority of boreholes have been put down in the Famagusta and Larnaca districts where drilling is comparatively easy and wells may be sunk without casing. There has, however, been increased activity in the Nicosia district during 1958 where one drilling rig was operating near Nicosia and three in the vicinity of Morphou.

By law, private drilling contractors are obliged to give notice of drilling, to keep records of depth of boreholes and static water levels, and to retain borehole samples for inspection by an officer of the Water Development Department. Test pumpings are not normally

carried out but from information received it is possible to arrive at an approximate figure of the total water yield of these private drillings. As many of the boreholes were drilled in the bottom of existing wells the increase in yields is somewhat conjectural but it is conservatively estimated that the increase in perennial irrigation as a result of these drillings is of the order of 2,000 donums in 1958.

The average cost of departmental drillings in 1958 was £228 per borehole or £1.090 mils per foot of drilling. These costs are inclusive of the expenses of laying casing pipes and of an 8-hour test pumping of successful boreholes. They are exclusive of the purchase price of borehole casing pipes and the capital cost and installation charges of permanent pumping plant. They include the wages of the drilling crews, fitters and blacksmiths, and the cost of workshop maintenance, fuel and lubricating oils, bit sharpening and repairs, and replacements of drilling tools and equipment. They do not include depreciation of drilling plant and the salaries and expenses of the supervisory staff. Thirty-one subsidised boreholes were drilling during 1958 costing an average of £188 each or £0.775 mils per foot of drilling. The beneficiaries contribution to the cost was £32.500 mils. Ninety one boreholes were drilled on a full repayment basis and thirty five were drilled entirely from Government funds.

APPENDIX 2

NUMBER AND FOOTAGE OF BOREHOLES

NUMBER OF BOREHOLES DRILLED

1951 - 1958

Purpose	1946-51	1952	1953	1954	1955	1956	1957	1958
For private individuals & Companies	612	195	169	182	170	128	202	106
For Government	164	21	51	57	101	55	62	35
For War Department and Air Ministry	93	26	10	15	62	30	29	16
TOTALS	869	242	230	254	333	213	293	157
Aggregate Footage Drilled	167,381	41,022	44,563	49,159	58,437	42,681	51,420	32,842
Average Depth	193	170	194	194	175	200	175	209

BOREHOLES DRILLED IN 1958

Purpose	No.	Existing well footage	Footage Drilled	%age successful	Total Tested Yield in gals/day
Irrigation	99	2,543	21,659	82.8	19,692,000
Domestic Water Supplies	11	-	2,606	90.9	1,756,800
Prospecting	26	325	6,131	84.6	3,256,800
Industrial	5	105	1,305	20.0	38,400
TOTAL FOR WATER	141	2,973	31,701	81.5	24,744,000
Observation Borehole	1	-	39	-	-
Technical and Geological Boreholes	15	-	1,102	-	-
TOTAL DRILLED	157	-	32,842	-	-

Old Boreholes Renovated: 40

APPENDIX 3

BOREHOLES DRILLED FOR WATER IN 1958

SUMMARY OF RESULTS

District	Locality	No. of B.H.s drilled	Number Successful *	% age Successful	Total Tested Output Gals/day	Average yield per successful B.H. Gals/day
Nicosia	Western Mesaoria Karavostasi-	49	48	98.0	17,210,400	358,500
	Limnitis	2	1	50.0	165,600	165,600
	Paleometokho-Yerolakkos	12	10	83.3	943,200	94,300
	Dhali-Kochati	3	1	33.3	144,000	144,000
	Xeri-Laxia	3	3	100.0	384,000	128,000
	Strovolos-Neapolis	2	1	50.0	120,000	120,000
Kyrenia	Boghaz	1	-	-	-	-
Famagusta	Kouklia-Vatili-					
	Strongylos	5	3	60.0	336,000	112,000
	Famagusta-Akhyritou	11	10	90.9	1,029,600	103,000
	Dherinia-Avgorou					
	Liopetri	9	7	77.7	734,400	104,800
Larnaca	Pergamos-Xylophagou	7	7	100.0	823,200	103,300
	Kalokhorio	4	-	-	-	-
	Troulli	5	1	20.0	38,400	38,400
Limassol	Cherkez Chiftlik					
	Trakhoni	7	7	100.0	1,101,600	157,500
	Polemidhia	4	3	75.0	436,800	145,600
	Ay.Athanasios-Yermasoyia	5	5	100.0	513,600	102,700
Paphos	Timi-Kouklia	2	1	50.0	168,000	168,000
	Ktima-Tala	10	7	70.0	595,200	85,000
	Totals	141	115	81.5	24,744,000	215,000

* A successful borehole is one that yields on test not less than 1,000 gallons per hour of usable water.

APPENDIX 4

SEISMIC GEOPHYSICAL SURVEY

By D.P. McGregor B.Sc. Assistant Director.

A seismic survey of selected river valleys in Cyprus was originally suggested by the Director of Water Development and at the request of the Government of Cyprus, and with the approval of the Secretary of State, was undertaken by the Directorate of Overseas Geological Surveys. The survey was originally planned for the summer of 1956 but because of the internal security situation in the island had to be postponed. The two geophysists, Mr. L.E. Makoweicki and Dr. D.J. Masson-Smith eventually arrived in Cyprus at the beginning of January, 1958 and spent 4½ months in the field. These notes are based on Mr. L.E. Makoweicki's report and interpretation of the results of the survey. The Directorate of Overseas Geological Surveys also provided the seismic refraction equipment used in the survey while technical assistance, labour, transport, explosives etc. were paid for from Cyprus Government funds.

The object of the survey was, by this rapid and comparatively inexpensive method of investigation, to determine the depths of water-bearing gravels in the valleys and the profiles of the underlying bedrock, as an alternative to laboriously slow and costly drilling operations.

The seismic method of determining the depth of the gravels (i.e. depth to bedrock) makes use of the fact that the velocity of the propogation of seismic waves in a given medium depends on the density and the elastic moduli of that medium. The seismic energy is usually created by the detonation of a small explosive charge at or near the ground surface and as the consolidated rock surface below the gravels normally causes the seismic waves to be reflected at a much higher velocity than those reflected by the intervening gravels, it is possible, under favourable conditions, to interpret the results in terms of depth to bedrock. The velocity of the waves is measured by the elapse of time between the explosion and the recorded arrival of the seismic energy at the point of measurement.

In this survey the standard technique of refraction recording was adopted. A spread, usually of 400 ft. length, was laid out along a traverse line with geophones (points of measurement) placed on the ground surface at 40 ft. intervals. As a rule four records were obtained for each spread with shots fired at each end of the spread and from the far ends of each adjacent spread. The average explosive charge used was about 1 lb of gelignite. The shots were electrically detonated by starting up the seismic measuring recorder which was carried in a Landrover and located at a safe distance from the explosions. A system of cables connected the explosive charges and the geophones with the seismic equipment by means of which the time intervals between the detonation and the arrival of the refracted seismic waves at the geophones were recorded photographically in milli-seconds.

In all some 2,300 records were obtained at 556 spreads. The total length of traverses carried out was about 14 miles. In some valleys movement was very difficult and the number of spreads covered in one day of field work varied from 3 to 15, with an average of 7½, equivalent to an average of 3,000 feet of traverse per day.

The accuracy of the results of the depth determinations cannot be guaranteed as they are dependent on certain technical factors concerning which it is not proposed to elaborate herein. As an example, however, it may be pointed out that it is extremely difficult to detect the presence of an old buried steep-sided narrow gorge. For the exact determination of depth to bedrock there is no known substitute for drilling. The usefulness of the survey, however, lies not only in time and cost economy but in the discrimination between parts of river valleys where bedrock is more or less uniformly shallow or where there is a sufficiently deep channel to be of potential hydrological interest from the viewpoints of either erecting dams or tapping reserves of groundwater. Unfortunately conditions have not, so far, been favourable for a programme of confirmatory drilling which is an essential follow-up to the seismic investigations. It is however interesting to note that in each of the three

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cases in which the seismic results were subsequently checked by drilling their accuracy was found to be within 10%. These three checks were made at Akhelia, Kandou and Phinikaria.

The field work carried out comprised the survey of selected parts of the following 14 river valleys:-

Yermasoyia	Pyrgos
Kouris	Limnitis
Dhiarizos	Xeros (Lefka)
Xeros (Paphos)	Pedieos
Ezuza	Yialias
Khrysokhou	Tremithios
Katouris	Vassilikos

A summary of the results of the survey is given below:-

Yermasoyia Valley. On the coastal plain between Yermasoyia village and the sea the depth of the river gravels was found to be from 70-100 ft. in a deep channel running slightly to the west of the present river course. Underlying this there is evidence of the existence of older, more consolidated gravels, possibly of marine origin, extending to a depth of over 150 ft., which are worth investigating. Seismic results also indicate the probability of the presence of the gravels to a depth of about 100 ft. in the valley for at least $1\frac{1}{2}$ miles and possibly 2 miles north of Yermasoyia. Still further upstream, above the river gorge, there is a flat basin-shaped area of about a square mile which again revealed the presence of a low velocity formation, about 50 ft. in thickness, underlain by rocks of slightly higher velocity. An uncompleted borehole subsequently confirmed the existence of previously unexploited water-bearing gravels in the upper section, underlain by silt. Unfortunately, for security reasons, the drilling rig had to be removed before bed-rock was reached.

Kourris Valley. The survey of the lower Kourris and adjacent low ground south of the Ktima - Limassol road was able to confirm and demarcate more accurately the course of the old buried river channel, over 200 ft. in depth, running from the river at Erimi south-east towards the Salt lake, and the presence of a ridge of bedrock, at the

comparatively shallow depth of only 50 ft. below the surface, along the course of the existing Kourris river south of the main road bridge. Northwards from Erimi deep gravels persist below the existing river channel rising gradually from 200 ft. at Erimi to 100 ft. below the surface at half-a-mile above Kandou. This appears to be about the upstream limit of the deep gravels for a short distance up the valley the depth to bedrock was recorded at only 40 ft. Traverses between this point and Khalassa showed gradually shallower gravels extending fairly uniformly over the full width of the valley.

Dhiarrizos Valley. This valley was surveyed at fairly frequent intervals from the Ktima - Limassol road upstream to just north of Kithasi. The results show the presence of unconsolidated river gravels getting progressively shallower upstream. Near the main road and for about a mile upstream their depth is of the order of 70 ft. At Prastiou village they are about 50 ft. deep and near Kithassi only 30 ft. in thickness. Most traverses, however, indicate the presence of a stratum, 40-60 ft. in thickness, of intermediate velocity, underlying the unconsolidated alluvium and above high velocity bedrock. It is not possible to suggest the geological significance of this intermediate layer without drilling. It may represent either clays or course boulder alluvium. If the latter should prove correct then the overall thickness of the potential water bearing formation along this valley is considerably more than indicated above.

Xeropotamos (Paphos) Valley. Traverses were carried out at intervals along this river valley from the Ktima - Limassol road to near Kelokedhara. The depth of gravels in the old buried river channel in the coastal plain and for the first mile or so upstream was found to be of the order of 100 ft. with bedrock clearly defined by a substantial difference between the velocities of the refracted seismic waves. Upstream the gravels appear to thin out rapidly to about 50 ft. near Phinakas and to about 20 ft. near Kelokedhara. In a section just south of Nata the survey again revealed the presence of the anomalous intermediate layer of moderately high velocity between the unconsolidated alluvium and bedrock similar to that found in the Dhiarrizos valley.

Ezuza Valley. The seismic survey of this valley reveals that near the Ktima - Limassol road the deepest section of the old river channel, with bedrock at 150 ft. below the ground surface, lies to the north-west of the present river and that deep gravels of upwards of 90 ft. in thickness extend upstream along the river for at least two miles. In the next section upstream as far as Pitargou village the gravels appear to be much shallower and may not exceed 30 ft. in depth. Above Pitargou, for a distance of about 2 miles, there are indications of deeper gravels, of from 60-100 ft. in thickness. One traverse across the river near Kourdaka showed bedrock, at a depth of over 120 ft., giving a very high seismic velocity, overlain by a layer of moderately high velocity rock. This anomaly is worth investigating.

Khrysokhou Valley. The area surveyed lies between Polis and Skoulli. In this valley the results show the presence of two distinct layers of rock giving fairly high seismic velocities overlain by a relatively small thickness of low velocity alluvium. The order of the higher velocity refractors indicate the probable presence of marls and clays of the Nicosia formation overlying older and more compact Pakhna marls. Only two small areas to the east of the road between Polis and Khrysokhou village, where the results indicate the possibility of finding deeper alluvium appear to be worthy of further investigation.

Katouris Valley. The surveyed section of this valley extends from the sea for 2 miles upstream. In this case the profile of the volcanic bedrock has been clearly defined, showing depths of gravel varying from 170 ft. near the sea to 110 ft. at the inland end of the section, with the deep channel closely following the course of the present river. Further inland the valley narrows considerably.

Pyrgos Valley. Three miles of this valley were surveyed and the recorded depth of gravel overburden varied from 150 ft. near Pyrgos to 100 ft. at the furthest inland traverse. Boreholes previously sunk showed the gravels to be about 20% deeper than the seismic results and while the seismic depth determinations may not be very exact it is felt that the general configuration of the bottom of the old valley floor has been deduced with reasonable accuracy.

Limnitis Valley. Traverses in this valley covered a section of about 3 miles inland from the sea. The recorded depth to bedrock varied from 140 ft. near the main road to 80 ft. a short distance north of the furthest inland traverse. Further upstream where the valley narrows bedrock was recorded at less than 50 ft. below the surface. As in the Pyrgos valley the accuracy of the depth determinations is suspect but the general configuration of the old valley bottom, as deduced from the seismic traverses, is considered to be reasonably correct.

Xeros (Lefka) Valley. Traverses were made at intervals along a four mile section of this valley inland from the coast. No features of particular interest were found. Depth of alluvium of the order of 100 ft. were recorded as far as 3½ miles inland. Beyond this the bedrock is at a much shallower level.

Pedieos Valley. Two long traverses of 8,800 ft. and 6,000 ft. respectively were made across the valley between Argates and Politiko to try to find the position of old buried river channels. The results show that the gravels are nowhere very deep. The underlying bedrock, apparently clay or marl of the Nicosia formation, is actually shallowest, at 20 ft. to 30 ft. below the surface near the centre of the valley. Deeper leads, of 60 to 80 ft. were located some distance on either side of the river and may be worth investigating.

Yialias Valley. The section of valley surveyed extends from about a mile above Nisou to half-way between Pyroi and Tymbou. The object of the work was to try to define the course of the old buried river channel which in this wide flat valley is known to deviate from the present river. Although lack of time restricted the number of traverses the results have proved most interesting in discovering deep gravel leads in previously unsuspected localities. North of the river near Nisou the depth of the old river gravels was found to be of the order of 80-90 ft. and south-east of Ay. Sozomenos an old 60 ft. deep channel was located 1500 ft. away from the river. Further downstream towards Pyroi and Tymbou the results confirm that in this direction the gravels thin out

considerably and nowhere was bedrock found to be more than 20-30 ft. below the surface. The moderate velocity of the seismic waves refracted from the bedrock indicates that the valley is probably wholly underlain by clays or marls of the Nicosia or Dhali formations except near Nisou where a deeper high velocity rock is probably a deposit of gypsum.

Tremithios Valley. Two traverses were made across this valley south of the Larnaca-Limassol road and above the headwell of the Bekir Pasha chain of wells from which Larnaca town obtains its water supply. This work was to determine the possibility of augmenting this supply. The results clearly show the profiles of the bedrock and suggest that little of the water in the overlying gravels is likely to by-pass the chain of wells. There are however two sections where a substratum of intermediate velocity has been located and where drilling is recommended to test the possibility of this being deeper water bearing coarse alluvium.

Vassilikos Valley. Two traverses were carried out across the valley above Kalavasos village but the results, which showed bedrock at only a few feet below the surface, rule out the possibility of the presence of any useful aquifer in this locality.

APPENDIX 5

HYDROLOGICAL NOTES 1957-58

By L. Mock B.Sc., Executive Engineer.

(This report covers the period from 1st October 1957, to 30th September, 1958).

Meteorological.

The principal features of the rainfall during the year were:

(a) The average rainfall over the whole island was about 18.3 inches which is about 95% of normal as compared with the average since 1908 which is 19.4 about inches.

(b) The rainfall for the year was higher than normal in the western and southern valleys of the Troodos mountains and about 80% to 90% of normal in the northern and eastern valleys. The east coast and north-west corner of the island had normal rainfall.

(c) Temperatures tended to be below normal during the autumn and above normal during the winter and spring. Most of the summer was mild although August was a degree or so warmer than normal. The highest temperature measured at Nicosia was 109° F in August.

Flood Discharges.

There were many flash flows during the heavy rains of autumn and early winter. The highest flood flows of the winter were 4700 cusecs at the Stavros River recorder near Evretou and 3400 cusecs at the Khrysokhou river recorder near Skoulli on the 1st December. The rainfalls on this day were 5.9 inches at Ayia Forest Station and 4.6 inches at Stavros Psokas.

The table below summarises some of the larger floods and gives an idea of the maximum rainfalls measured in the catchment on the day of the flood.

River	Place	Peak flow in cusecs	Rainfall in inches	Place	Date
Yialias	Kochati	1200	1.9	Kionia	30/5
Yialias	Kochati	1100	2.0	Kionia	2/1
Yialias	Aphania	1000	2.1	Athalassa	20/10
Tremithios	Ayia Anna	1800	2.9	Kornos	1/12
Tremithios	Larnaca-Limassol Road	1000	1.0	Kornos	21/10
Stavros	Evretou	4700	4.6	Stavros	1/12
Khrysokhou	Skoulli	3400	5.9	Ayia	1/12
Dhiarizos	Kouklia	1600	2.0	Kalokedhara	2/12
Yermasoyia	Yermasoyia	2900	1.4	Kalokhorio	30/5
Atsa	Petra Dams	2500/3000	3.1	Evrykhou	17/10
Meriki	Nicosia-Morphou Road	2000/2500	1.4	Deftera	17/10
Vathys	Nicosia-Famagusta Road	1800	2.1	Athalassa	20/10

River Discharges.

The intensity of rainfall and frequent spate flows resulted in considerable quantities of water reaching the sea in the southern Troodos rivers. For example it is estimated that almost 1800 million cubic feet of water flowed under the Dhiarizos and Xeros bridges on the Limassol to Paphos road. The rainfall in these valleys was about 105% to 110% of normal. Further east in the Yermasoyia river at Yermasoyia the discharge was estimated to be 300 million cubic feet. The rainfall in this valley was 100% to 105% of normal.

At the end of the hydrological year the following water level recorders were in operation.

No.	Catchment	Location	Type of Installation
1	Pedieos	Nicosia	Depth recorder
2	Yialias	Near Kochati	60 ft.measuring weir
3	Ovgos	Morphou-Kyrenia bridge	Depth recorder
4	Serakhis	Near Morphou	Depth recorder
5	Xeros (N)	Karavostasi bridge	Depth recorder
6	Marathasa	Lefka-Skouriotissa bridge	Depth recorder
7	Kharangas (F)	Near Kato Varosha	70 ft.irrigation weir
8	Avgorou	Near Avgorou	40 ft.measuring weir
9	Paralimni	Near Paralimni Lake	2 ft. flume
10	Pyrgos	Near Phlevas sawmill	30 ft.measuring weir
11	Limnitis	Near Limnitis sawmill	30 ft. measuring weir
12	Ovgos	Near Syrianokhori	6'7" removable plat weir
13A	Kouris	Limassol-Troodos bridge	18 ft.measuring weir
13B	Kouris	Near Kouris weir	1'6" flume
14	Peristerona	Near Panayia bridge	25 ft.measuring weir
15	Tremithios	Kiti	70 ft.irrigation weir
16	Yermasoyia	Nicosia-Limassol bridge	Depth recorder
17	Kouris	Near Kandou	300 ft.irrigation weir
18	Kalopannes	Near Kalopsidha	25 ft.measuring weir
19	Akhna	Near Ay.Yeorghios Church	40 ft.measuring weir
20	Phrenaros	Near Phrenaros	40 ft.measuring weir
21	Kokkini-Trimithia	Near Kokkini-Trimithia	40 ft.measuring weir
22	Liopetri	Near Liopetri	40 ft.measuring weir
23	Akaki	Near Malounda	40 ft.measuring weir
24	Skylloura	Near Ay.Vasilios	60 ft.measuring weir
25	Ak-Sou	Near Petra-tou-Dhigheni	30 ft.measuring weir
26A	Almiros	Near Geunyeli	40 ft. measuring weir
26B	Almiros	Near Geunyeli	2'6" flume beside weir
27	Khrysokhou	Near Skoulli	40 ft.measuring weir
28	Evretou	Near Trimithousa	25 ft.measuring
29	Syrgates	Near Skarinou	Depth recorder

No.	Catchment	Location	Type of Installation
30	Dhiarizos	Limassol-Paphos bridge	Depth recorder
31	Xeros (P)	Limassol-Paphos bridge	Depth recorder
32	Tremithios	Near Ayia Anna	40 ft.measuring weir
33	Karyiotis	Near Pendayia	60 ft.measuring weir
34	Alakati	Near Ayios Amvrosios	22 ft. measuring

Measured discharges 1957/58

The discharges measured at the gauging stations of the previous paragraph are as follows:-

Recorder No.	Catchment	Rainfall 10^6c.ft.	Run off 10^6c.ft.	Maximum discharge in a day 10^6c.ft.	Maximum flow cusecs	Percent Run off
1	Pedieos	1752	20	7.1	30	1.1
2	Yialias	1305	203	9.3	1250	16
3	Ovgos	2373	50	12	800	2.1
4	Serakhis	6741	102	11	900	1.5
5	Xeros (N)	1763	21	3.2	55	1.2
6	Marathasa	1557	171	3.3	40	11
7	Kharangas	226	13	6.1	500	6
8	Avgorou	441	2	-	140	0.4
9	Paralimni	-	10	-	-	-
10	Pyrgos	858	134	3.5	50	16
11	Limnitis	1461	278	6.2	130	19
12	Ovgos	-	3.5	-	-	-
13	Kouris (Trimiklini)	1661	370	9.2	200	22
14	Peristerona	1723	556	17	290	32
15	Tremithios (Kiti)	2045	2	-	1100	0.1
16	Yermasoyia	2237	300	19	2950	13
17	Kouris (Kandou)	8794	697	20	780	8
18	Kalopannes	-	1.4	0.6	-	-

Recorder No.	Catchment	Rainfall 10^6c.ft.	Run off 10^6c.ft.	Maximum discharge in a day 10^6c.ft.	Maximum flow cusecs	Percent Run off
19	Akhna	379	-	-	-	-
20	Phrenaros	129	6	3.5	430	5
21	Kokkini Trimithia	274	-	-	-	-
22	Liopetri	137	9	2.4	200	6
23	Akaki	1816	238	10.6	300	13
24	Skylloura	894	41	18.5	700	5
25	Ak-Sou	117	1.2	-	90	1.1
26	Almiros	360	29	5.7	800	8
27	Khrysokhou (Stavros)	1434	224	54	3400	16
28	Stavros	2327	193	22	22	13
29	Syrgates	2684	64	3.2	3.2	2.4
30	Dhiarizos	7249	1354	59	59	19
31	Xeros	5615	436	13	13	-
32	Tremithios (Ay.Anna)	-	111	-	-	-
33	Karyotis	-	57	-	-	2.7
34	Alakati	210	3.7	1.1	1.1	1.8

Spring Discharges.

The discharges of 266 springs or small streams were measured regularly involving 1508 measurements during the year. At the beginning of the year spring yields everywhere, except in the high valleys at the eastern end of the Troodos mountains, were well below normal. All spring flows increased considerably during the heavy autumn and early winter rains and at the end of this period were higher than last year and in some cases higher than normal. But, except in the south-western and western Troodos mountains, most yields began to deteriorate earlier than normal during the relatively dry late winter and spring months; and by the end of the year many springs were even lower than last year and very much below normal.

Ground-water used for Town Water Supplies:

Details of the water extracted from underground sources for the three largest towns of Cyprus are given below:-

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Nicosia	Quantity (Million Cub.Ft.)	Percentage
Trimithia	61.5	45
Athalassa	1.8	1
Arab Ahmet (upper and lower)	7.8	6
Laxia	5.9	4
Makedhonitissa	5.4	4
Dhali	6.6	5
Sykhari	9.6	7
Dhikomo	1.0	1
Prodhromos (approx.)	15.1	11
Others (approx.)	22.3	16
Total extraction during 1957/58	137.0	100
Famagusta		
Phrenaros West Boreholes	14.5	31
Phrenaros North Boreholes	28.2	60
Panayia springs	1.9	4
Others	2.4	5
Total extraction during 1957/58	47.0	100
Limassol		
Kephalovrysos Krya Pighadhia and Mavrommata springs	74.1	89
Chiftlikoudhia chain-of-wells	9.3	11
Total extraction during 1957/58	83.4	100

Groundwater Levels.

Groundwater levels began to recover early in the year when pumping for irrigation ended with heavy rain in October and November. During the above normal rainfall in December and January the increase in water levels was greater than normal and more rapid. But as a result of the poor rainfall in late winter and spring, irrigation pumping started earlier than usual and groundwater levels began to decline a month or so before normal. The decrease in water levels during the long irrigation season was greater than normal.

At Kokkini Trimithia the pumping for Nicosia water supply reduced the seasonal recovery of the aquifer which has only been about 0.6' during each of the past 2 winters. The average seasonal increase of the preceding 5 years is about 3.2'. Combined with the effect of the long irrigation season this has resulted in a decrease in 4.1' in the water level during the year and this is almost twice the average decrease of the past years. Rainfall over the eight seasons 1950/51 to 1957/58 has been about 101% of normal. There is no doubt that in this area extraction is now greatly in excess of recharge and that unless pumping is restricted many wells and boreholes will fail in the near future. Further information on this subject is given in the penultimate section of this appendix.

At Morphou Bay the gradient of the water table towards the sea has decreased by almost 50% during the last 4 years and the decline is continuing. There is no indication from chemical analyses of water from the control boreholes, or from boreholes under test pumping, of any deterioration in the quantity of water during the last few years.

The average water levels in the control boreholes at Phrenaros North and Phrenaros West are falling at the rate of 3 ft. and 2 ft. per year respectively. These areas supply most of the water used in Famagusta town and the continuous high rate of fall is viewed with considerable concern. The rainfall has been exactly average over the five seasons 1953/54 to 1957/58 and there is no doubt that in this area extraction greatly exceeds recharge as shown in closing sections of this appendix.

Near Xylophagou, in the area that is to supply water to Famagusta in future, the water table was in equilibrium until 1956 but during the last 2 years it has fallen by 1 foot in each year.

In Ayios Memnon about 10½ million cubic feet of water were recharged artificially from Paralimni Lake during the winter and there was no considerable change in the aquifer level. Salinity analyses did not show any significant variation. It is possible that without the artificial recharge the water level would have fallen.

Recharge Activities.

During the heavy rainfall in December 1957 about 2 million cubic feet of water collected in the Ayios Loucas reservoir at Famagusta. Most of this was run off from the Kharangas river. There was considerable dissipation of water by flooding or infiltration between the Kharangas measuring weir and the reservoir. It is estimated that 4 million cubic feet of water passed over the weir in November and 8½ million in December. The total recharge between the Kharangas weir and the Ayios Loucas reservoir during October, November and December was thus about 12½ million cubic feet but of this perhaps only one million entered through the recharge tunnel. During November and December water also collected in the Paralimni lake and was released to recharge the Ayios Memnon area. The flow continued into March and from November to March it is estimated that about 10½ million cubic feet of water passed through the flume below the outlet tunnel from the lake and thence into the Ay.Memnon end of the recharge tunnel.

In Limassol during 1957-1958 the following quantities of water were recharged into and pumped from the Chiftlikoudhia chain-of-wells.

Total Recharge into Aquifer.	Total Pumped from Aquifer.
8/11/57-25/7/58	26/7/58-30/9/58
16.45 M.cub.ft.	9.24 M.cub.ft.

The water remained of good quality throughout the pumping season.

Chemical Analyses.

During the year 1171 samples of water were sent to the Government Analyst. This number included 80 samples for full analysis and 712 for partial analysis from domestic water sources and 379 samples for partial analysis from springs, observation boreholes and irrigation boreholes.

Bacteriological Analyses.

During the year 381 samples from domestic water supply sources were sent to the Government Pathologist.

The laboratories were unable to accept water for analysis from October to December because of extra work caused by the diphtheria outbreak.

The total number of samples collected and the number of unsatisfactory samples are as follows:-

Water Supply	No. of Samples	No. of unsatisfactory samples
Nicosia	233	36
Famagusta	72	5
Limassol	15	6
Larnaca	36	16
Paphos	15	2
Others	10	2
Totals	381	67

9.1. Most of the unsatisfactory samples from the Nicosia supply were collected from boreholes but contamination does not appear to be continuous because second samples usually prove to be satisfactory. The water from the Arab Ahmet and Makedhonitissa Chains-of-Wells tends to be generally unreliable in summer. All chlorinated samples at all reservoirs were satisfactory.

The unsatisfactory samples at Limassol and Famagusta were usually of unchlorinated spring water. All chlorinated samples at the reservoir were satisfactory.

The water at the intake of the Bekir Pasha Chain-of-wells Larnaca was often slightly contaminated and until chlorination was started in May, unsatisfactory samples were collected from the mains.

Special Investigation at Phrenaros.

A detailed study is in progress of the naturally stored groundwater in relation to rainfall and pumping in an area of 13 square miles. Measurements and calculations were made for the year mid-March 1957 to mid-March 1958, during which the rainfall was 90% of normal. The results appear to indicate the following:-

Recharge		Extraction	
Rainfall	525 m.g.	Irrigation	570 m.g.
Underground flow	90 m.g.	Domestic	315 m.g.
Total	615 m.g.	Total	885 m.g.

Excess of Extraction over Recharge 270 m.g. or 44%.

It is thus clear that unless the volume of pumping is reduced or alternatively, unless some 270 million gallons per year can be supplied by artificial recharge, the result will be the failure of many wells and boreholes in the area.

Special Investigation at Kokkini Trimithia.

A detailed study is being made of the water balance of an area of 5½ square miles within the main hydrological area. In this case the aquifer is not so homogeneous as at Phrenaros and the clay surface beneath or sometimes within the aquifer is not so easy to define. The rainfall was about 95% of normal over the period for which figures are available, namely the two years April 1956 to March 1958. The results indicate the following:-

Recharge		Extraction	
Rainfall	175 m.g.	Irrigation	280 m.g.
Underground flow	205 m.g.	Domestic	220 m.g.
Total	380 m.g.	Total	500 m.g.

Excess of Extraction over Recharge 120 m.g. or 31%.

In this case, if pumping is not reduced, many wells and boreholes are certain to fail within the near future.

Water Duty.

The table on the next sheet shows the actual quantities of irrigation water used in certain places where meters were installed on private pumps with the object of determining the actual quantity of water used in practice by ordinary irrigators. There is no doubt that if better methods and practices were used in the application of the irrigation water a smaller quantity would produce equal crops.

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Well No.	Place	Chief Crops	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Area in donums		
												Spring	Early Summer	Late Summer
67	Phrenaros	Potatoes and melons	560	610	700	910	910	1720	1710	1150	880	22	17	10
283	Phrenaros	Potatoes and melons	1100	1100	Meter out of order		1210	1970	2570	1920	1860	30	22	8
284	Phrenaros	Potatoes and melons	1240	1250	1450	1600	1620	1770	1860	1630	1360	23	18	10
294	Phrenaros	Potatoes beans and melons	-	570	890	1090	1220	1780	1900	1730	1660	16	12	4
416	Phrenaros	Citrus	-	680	770	790	860	930	980	980	970	75	75	75
761	Phrenaros	Potatoes beans and melons	1100	1250	1450	1560	1620	Meter removed				12	12	12
792	Phrenaros	Kolokasi, beans	-	2110	2460	2690	3070	3910	3560	3340	3210	4	3	3
430	Kokkini Trimithia	Potatoes and carrots	-	1680	1860	1870	2100	1800	1870	1800	1500	73	20	50
441	Kokkini Trimithia	Potatoes and carrots	-	1560	1620	1730	3000	2600	2500	2360	2350	58	9	53
-	Ay.Pappos (Lapathos)	Potatoes	1550	1550	1580	1580	Pump damaged by sabotage					62	-	-

Note. (a) No irrigation took place before March or after November (b) 1 donum = 0.33 acres approx. (c)Areas are approx.only

MEASUREMENTS OF WATER APPLIED TO CROPS 1958

(GALLONS PER DONUM PER DAY)

APPENDIX 6
WATER LEVEL IN CONTROL BOREHOLES
(Feet above sea level)

Place	Borehole No. and Year	Maximum water level			Minimum water level		
		Year after drilling	56-57	57-58	Year after drilling	56-57	57-58
1. Kokkini Trimithia	90/50	685.8	672.0	669.0	681.2	669.2	666.2
2. Kokkini Trimithia	106/50	682.7	671.7	670.3	679.8	670.1	667.5
3. Kokkini Trimithia	161/50	686.0	670.5	668.2	680.2	666.8	663.3
4. Astromeritis	91/50	370.4	357.5	357.5	365.1	330.3	338.5
5. Morphou	168/50	89.2	80.8	80.5	84.1	77.6	74.8
6. Morphou	92/50	83.7	67.8	67.1	69.9	51.6	47.7
7. Prastio	93/50	27.1	20.5	18.3	22.1	15.0	13.3
8. Prastio	11/57	-	15.6	20.1	-	13.4	11.5
9. Ghaziveran	94/50	18.5	13.8	13.0	16.2	10.9	10.7
10. Pendayia	95/50	10.6	10.2	10.4	8.0	6.9	7.3
11. Syrianokhori	150/54	9.7	9.2	-	8.4	7.2	7.0
12. Syrianokhori	151/54	9.3	8.8	8.3	8.1	6.5	5.3
13. Syrianokhori	152/54	7.2	6.2	5.8	5.2	3.9	3.4
14. Syrianokhori	153/54	4.3	3.9	3.5	3.4	2.4	2.3
15. Syrianokhori	1/55	23.1	18.0	19.4	17.7	12.0	10.0
16. Syrianokhori	23/55	20.9	16.3	15.0	17.4	12.2	10.4
17. Syrianokhori	201/56	-	17.2	16.2	-	12.2	10.5
18. Syrianokhori	209/56	-	16.1	15.2	-	11.5	9.7
19. Syrianokhori	195/57	-	-	7.1	-	-	4.2
20. Syrianokhori	209/57	-	-	3.5	-	-	2.3
21. Syrianokhori	212/57	-	-	3.7	-	-	2.9
22. Syrianokhori	248/57	-	-	8.9	-	-	5.5
23. Syrianokhori	253/57	-	-	9.5	-	-	5.8
24. Xylophagou	70/51	19.1	15.5	14.7	15.9	14.3	13.0
25. Xylophagou	71/51	13.1	8.2	7.5	10.6	6.0	2.5
26. Xylophagou	72/51	18.5	18.7	15.3	14.7	14.9	13.3
27. Xylophagou	73/51	6.0	6.0	6.4	3.7	5.2	4.1
28. Xylophagou	74/51	6.9	6.0	5.9	4.5	5.1	5.3
29. Ormidhia	189/57	-	-	1.5	-	-	2.3
30. Ormidhia	227/57	-	-	0.7	-	-	0.4
31. Ormidhia	246/57	-	-	0.8	-	-	1.2

/55.

Place	Bore-hole No. and Year	Maximum water level			Minimum water level		
		Year after dril-ling	56-57	57-58	Year after dril-ling	56-57	57-58
32. Makrasyka	48/54	117.0	113.2	111.3	110.7	108.3	107.1
33. Makrasyka	49/54	120.1	116.4	114.6	117.4	114.2	112.7
34. Kalopsidha	54/54	68.5	63.3	61.4	60.3	57.1	57.1
35. Kalopsidha	55/54	73.9	70.8	69.2	72.4	69.2	68.0
36. Kalopsidha	56/54	75.3	72.6	71.6	74.4	71.5	70.3
37. Pergamos	86/51	256.6	248.3	246.3	254.7	245.1	242.2
38. Phrenaros	51/51	87.0	71.8	70.1	86.6	68.8	67.5
39. Phrenaros	52/51	85.8	71.1	69.9	85.4	68.6	65.3
40. Phrenaros	53/51	85.2	74.3	72.9	84.9	72.1	70.2
41. Phrenaros	67/53	81.1	74.2	72.2	80.4	72.5	70.2
42. Phrenaros	108/52	72.2	60.5	58.2	71.3	57.3	54.1
43. Phrenaros	109/52	70.6	59.9	57.6	67.0	57.3	54.1
44. Phrenaros	110/52	70.2	60.1	57.7	66.6	57.6	54.6
45. Phrenaros	76/56	-	57.6	55.7	-	55.8	53.2
46. Phrenaros	77/56	-	63.8	62.7	-	62.6	61.5
47. Phrenaros	78/56	-	65.0	63.1	-	63.1	60.9
48. Phrenaros	79/56	-	72.8	71.1	-	70.8	68.5
49. Ay.Nicolaos (F/gusta)	89/56	-	29.3	28.4	-	28.5	27.3
50. Ay. Memnon	69/38	13.3	13.3	13.4	17.1	18.6	18.5
51. Ay. Memnon	50/53	8.9	10.1	9.7	11.9	13.7	13.8
52. Kolossi	88/54	16.0	11.5	12.0	12.0	8.0	8.0
53. Laxia	208/55	672.2	668.1	668.7	666.3	663.7	662.5
54. Ephtakomi	163/55	496.4	491.5	486.0	490.2	486.1	476.2

APPENDIX 7

IRRIGATION SCHEMES COMPLETED IN 1958

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
1.	Pano Platres (In the village)	Lining of channels in R.C.	-	5	5
2.	Potami (Sykamies)	Repairs-spring & piping	-	-	-
3.	Morphou (Kalokerinon Lekanes)	Tunnelling	360	40	400
4.	Lapithos (Kholiarides)	Spring tank & R.C. channels	-	10	10
5.	Kazaphani (Vassiliki)	Distribution box & piping	-	-	-
6.	Tris Elies (Lakkotis)	Lining of channels in R.C. & piping	-	10	10
7.	Prodhromos (Kyparisi)	Small irrigation tanks	-	10	10
8.	Aplanda	Minor repairs to channel	-	-	-
9.	Polis (Castraphi)	Pre-Cast cement piping	-	10	10
10.	Ay. Marina (Khrysokhou) 1st Stage	Distribution system R.C.channels,piping & temporary intake	550	-	550
11.	Kouklia (F) (E.M.I.W.)	Kouklia Prastion Reservoir Embankment	-	-	-
12.	Agridhia (Kaouros)	Settling tank & piping	-	4	4
13.	Ay.Theodhoros (Tylliria) (Sykies)	Small weir & piping	7	1	8
14.	Ay.Anargyri	Piping & retaining wall	-	2	2
15.	Ay.Georghios(II) (Kato Livadhia)	Weir and piping	-	5	5
16.	Ay. Georghios (Mousa)	Repairs	-	-	-
17.	Morphou (Deaf & Dumb School)	Pumping & Piping	-	3	3
18.	Dhierona	Repairs	-	-	-
19.	Lefka (Marathasa) 1st Stage	Temporary intake weir and piping	-	80	80
		Carried Forward	917	180	1097

/57.

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	917	180	1097
20.	Lythrothonda (Kato Pervolia)	Circular R.C.Storage tank repairs to tunnel	-	10	10
21.	Ay.Constantinos (Mesi Vavatsinia)	Repairs to weir	-	-	-
22.	Ay.Constantinos (Petranis)	Minor repairs	-	-	-
23.	Ay.Constantinos (Pano Vavatsinia)	Construction of a retaining wall, minor repairs	-	-	-
24.	Prodhromos (Mazourka)	Construction of small weirs and R.C. channels	-	24	24
25.	Ay.Constantinos (Merika)	Minor repairs	-	-	-
26.	Ay.Georghios (Ll) (Syrka)	Distribution piping	-	-	-
		Totals	917	214	1131

/58.

APPENDIX 8

IRRIGATION SCHEMES IN HAND AT THE END OF 1958

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
1.	Trimiklini	Distribution system piping, settling tanks etc.	-	-	-
2.	Kythrea	Lining of channels in reinforced concrete	-	1000	1000
3.	Xeros (Paphos), Co-operative Farming Society)	River training works construction of gabions, wire-staking	-	-	-
4.	Agridhia (Kato Netikon)	Irrigation tank & piping	-	13	13
5.	Akhelia Chiftlik (Paphos)	Pump-house pipe-crossing Lining of channels in R.C.	-	300	300
6.	Ay.Constantinos (Ll) (Vrysakia etc.)	Springs, piping, small weirs	-	20	20
		Totals	-	1333	1333

/59.

APPENDIX 9

IRRIGATION SCHEMES READY FOR CONSTRUCTION AT THE END OF 1958 BUT NOT YET STARTED

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
1.	Peristerona (Trehaton Neron tis Eterias)	Cleaning & repairs to tunnels, lining of channels in R.C.	1000	600	1600
2.	Ay.Ioannis (Malounda) (Neron-tou-Khoriou)	Tunnelling and lining of channels in R.C.	800	50	850
3.	Argaka-Magounda III	Construction of a dam piping and R.C. channels	1200	200	1400
4.	Askas (Pano Ambelia)	Irrigation tank & piping	-	12	12
5.	Ayios Epiphanios (Orinis) (Parisi)	Irrigation tank & channels	20	14	34
6.	Vouni (Klokkaris)	Irrigation tank & piping	-	12	12
7.	Vouni (Palea Vrysi)	R.C. channels	-	10	10
8.	Phini (Kambitou-Stavrou)	Weir, tank and channels	-	68	68
9.	Vikla	Weir, pipes and irrigation tank	135	32	167
10.	Gouphes	Channels and irrigation ports	100	-	100
11.	Sotira	Weir, R.C.channels & Irrigation tank	300	150	450
12.	Marathounda	Weir, Irrigation tank and piping	-	100	100
13.	Potami (Poliati)	Weir, channels and tank	70	22	92
14.	Kholetria-Nata	River-training-staking	-	-	-
15.	Psevdhas	Irrigation ports, culverts	200	-	200
16.	Ora	Lining of channels in R.C.	16	4	20
		Carried Forward	3841	1274	5115

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	3841	1274	5115
17.	Kalokhorio (Ll)	Repairs and lining of channels, weir piping & irrigation ports	10	5	15
18.	Kyperounda (Khalospities	Irrigation tank and piping	-	12	12
19.	Kyperounda (Piyi)	Spring and piping	-	5	5
20.	Episkopion (N)	Construction of intake and channel	300	-	300
21.	Krini	Lining of channels in R.C.	200	100	300
22.	Louroudjina (Armyrkos)	Cleaning & lining of chain-of-wells Construction of Irrigation tank and channels	-	26	26
23.	Kalopanayiotis Oekos, Pano Gnoudhias	Irrigation tank	-	26	26
24.	Pera(Phaseron)	Tunnels, cutting R.C. channels	720	-	720
25.	Kyperounda (Appis)	Repairs to channels and wing walls	-	5	5
26.	Ay.Therapon (Platania Pezoules)	Lining of channels in R.C.	-	130	130
27.	Khalassa (Ypsonas)	Groyne intake and channels	1000	-	1000
28.	Ay.Georghios (Ll) Kato Piyenia	Piping	-	18	18
29.	Plataniskia	Lining of channels in R.C.	-	10	10
30.	Kaminaria (Hlios)	Spring Irrigation tank	-	10	10
31.	Agridhia (Pano Lahania)	Spring and Irrigation tank	-	22	22
		Carried Forward	6071	1643	7714

/61.

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	6071	1643	7714
32.	Agros (Vrysia)	Repairs to irrigation tank	-	3	3
33.	Arsos (Pesous)	Lining of channels in R.C.	-	20	20
34.	Agros (Pano Vrysia)	Construction of irrigation tank	-	4	4
35.	Athrakos (Halourakes)	Weir channels and piping	-	24	24
36.	Agros (Kato Netikon)	Irrigation tank and channel	-	6	6
37.	Kyperounda (Kardhama Paranga)	Excavation of spring	-	5	5
38.	Ayios Pavlos (Styrakas)	Irrigation tank and channels	-	24	24
39.	Kato Amiandos (Pelendria-Chrysovrysi)	Springs, piping irrigation tank	-	21	21
40.	Pelendria (Filagra)	Weir and irrigation tank	-	8	8
41.	Pelendria (Raftis)	Irrigation tank and piping	-	8	8
42.	Vitsadha	Construction of anti-erosion weirs	-	-	-
43.	Ay.Andronikos (F) (Vrysi)	Lining of channels in R.C.	10	60	70
44.	Polis Chiftlik	Lining of channels in R.C.	-	330	330
45.	Ay.Nicolaos (P)(Kamishlik)	Lining of channels in R.C.	-	20	20
46.	Kithasi (Dhiarizos)	Irrigation tank and piping	12	12	24
47.	Pano Archimandrita	Spring and R.C. channels	-	5	5
48.	Ora	Irrigation tank & channels	180	10	190
49.	Meneou (New Mental Hospital)	Tunnels-pumphouse, Irrigation tank, piping	-	40	40
50.	Odhou	Lining of channels in R.C.	-	10	10
		Carried Forward	6273	2253	8526

/62.

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	6273	2253	8526
51.	Mousoulita-Marathovounos (Pedhieos River)	Reformation of banks, cleaning and regrading of canals	1000	-	1000
52.	Pomos (Paliambela)	Weir and channelling	700	50	750
53.	Kithasi	Storage tank & piping	12	12	24
54.	Sarama (Vrysimo water)	Weir channels & piping	200	95	295
55.	Phinikas (Xeros River)	Spring, Lining of channels in R.C.	-	280	280
56.	Pelathousa (Vrysi-tou-Khoriou)	Repairs to spring, piping and irrigation tank	20	9	29
57.	Terra (Upper Quarter)	Pumping Scheme	-	25	25
58.	Istinjo (Khalassa)	Weir and channelling	-	25	25
59.	Zacharga (Vrysi-Khoriou)	Irrigation tank and piping	-	12	12
60.	Philousa (Khrysokhou)	Weir and lining of channels in R.C.	-	28	28
61.	Steni-Ayios Isidhoros	Piping additional	-	10	10
62.	Amargetti (Ziripilli)	R.C.channels repairs	-	-	-
63.	Koloni-Yeroskipos (Kotchati River)	Settling tank - precast cement piping	-	25	25
64.	Pyrgos (Patticha)	Weir and channelling	-	30	30
65.	Kaminaria (Kryos Potamos)	Weir, piping etc.	-	165	165
66.	Ay.Dhimitrios (Kaloyiros)	Construction of small R.C.circular storage tanks and R.C.channels	-	50	50
		Carried Forward	8205	3069	11274

/63.

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	8205	3069	11274
67.	Paleomylos	Construction of weirs & channels	-	12	12
68.	Arakapas	Re-Construction of a weir	-	-	-
69.	Ay.Dhimitrios	Construction of one aqueduct	-	6	6
70.	Prastion (P) (Katarraktis)	Minor Repairs	-	-	-
71.	Mora (Ornithi)	Regrading of earth channels and re-shaping	100	-	100
72.	Sinda(Kuchuk Dere)	Regrading of channels etc.	100	-	100
73.	Famagusta-Dherinia (Ay.Lucas)	Regrading of tunnels etc. (Re-charge works)	-	-	-
74.	Famagusta-Dherinia (Ay.Nicolaos Drain)	Construction of drainage canals-re-charge works	-	-	-
75.	Lakatamia (Kato Mavrovrisi)	Chain-of-wells - channelling irrigation ports	600	120	720
76.	Yerolakkos (Ovgos River)	Pumping scheme	-	20	20
77.	Platanistasa (Stavros)	R.C.channels and tank	-	12	12
78.	Pano Zodhia (Kato Koutraphas)	Intake, lining of channels in R.C.	11000	-	11000
79.	Kyra (Summer water)	Pumping Scheme, Lining of channels in R.C. etc.	-	200	200
		Carried Forward	20005	3439	23444

/64.

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	20005	3439	23444
80.	Geunyeli (Jinnar Dere)	Re-construction of a weir, channelling (flood damage)	-	-	-
81.	Kambi-Pharmakas (Vazanosykia)	R.C.irrigation tank & piping	-	8	8
82.	Pano Koutraphas	Groyne intake & channelling	-	160	160
83.	Ayii Trimithias (Asproyi)	Intake and retaining wall	230	-	230
84.	Politikon Moulos water	Head works extension of chain-of-wells R.C.channels and storage tank	-	400	400
85.	Pedhoulas	R.C. channels	-	150	150
86.	Lefka (Marathasa) Stage II	Construction of a dam	-	780	780
87.	Nisou (Frangos Chiftlik)	Chain-of-wells lining of channels in R.C.	-	200	200
88.	Morphou Katokopia Pano & Kato Zodhia (Naos)	R.C. channels & groyne intake	1800	-	1800
89.	Argates	Groyne intake, overflow spillway irrigation ports	370	-	370
90.	Syrianokhori	Lining of channels in R.C.	-	700	700
91.	Mora	Improvement works, Irrigation ports repairs to channels	200	-	200
		Carried Forward	22605	5837	28442

/65.

Ser. No.	Location	Nature of Construction	Donums Commanded New Irrigation		
			Winter or Spring	Summer	Total
		Brought Forward	22605	5837	28442
92.	Akaki(Merika water)	Repairs to channels	-	-	-
93.	Akaki Avlona	Repairs	-	-	-
94.	Spilia (Kleftis Kato)	Small weir, channels and storage tank	-	13	13
95.	Kato Zodhia (Komitis River)	Screw - gates protecting walls	150	-	150
96.	Potami (Kashanos)	Repairs to tunnels etc.	-	10	10
97.	Kato - Pano-Pyrgos Selemani	Repairs to channels	-	-	-
98.	Tembria-Sina Oros (Makronides)	Lining of channels Repairs to aqueducts	-	15	15
99.	Tembria (Emirona)	Irrigation ports etc.	-	8	8
100.	Galata-Sina Oros (Kappadhoukas)	Lining of channels in R.C.	-	20	20
101.	Argaka - Magounda	Construction of a dam etc.	400	400	800
102.	Kiti Ammous	Retaining walls screw gates, channelling	250	-	250
103.	Kiti (Kokkinos)	Repairs to apron, channels etc.	-	-	-
104.	Kivisil	Repairs to weir, apron and channels	-	-	-
105.	Ay.Theodhoros (Pendeshinos)	Channelling, irrigation ports	200	-	200
106.	Tseri (Almyros)	Re-construction of a diversion weir	180	-	180
		Totals	23785	6303	30088

APPENDIX 10
TOWN WATER SUPPLIES

by R.S. Wood B.Sc., A.M.I.C.E., M.I.W.E., Senior Engineer.

NICOSIA AND SUBURBS

The construction of Greater Nicosia water supply scheme was almost completed during the year including the three main reservoirs at Engomi, Lakatamia and Hamid Mandres. The water supply system has been operated throughout the year and a maximum monthly average of 1,300,000 gallons of water per day was produced during August. A steady supply of 200,000 gallons per day was delivered from the Dhali boreholes to Lakatamia Reservoir, which has a direct connection to the Strovolos reservoir of the Nicosia Water Board. About half the total supply during the summer came from the Sykhari Adit through the Hamid Mandres reservoir to the outer ring main of the Greater Nicosia scheme. The water in the Kokkini Trimithia and Dhikomo boreholes was conserved as far as possible this year and the former was only used for the Ayios Dhometios area, which required to be supplied direct from Engomi reservoir.

The Town Water Supplies Section was occupied chiefly in the construction of the distribution system of the Greater Nicosia scheme and eight pipe laying gangs were working continuously until the majority of the mains and house connections were completed by the end of September. By the end of the year 65 miles of distribution mains had been laid and 3,900 house connections had been made. In addition to the original scheme an extra 12 miles of mains were laid to satisfy the demand for water in the outlying areas. Water mains have also been laid on payment for private developers and this work is continuing, otherwise the laying of mains is complete. A total of 405 fire hydrants were installed on the distribution mains.

Bulk supplies were given during the summer to the Nicosia Water Board and to the villages of Ayios Dhometios and Eylenja. Most water was supplied to the Board which took an average of 900,000 gallons per day in August.

The maximum average summer demand of suburban Nicosia area was 680,000 gallons per day in September when most of the house connections had been made. Now, in winter, no water is supplied to the Board and in suburban Nicosia the demand is only 260,000 gallons per day, which in this case is about 38% of the maximum summer supply.

Morphou Bay Scheme - Most of the materials have arrived for the 24 mile pipeline from Morphou Bay to Nicosia. The construction of the pipeline and the ordering of materials for the pumping station had to be postponed for financial reasons. All the pipes were received in one ship load from Cape Town in November and 3,600 tons of 18" and 16" steel pipes were unloaded in 7 days and stored on a site to the north of the walls of Famagusta.

FAMAGUSTA

A pipeline was laid from Panayia Spring to Stavros reservoir for the Famagusta Water Board under the supervision of this Department. The work involved digging 8 miles of trenches, of which 85% was in rock and had to be excavated by compressors. The pipeline was laid to replace the old Venetian aqueduct which leaked and allowed field water to enter by seepage and contaminate the spring water. The line of the old aqueduct was followed where possible and economical. Since completion, a maximum of 115,000 gallons of water per day can now be obtained from the Panayia and Kanna springs at the low level tank at Stavros and the water is perfectly pure. If the water is turned straight into the reservoir reception tank 90,000 gallons per day can be obtained without pumping. The cost of the scheme was £36,800. It was mostly carried out by the Famagusta Water Board with technical assistance from the Department of Water Development.

Restrictions on the supply during the summer were just avoided by working all pumps to full capacity and with the operation of the three pumps, which were installed for an emergency scheme last year, and by using up to 13% of the saline water from the boreholes near the reception tank at Stavros.

Some materials have been ordered for part of the new water supply scheme prepared in 1956, which includes bringing water from 6 boreholes at Xylophagou to Stavros reservoir. The pumps, tower tank and specials for the pipeline have been ordered at a total cost of about £12,000, but not the pipes which should have a shorter delivery period. Some of these materials have already arrived and are stored at Stavros reservoir.

LIMASSOL

A water shortage was experienced in Limassol this summer and restrictions had to be imposed by turning off the distribution area valves at night between the hours of 11 p.m. and 5 a.m. for the period 19th August to 6th October. An emergency diesel engine and pump were again installed this year on the borehole to the North East of the Chiftlikoudhia pumping station to pump water from this borehole into the end well of the chain of wells which feeds pumping station. This water assisted in keeping the pump in the pumping station running at nearer full capacity and prevented the exhaustion of the chain of wells. Break-downs of the old "National" oil engine on several occassions showed that another stand-by electric motor was required, and the pump well head was accordingly enlarged to provide space for another motor to be fixed next year.

LARNACA

Restrictions on the water supply were again necessary in Larnaca so that the higher areas of the town could draw water for some hours each day. The distribution system was split into 4 areas by the insertion of sluice valves at required points. This will also facilitate the division into areas as required under the proposed improvement scheme which is to be carried out when funds are available. The restrictions were imposed from 8 a.m. to 6 p.m. each day from 5th July to 2nd December, each of the lower areas being turned off for 7 hours per day.

A temporary chlorinator was installed at the source of supply at the lower end of the chain of wells, as unsatisfactory analyses had been obtained from samples taken at this point, and since 3rd June the water has been chlorinated continuously.

Supervision of the laying of water mains for new development has been undertaken on payment of cost.

GENERAL

Water Board meetings are attended regularly by the writer and technical advice is given as required on behalf of the department.

The Government water supply in Nicosia has been maintained and minor improvements carried out. An average of 72,000 gallons of water per day was supplied from Government sources during the summer for Government residences, offices and institutions.

The testing of water meters is carried out for the Water Boards and other water authorities and 4,320 meters have been tested, including 4,000 for the Greater Nicosia Scheme.

APPENDIX 11

TOWN WATER CONSUMPTION, SUMMER 1958

QUANTITY SUPPLIED AT SOURCE IN GALLONS PER HEAD PER DAY

Town	Estimated Population	June g.h.d.	July g.h.d.	August g.h.d.	September g.h.d.
Nicosia within the walls	25,000	18.8*	18.8*	20.6*	19.0*
Nicosia Water Board Area outside the walls	39,000	49.2	53.8	58.3	55.2
Nicosia suburbs	23,000	-	-	16.7*	16.8*
Nicosia, whole town and suburbs	87,000	37.3*	40.4*	36.5*	34.5*
Limassol	41,000	34.5	35.5	37.2*	34.5*
Famagusta	30,000	31.7	35.1	36.9	33.0
Larnaca	19,000	45.6	45.6*	45.6*	43.2*

* Restricted or partial supplies see Appendix 10 and notes below.

Notes:

1. The population figures are based on "Population Estimates October 1956" published by the Statistics Section of Financial Secretary's Office, Nicosia and "Census of Cyprus 1946". Unless otherwise stated below the quantity of water supplied is measured by meter at source.

2. Nicosia:

The area within the walls was supplied with water from the pumps P_1 and P_2 on wells in the Prodhromos quarter, from the Sykhari Adit via the old pipeline now metered at source, and from the Water Board supply. The Lower Arab Ahmet was dry from April until the end of the year. The water was restricted to a supply of 6 hours per day throughout the year.

The Water Board Area outside the walls was supplied from the Water Board's own sources, from the private boreholes of Mr. Charalambous at Kokkini Trimithia and from the Greater Nicosia supply through meters at Strovolos Reservoir, Ayii Omoloyitadhes and Pallouriotissa.

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Water from the former private companies now taken over by the Water Board and from the Kykko supply is included but represents only about 4% of the total supply of the whole town and suburbs.

The Nicosia Suburbs were supplied by the new Greater Nicosia scheme from sources at Kokkini Trimithia, Dhali, Dhikomo and Sykhari. House connections were not made until August and were not all completed at the end of the year; the figures for Nicosia suburbs are therefore not representative of the demand.

3. Limassol:

The water is measured by meter at the outlet of the reservoir and an allowance of 3% is added for losses in the supply pipelines from the springs to the reservoir.

4. Famagusta:

The water from Phrenaros is measured by meter at sources, while the Panayia and Stavros supplies are measured by meter at Stavros reservoir.

5. Larnaca:

The water supplied is measured by gauging at source and 9% is deducted for water supplied by saccoraphi for irrigation of plantations and farms.

APPENDIX 12

DATA CONCERNING TOWN WATER SUPPLIES

1958

	Nicosia			Limassol	Famagusta	Larnaca
	Water Board and Administration	Government	Total #			
a) Sources in regular use - Number	22+	12	34	3	9	1
b) Sources for emergency use - Number	9⊕	1	10	1	6	Nil
c) Capacity of sources in average summer, m.g.d.	1.75Q	1.25	3.0	1.0	1.0	1.0
d) Main reservoir capacity, million gallons	0.8	3.2	4.0	0.8	0.7	Nil
e) Supply mains, miles	41	26	67	18	22	3.5
f) Distribution mains, miles	128	72	200	63.3	65.5	28.3
g) Pumps in regular use in wells and boreholes	24	11	35	Nil	8	Nil
h) Consumer meters in December 1958 - Number	7,080	3,900	10,980	7,929	6,950	1,208
i) Saccoraphia connections - Number	3,260	-	3,260	-	-	1,297
j) Fire Hydrants - Number	653	405	1,058	389	420	21

Excludes private companies which together supply up to about 0.15 m.g.d.

\+ Includes 9 boreholes at Kokkini Trimithia owned by Mr. Charalambous. On 1st July under a new agreement Mr. Charalambous undertook to supply the Nicosia Water Board with a maximum of 3 million gallons per day and a minimum 600,000 g.p.d. In practice, he never supplied more than 1.20 m.g.d. and in October he was unable to exceed 0.90 m.g.d.

Q Includes 0.90 m.g.d. from Mr. Charalambous

⊕ Includes 8 boreholes owned by Mr. Charalambous

m.g.d. = million gallons per day.

APPENDIX 13

NUMBER AND PERCENTAGE OF VILLAGES WITH PIPED DOMESTIC WATER

31st December, 1958.

District	Villages with piped water			Villages with no piped water		Total Villages
	Satisfactory	Needing Improvement	Total			
	No.	No.	No.	No.	%	No.
Nicosia	94	42	136	40	22.77	176
Larnaca	41	9	50	9	15.00	59
Limassol	63	40	103	10	8.85	113
Famagusta	52	14	66	32	34.69	98
Paphos	90	33	123	11	8.21	134
Kyrenia	26	13	39	8	17.00	47
Totals	366	151	517	110	17.38	627
Percentage	58.37	24.25	82.62	17.38	17.38	100

Note: The above figures were obtained from a new survey and they do not correspond with others given in the annual reports of former years. Some supplies that were formerly satisfactory are now considered unsatisfactory, because with an expanded population and higher standards of living more water and more facilities are required.

APPENDIX 14

VILLAGE WATER SUPPLY SCHEMES COMPLETED IN 1958

No.	Village	District	Nature of work	Date of completion
1	Skarinou	Larnaca	⁄	13th January
2	Skoulli	Paphos	⁄	16th "
3	Polis	"	⁄	31st "
4	Arsos	Larnaca	⁄	4th February
5	Tremethousa	"	⁄	18th "
6	Ayios Theodhoros	Famagusta	⁄	19th "
7	Yialousa	"	⁄	26th "
8	Kato Zodhia	Nicosia	⁄	28th "
9	Gourri	"	⁄	4th March
10	Lazania	"	⁄	4th "
11	Lefka	"	⁄	13th "
12	Pyroi	"	⁄	16th "
13	Pano Dhikomo	Kyrenia	⁄	17th "
14	Kato Dhikomo	"	⁄	17th "
15	Malia	Limassol	⁄	3rd April
16	Miliou	Paphos	⁄	16th "
17	Ghaziveran	Nicosia	*	26th "
18	Akrounda	Limassol	⁄	30th "
19	Akrotiri	"	*	26th May
20	Yerolakkos	Nicosia	⁄	29th "
21	Kato Akourdalia	Paphos	⁄	31st "
22	Vatili Police Station	Famagusta	⁄	23rd June
23	Mennoyia	Larnaca	⁄	5th July
24	Anaphotia	"	⁄	5th "
25	Aplanda	"	⁄	5th "
26	Kokkini Trimithia (Detention Camp)	Nicosia	⁄	9th "
27	Aphania	Famagusta	⁄	1st August
28	Psillatos	"	⁄	4th "
29	Ayia Anna	Larnaca	⁄	7th "
30	Kilani	Limassol	⁄	19th "
31	Pyla No. 1 (Detention Camp)	Larnaca	⁄	20th "
32	Ayia Napa	Famagusta	⁄	6th September
33	Asha	"	⁄	10th "
34	Ambelikou	Nicosia	*	25th "
35	Khirokitia	Larnaca	⁄	29th October
36	Vitsadha	Famagusta	⁄	29th "
37	Petrophani	Larnaca	⁄	8th November
38	Pendakomo	Limassol	⁄	19th "
39	Camp P. 2	Larnaca	⁄	5th December
40	Camp "M"	Nicosia	⁄	23rd "

* New Schemes
⁄ Improvements to an existing supply
⁄ Water Supply to schools and police station

APPENDIX 15

VILLAGE WATER SUPPLY SCHEMES IN HAND
AT THE END OF 1958

Serial No.	Village	Serial No.	Village
1	Ayios Symeon	5	Klavdhia
2	Galinoporni	6	Argaka
3	Korovia	7	Koloni
4	Neta	8	Magounda

APPENDIX 16

VILLAGE WATER SUPPLY SCHEMES READY FOR CONSTRUCTION AT THE END OF 1958 BUT NOT YET STARTED

Serial No.	Village	Serial No.	Village
	Nicosia		
1	Amadhies	21	Mia Milea
2	Astromeritis	22	Milikouri
3	Askas	23	Mitsero
4	Ayii Trimithias	24	Morphou
5	Ayios Ioannis (Selemani)	25	Neokhorio
6	Ayios Nicolaos (Lefkas)	26	Nikitari
7	Ayios Sozomenos	27	Nisou
8	Ayios Yeorghios (Lefkas)	28	Palekythro
9	Bey Keuy	29	Paleometokho
10	Dhenia	30	Pera Khorio
11	Epikho	31	Peristeronari
12	Exometokhi	32	Phlasou
13	Kalokhorio (Lefkas)	33	Phterikhoudhi
14	Kambos	34	Potami
15	Kannavia	35	Prastio Morphou
16	Katokopia	36	Spilia
17	Korakou	37	Trakhoni
18	Kythrea	38	Tymbou
19	Linou	39	Voni
20	Louroujina	40	Xerovounos
		41	Zodhia Pano
	Kyrenia		
42	Ayia Irini	50	Kondemenos
43	Asomatos	51	Myrtou
44	Ayios Epiktitos	52	Orga
45	Ayios Ermolaos	53	Paleosophos
46	Ayios Yeorghios	54	Photta
47	Dhiorios	55	Pileri
48	Karpasha	56	Sykhari
49	Kazaphani	57	Vasilia
		58	Vouno
	Famagusta		
59	Akanthou	67	Makrasyka
60	Athna (Akhna)	68	Paralimni
61	Ayia Trias	69	Pervolia-tou-Trikomou
62	Engomi		
63	Galatia	70	Sotira
64	Kouklia	71	Styllos
65	Livadhia	72	Vatyli
66	Lysi	73	Yialousa

Serial No.	Village	Serial No.	Village
	Larnaca		
74	Alaminos	82	Mari
75	Anglissidhes	83	Melousha
76	Aradhippou	84	Mosphiloti
77	Athienou	85	Odhou
78	Ayii Vavatsinias	86	Ormithia
79	Kivisil	87	Psematismenos
80	Pomos	88	Pyla
81	Livadhia	89	Tersephanou
	Limassol		
90	Agros	108	Mathikoloni
91	Alectora	109	Monagri
92	Amiandos Kato	110	Omodhos
93	Arsos	111	Pareklisha
94	Asgata	112	Perapedhi
95	Ayia Phyla	113	Platres Kato
96	Ayios Amvrosios	114	Polemidhia Kato
97	Ayios Athanasios	115	Polemidhia Pano
98	Ayios Demetrios	116	Potamiou
99	Dhierona	117	Prodromos
100	Dhoros	118	Silikou
101	Evdhimou	119	Trakhoni
102	Kaminaria	120	Trimiklini
103	Kyperounda	121	Tris Elies
104	Lania	122	Vouni
105	Lemithou	123	Yermasoyia
106	Limnatis	124	Ypsonas
107	Mandria		
	Paphos		
125	Akoursos	133	Letimbou
126	Arkhimandrita	134	Mandria
	Kato	135	Marathounda
127	Arnou	136	Marona
128	Ayios Yeorghios	137	Mesakhorio
129	Kallepia	138	Nata
130	Kathikas	139	Phasoula
131	Khlorakas	140	Pitargou
132	Khrysokhou	141	Tala

Note. The above list excludes certain schemes that were included in similar lists of previous years because rising standards and increased demands have now made it necessary to revise or to abandon many proposals that would formerly have been satisfactory.

APPENDIX 17
MECHANICAL PLANT
(as on 31/12/58)

		No.
MOBILE PLANT:	Ruston Bucyrus drilling rigs 22W ...	11
	Bucyrus Erie " " 33W ...	1
	Ruston Bucyrus " " 60RL ...	1
	Edeco drilling rigs ...	3
	Cheshire earth boring machine ...	1
	Allen Trencher 12/21 ...	2
	Avelling-Barford Trencher ...	1
	Caterpillar Traxcavators 955 ...	3
	" " HT4 ...	1
	" Bulldozer D2 ...	1
	International Bulldozer ...	1
	Ruston Bucyrus Excavator RB10 ...	1
	" " " RB19 ...	1
	Compressors ...	11
	Morrison diesel alternator on trailer for use with electro-submersible pumps ...	2
	Turbine deep-well test pumping units	2
	Plunger deep-well test pumping units	2
	Centrifugal pumping units ...	4
	Portable works pumps ...	18
	Sheepfoots roller ...	1
	Granes ...	2
	Hoists ...	3
	Concrete mixers ...	28
	Vibrators ...	10
	Low Loader ...	1
	Austin Countryman Vans ...	6
	Land Rovers ...	6
	Light Lorry - 15 cwt. Morris ...	1

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		No.
	Humber Utility Vans ...	2
	Thornycroft Tractive Unit for Low Loader	1
	Aveling Barford Dumpers ...	2
FIXED PLANT IN WORKSHOP:-	Lathes ...	4
	Shaping machine ...	1
	Screwing machine ...	1
	Drilling machine ...	3
	Planing machine (timber) ...	1
	Bandsaw (timber) ...	1
	Bar Bender ...	1
	Bar Cutter ...	1
	Electric Welders ...	3
	Forges ...	3
	Pipe slotting machine, oxy-acetyline	1
	Vibrating table ...	1
	Water meter testing plant ...	1
	Concrete block making machines ...	2
	Concrete testing machine ...	1
	Compressor Air (Tecalemit) ...	1
	Milling machine ...	1
	Grinding machine ...	1
	Hack-saw Electrical ...	1