

SOUTHERN CONVEYOR PROJECT



CYPRUS

PREFACE

This brief report is a summary of the main findings of the Southern Conveyor Project Feasibility Study which was carried out within the Water Development Department of the Ministry of Agriculture and Natural Resources, Cyprus, between 1978 and 1982. The main report of the study is presented as Volume 1 of a 19 Volume Feasibility Study Report which was prepared by a Project team consisting of Cyprus Government staff, overseas consultants and UK technical specialists provided under the bilateral cooperation programme.

The purpose of this separate summary report is to inform the reader of the main objectives and components of the Project along with the associated costs, benefits and financial implications. For a full understanding into the background and formulation of the Project, and for a detailed description of the Project works and economic analysis it is necessary to consult the Main Report and its support volumes.

CONTENTS

	<u>Page</u>
PREFACE	i
CONTENTS	iii
CYPRUS - KEY ECONOMIC INDICATORS	iv
1. BACKGROUND	1
2. THE PROJECT	1
Objectives	1
Proposed Works	2
Irrigation	6
Domestic Water Supply	6
3. PROJECT COSTS	6
4. PROJECT BENEFITS	8
5. PROJECT EVALUATION	8
6. PROJECT ORGANISATION	9
7. PROJECT FINANCE	10
8. OTHER ISSUES	10
Political Settlement in Cyprus	10
Hydroelectric Power	10
Land Consolidation	11

LIST OF TABLES

TABLE 1	Project Investment Costs	6
2	Results of Economic Analysis	8
3	Economic Returns by Sector	9

LIST OF FIGURES

Figure 1	Diagrammatic representation of design flows in conveyors	3
2	Project supply and demand	5
3	Construction timetable	7

Cyprus - Key Economic Indicators (1980)

<u>Population</u>			<u>Employment</u>		
Total	:	629 000	Economically active population: 208 000		
In Government controlled area	:	511 000	Unemployed as % of economically active : 2%		
Greek Cypriot refugees:		198 000	Increase in retail prices, 1979-80: 13.5%		
Rate of population growth, 1976-80	:	0.9%			
<u>National Income</u>			<u>Public Finance</u>		
GNP	:	C£ 768 M	Government receipts	:	C£ 172.8 M
GNP per capita of population of Government controlled area	:	C£ 1 503	Government expenditure	:	C£ 205.6 M
Average growth rate in real terms, 1976-80	:	11.2%	Budget deficit	:	C£ -34.7 M
<u>Area</u>			<u>Sectors</u>		
Total	:	9.300 km ²		Contribution to GDP	Employment
Population density	:	67.6/km ²	Agriculture	12%	25%
Occupied area	:	40% of total	Manufacturing	16%	22%
			Trade	16%	11%
			Construction	13%	10%
			Services	11%	16%
			Other	32%	16%
<u>Balance of Payments</u>			<u>Rates of Exchange</u>		
				US\$ per C£	£sterling per C£
Trade balance	1979	1980	1976	2.437	1.352
Invisible balance	99.1	122.8	1977	2.451	1.406
Current account balance	-72.6	-85.5	1978	2.679	1.398
Overall balance	-11.4	+3.3	1979	2.822	1.332
			1980	2.834	1.220

Abbreviations

- GNP - Gross national product
MCM - Million cubic metres
ha - Hectare
mil - Thousandth part of Cyprus pound (C£)

SOUTHERN CONVEYOR PROJECT

1. BACKGROUND

In recent years there has been serious and growing concern in Cyprus about the shortage of water for both agricultural and domestic consumption. This shortage is caused by both an increasing demand and a reduction in the supply of water available. On the supply side the reduction has been most serious in the Kokkinokhoria area south of Famagusta (see Map 1 at the end of the report) where the water table is falling disastrously, and the intrusion of sea water has in parts raised salinity to levels unacceptable for domestic or agricultural use. On the demand side the increase is greatest in Nicosia where rising per capita requirements, industrial and commercialisation, and increasing population (including refugees) have necessitated cutting off water supplies to consumers up to 75% of the time for 10 months a year.

Additional water supplies are therefore needed for reasons of social welfare, health and hygiene, and there is little question that in agriculture this water can be productively and economically used. The resources of good land and skilled labour are available, as are crop markets and marketing systems, especially so in the case of Kokkinokhoria where the replacement of groundwater, is clearly the factor which will most limit continued agricultural production.

2. THE PROJECT

Objectives

The basic objective of the Southern Conveyor Project (SCP) is to collect and store surplus water currently flowing to the sea in the more mountainous and relatively wetter part of the island and convey it by means of a regional water carrier for use in areas to the east where the water is most needed.

In aiming to devise a socially and financially acceptable, and economically viable scheme the SCP has to recommend the irrigated farming development in the south coastal region between Limassol and Famagusta that would benefit most from the Project. In addition the SCP has to meet the future domestic and industrial water demands up to the year 2010 for the towns of Limassol, Larnaca, Famagusta and Nicosia and numerous village communities, and also supply the needs of touristic development along the southern and eastern coastline.

Proposed Works

The main works of the Project as shown on Map 1 are as follows:

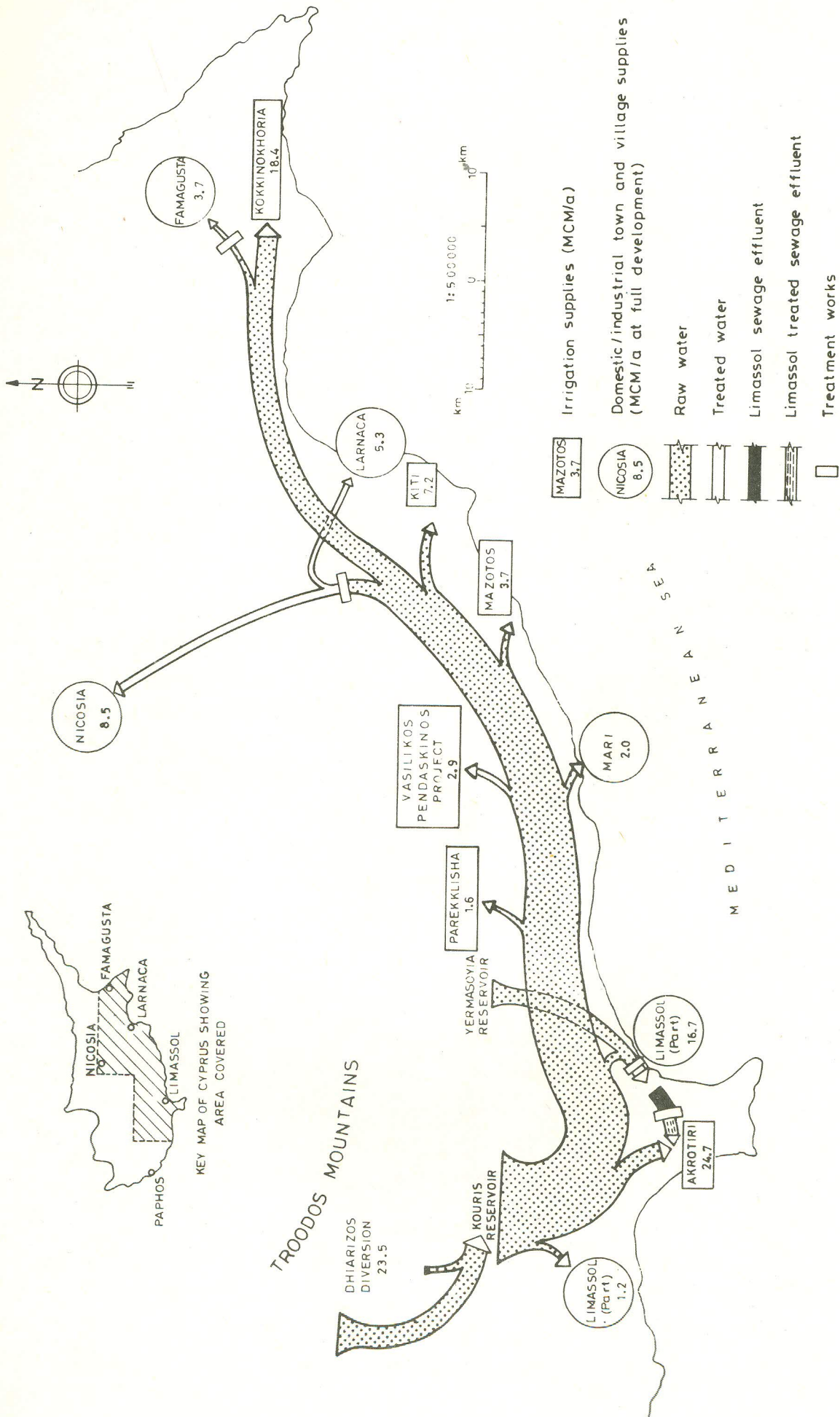
Kouris Reservoir This 120 MCM capacity reservoir is the main water storage component and is designed to provide seasonal and inter-annual storage of the flows of Kouris River and its tributaries. Such storage, by balancing the variable inflows will permit a steady and reliable supply to the Project benefit areas via the Southern Conveyor. The Kouris Dam, of zoned earthfill embankment construction (similar to other recent dams in Cyprus) will be 100 m high, containing 7 MCM of fill material obtained from the Kouris Valley. The 5 km long reservoir will have a surface area of 350 ha.

Main Conveyor This 110 km long pipeline of diameter ranging from 1600 mm down to 900 mm will convey the stored water entirely by gravity from Kouris Reservoir to a terminal reservoir at Akhna. Branches from the conveyor will supply the Project irrigation areas, domestic water treatment works and the Mari industrial area as well as provide compensation water to existing users in the Kouris Delta area. At full development 65 MCM of water will be conveyed in an average year. Figure 1 gives a diagrammatic representation of the design flows.

Akhna Reservoir A 16 m high earthfill embankment dam will retain 6 MCM of water, enabling the reservoir to provide balancing storage in the Kokkinokhoria area. Water will be pumped to the nearby Irrigation Area at times of peak irrigation demand to supplement flows in the main conveyor and thus reduce the size of pipeline otherwise required.

Yermasoyia Reservoir The mode of operation of this existing 14 MCM capacity reservoir will change with the advent of the SCP to allow water stored at its modest elevation to be more economically deployed in supplying Limassol for domestic water purposes. Shortfall in the domestic supply will be made good from Kouris Reservoir.

Dhiarizos-Kouris Diversion After several years of Project operation the inflow to Kouris Reservoir will be supplemented by flows from the upper Dhiarizos and Khapotami Rivers diverted by gravity through a pipeline and 16 km of tunnel bored through chalky rocks.



DIAGRAMMATIC REPRESENTATION OF DESIGN FLOWS IN THE CONVEYORS

Fig. 1

Limassol Sewage Tertiary Treatment A sewage treatment works for Limassol is scheduled for operation in the early 1990s. The SCP will treat the effluent with a further process to enable pumped supplies to be blended with conveyor water and thus permit unrestricted irrigation use in the Akrotiri Area.

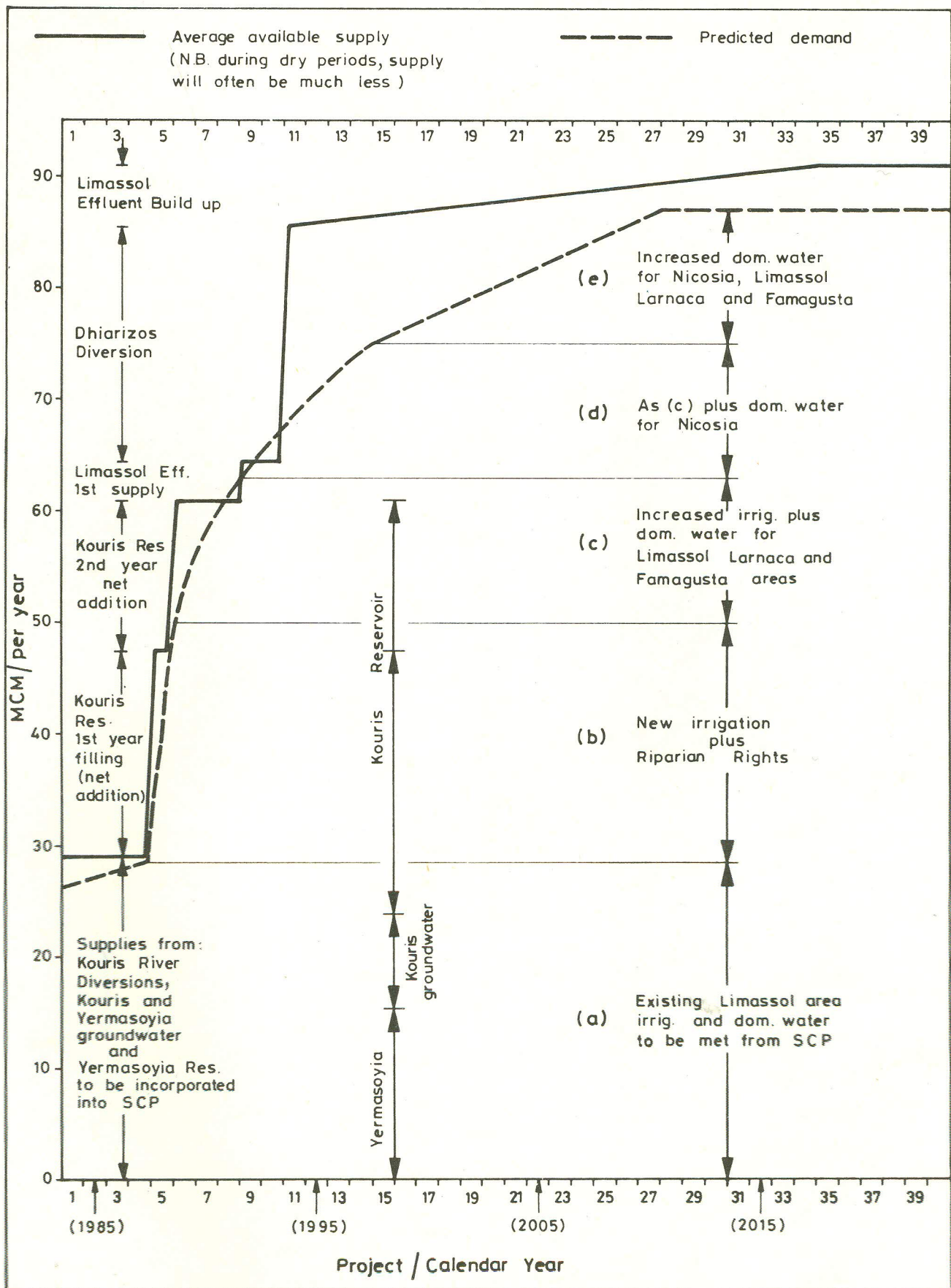
Irrigation Systems Over 10 000 ha of irrigated land will be supplied with Project water. The Akrotiri (1755 ha), Parekklisha (320 ha), Mazotos (660 ha), Kiti (1600 ha) and Kokkinokhoria (5125 ha) Areas plus a small area of the Vasilikos-Pendaskinos Project will be directly supplied via branches from the main conveyor. An irrigation area at Evdhimou will receive indirect supplies by means of non-Project transfers from the Kouris River tributary upstream of Kouris Reservoir.

The first four irrigation areas have been designed as 'on-demand' systems with buried pipelines delivering water to farm outlets at sufficient pressure to enable full use of modern irrigation equipment. Balancing the peak daily demands will be by night storage reservoirs. Farmers of the Kokkinokhoria Area will receive an 'on-rotation' supply to supplement their existing groundwater supplies which will thus be protected from further decline. Recovery of water levels will be possible by means of artificial recharge of the aquifer using the main conveyor supply from Kouris Reservoir.

Domestic Water Supply Three treatment works will treat the raw water from the new Kouris and the existing Yermasoyia Reservoirs for delivery to the towns of Limassol, Larnaca and Nicosia, the coastal touristic development of the Limassol, Larnaca and Famagusta Districts and some 56 villages within reasonable distribution range of the conveyor and its supply branches. Nearly 200 km of treated water pipeline is required.

The build up in Project water supply and the demand it is designed to serve is shown in Figure 2 for average year conditions. It will be seen that the Project as a whole will be supplying around 90 MCM/a at full development. During periods of shortage, occurring on average around once in every five years, a certain degree of rationing will need to be imposed and tentative control rules for the operation of Kouris Reservoir have been devised.

Further water could be introduced to the SCP by raising the level of Yermasoyia Dam and increasing the reservoir storage by 10 MCM or so, and also by building a new reservoir of around 1 MCM capacity at Pyrgos in the Parekklisha Area. Both projects have been found to be technically feasible, as a result of investigations undertaken during the feasibility study.



PROJECT SUPPLY AND DEMAND

Irrigation

The principal crop to be grown is potatoes which is predicted to cover 2800 ha or 43% of the area dependent exclusively on Project water; this is the hectarage required just to replace the production expected to be lost through the depletion of groundwater. The other crops of significance are citrus (18%) and vegetables (24%). At Project maturity the total demand for water to irrigate these crops rises to about 36 MCM per year.

Domestic Water Supply

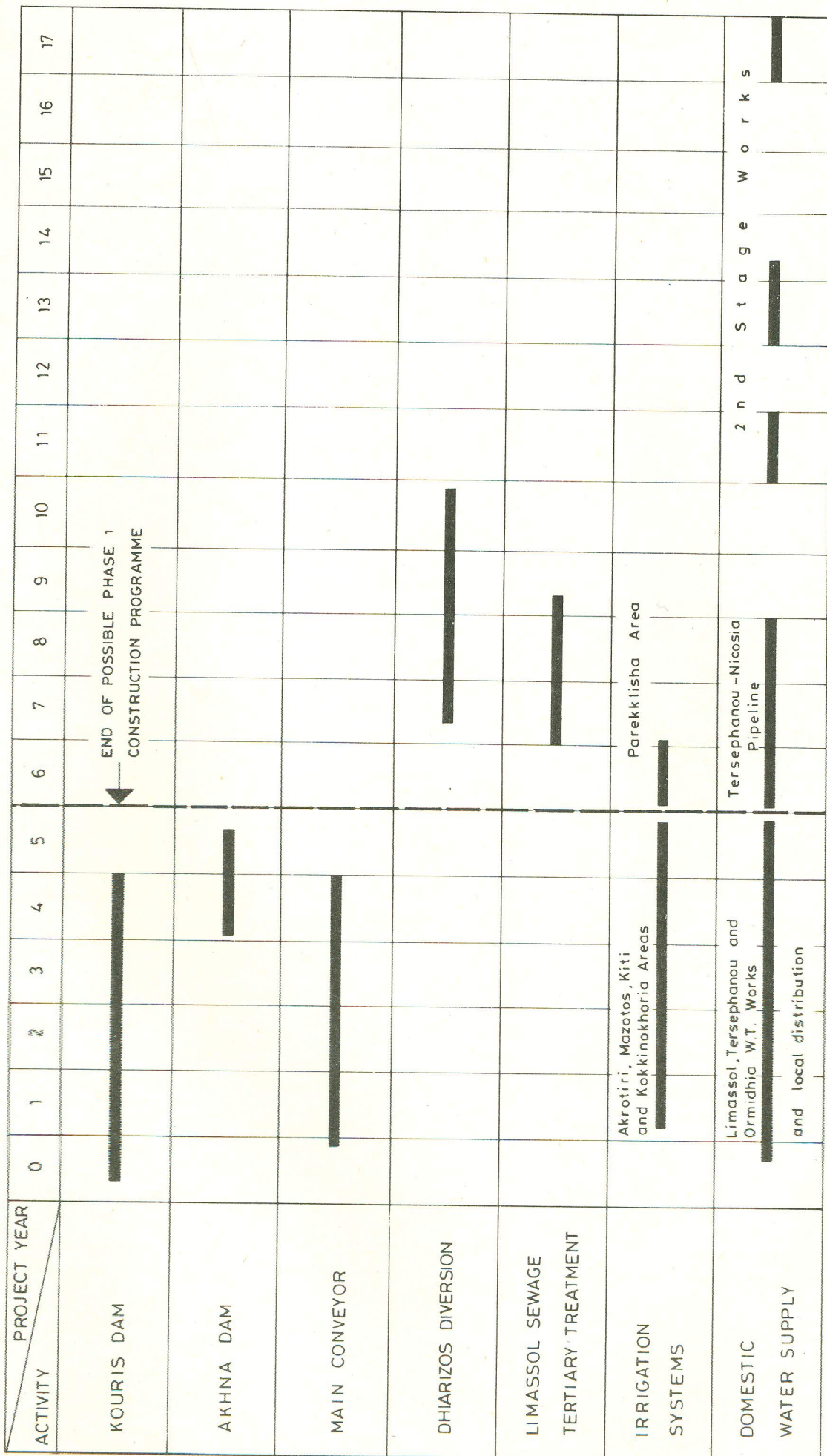
On the domestic side a total of about 570 000 people living in the four towns and their surrounding villages, or 75% of the total population, will at Project maturity benefit from the provision of water under the SCP. The Project will satisfy at this time a per capita consumption of 250 litres per day in the towns and 200 litres per day in the villages, and the total demand for domestic water will be about 38 MCM per year.

3. PROJECT COSTS

The total investment cost of the proposed works described above is C£ 133 M. The costs of the individual components are summarised in Table 1. While water will be provided onwards from the sixth year of the Project, investments will continue as water demand builds up. Cost disbursements associated with the construction timetable shown in Figure 3 will exceed C£ 10 M in each of the first six years.

TABLE 1 Project Investment Costs (1981 prices)

Component	Cost (C£ M)
Kouris Reservoir	28.3
Main Conveyor	37.2
Akhna Reservoir	2.3
Dhiarizos Diversion	13.6
Limassol Sewage Tertiary Treatment	3.8
Irrigation Systems	24.9
Domestic Water Supply Works	21.7
Project control and administration	0.7
Total	132.5



CONSTRUCTION TIMETABLE

4. PROJECT BENEFITS

The water provided by the Project produces benefits in both the agricultural and domestic sectors. On the agricultural side the benefits from this water are obtained by multiplying the net returns per hectare of each crop by the number of hectares grown, making allowances for shortages in years of drought. On the domestic side the benefits from water are obtained by multiplying the unit value of water by the quantity supplied each year, with similar allowances for drought. At Project maturity it is expected that total annual benefits will be approximately C£36 M, nearly 60% of which arise from the domestic sector. By this time it is anticipated that a total of 570 000 domestic water consumers will benefit from the enhanced supplies provided by the SCP whilst the number of farming units to be wholly irrigated from Project supplies is expected to be around 2600.

5. PROJECT EVALUATION

The results of the comparison between the Project costs and benefits are given in Table 2. It can be seen that the Project produces a Net Present Value (NPV) of nearly C£ 44 M and an Internal Rate of Return (IRR) of 13.1%. The unit cost of Project incremental water supply is around 320 mils per m³, and that of gross water supply - including water provided in compensation for lost spate and groundwater - is 270 mils per m³. In the event that investment costs increase by 20% the Project remains economically viable, producing an IRR of 11.6%. Similarly the Project could also withstand a reduction of benefits by as much as 20% or a delay in benefits (due to construction time-table overrun for example) by 3 to 4 years.

TABLE 2 Results of Economic Analysis

Solution	NPV	IRR	Unit cost of water	
			Gross water supply	Net water supply
Core	£43.6	13.1%	270 mils/m ³	320 mils/m ³
20% cost increase	£24.5	11.6%	310 mils/m ³	370 mils/m ³
20% reduction in overall benefits	£2.8	10.2%	270 mils/m ³	320 mils/m ³
2 year delay in project benefits	£31.1	12.1%	270 mils/m ³	320 mils/m ³

The economic returns have also been analysed by sector and the results are presented in Table 3. Despite the high cost of domestic water the NPV of this sector is higher than irrigation by about 20%. It can also be seen that each of the irrigation areas is economically viable with Kokkinokhoria producing nearly two thirds of the agricultural NPV.

TABLE 3 Economic Return by Sector, at 10% Discount Rate

Irrigation Area Sector	Total discounted benefits £'000	Total discounted costs £'000	NPV £'000	Unit cost of water mils/m ³
Akrotiri	7 741	5 931	1 810	245
Parekklisha	2 511	2 052	459	346
Mazotos	5 367	3 759	1 608	238
Kiti	10 888	7 205	3 683	269
Kokkinokhoria	42 102	28 833	13 269	259
Total Irrigation Sector	68 609	47 780	20 829	259
Domestic Water Sector	91 453	66 291	25 162	405

6. PROJECT ORGANISATION

In view of the very heavy expenditure of the SCP and other major irrigation projects in Cyprus now at the construction or planning stage the creation of a National or Central Water Authority is encouraged. This would take responsibility for all water resource planning, development and control activities. For purposes of Project planning it is assumed that restructuring of the water industry will occur by the time the SCP first delivers water.

Completion of the Project preparation phase and supervision during the construction stage will be undertaken within the WDD which will then provide a team to administer and manage the operation of the Project.

A small Evaluation Unit will monitor the overall performance of the Project for the benefit of Project management, Government and external financiers. Day to day operation will be from a Project Control Centre receiving telemetered signals from outstations which will be processed using modern computer facilities and data logging and retrieval systems.

7. PROJECT FINANCE

The construction timetable presented in Figure 3 would involve a first phase investment approaching £100 M. Unless Government is able to accord the SCP priority to the exclusion of other infrastructure projects it is likely that modification to such an idealised implementation programme will have to be made. For the purpose of financial analysis, however, a financial plan has been prepared by the feasibility study team based on assumptions concerning foreign exchange loans and water charges associated with the programme described above. Foreign loan requirements by Government would total £63 M during the first phase and £20 M during a succeeding phase of similar length. Local costs would total £36 M and £13 M respectively.

Based on the financial arrangements given above, and water charges of 100 mils/m³ and 450 mils/m³ to irrigators and domestic water consumers respectively, the Project cash inflows and outflows indicate that Government will have a negative cash balance up to the 12th year of the SCP from when on it will remain positive. The overall financial rate of return is calculated to be about 9%. Resulting from a farm investment analysis for 10 farm models, representing farming units throughout the SCP area, it is found that even with a water charge of 100 mils/m³ with good management all farm models provide a good financial return. The 400 mils/m³ cost of water supplied from the SCP to the water boards compares with existing costs averaging 200-300 mils/m³.

8. OTHER ISSUES

Political Settlement in Cyprus

In the event of a settlement between the Greek and Turkish Cypriot communities a considerable increase in domestic water demand in the southern part of Famagusta town could develop due to the return of the original inhabitants. The SCP is well placed to provide for an extension of demand in this area.

Hydroelectric Power

Full advantage is taken of available head between Kouris and Akhna Reservoirs to enable water in the conveyor to flow entirely by gravity.

Scope to also generate power is therefore restricted. A preliminary study into the possibility of using the head difference between the variable Kouris Reservoir level and the fixed control level required for conveyor flows indicated that such a scheme, generating around 1.3 MW at the maximum, was economically marginal. A further study may be undertaken.

Land Consolidation

An early start on a comprehensive land consolidation programme in all five Project Irrigation Areas will be required in accordance with recommendations of the Land Consolidation Authority.