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APPRAISAL

OF THE

SECOND WATER SUPPLY PROJECT

IN

PAPUA NEW GUINEA

June 1978

828 PG.MA78
1226

CURRENCY EQUIVALENTS
(As of 1 May 1978)

Currency Unit :		Kina (K)
K1.00	"	US\$1.3912
K1,000,000	"	US\$1,391,200
US\$1.00	"	K0.7188
US\$1,000,000	"	K718,804

ABBREVIATIONS

PNG	-	Papua New Guinea
DWS	-	Department of Works & Supply
DPH	-	Department of Public Health
B&P	-	Binnie & Partners
cu.m.	-	cubic meters
cu.m./day	-	cubic meters per day
lpcd	-	liters per capita per day
km	-	kilometer
m	-	meter
mm	-	millimeter
A. D. D.	-	Average Daily Demand
M. D. D.	-	Maximum Daily Demand

Fiscal Year

The Government's Fiscal Year ends on 31 December.

Notes:

- (i) The Kina was introduced on 19 April 1975 and was kept at par with the Australian dollar until 25 July 1976, when the Kina was revalued.
- (ii) Throughout this Report, "\$" means U. S. dollar.

DEFINITION OF HOUSING TYPES

- High Covenant Houses** : Generally of the order of 110 square meters or more. Most have electricity, a telephone, a sanitary system and refuse collection services.
- Low Covenant Houses** : Approximately half the area of high covenant houses and of simplified design. Services mostly similar to high covenant houses, except that telephones would be unusual.
- No Covenant Houses** : Temporary type of accommodation, usually smaller than low covenant houses, on special allotments made available to ease overcrowding in urban settlements. Most services are of low standard and are communal, often involving a central water supply point with associated washing facilities and a central toilet block.
- Urban Settlements** : Indigenous village and squatter settlements comprising native huts or temporary housing. Urban settlements do not have electricity or water, and usually have pit latrines.

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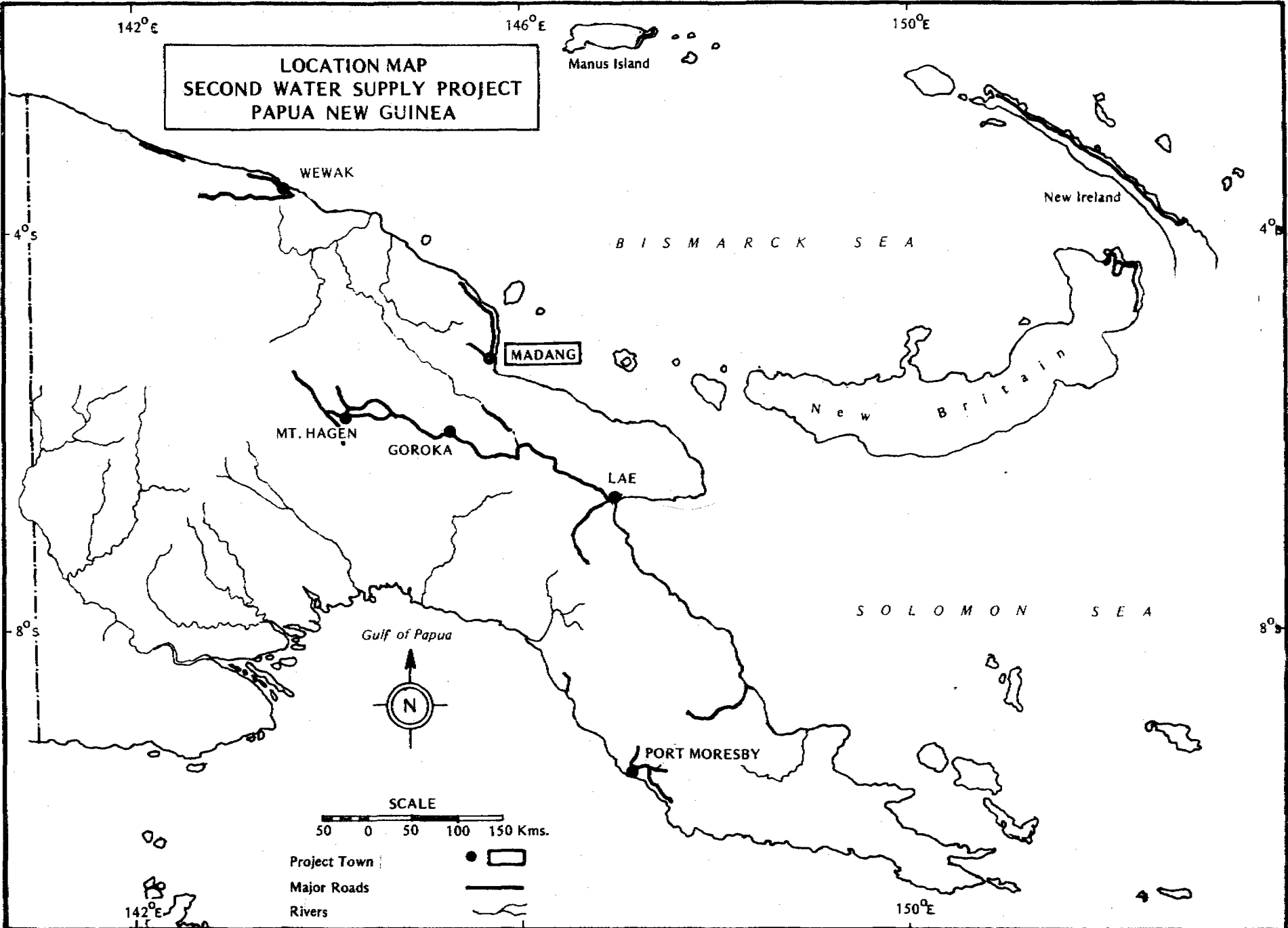
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LOCATION MAP
SECOND WATER SUPPLY PROJECT
PAPUA NEW GUINEA



(111)

I. INTRODUCTION

1. The Government of Papua New Guinea (PNG) has requested the Bank to finance the foreign exchange cost of the Second Water Supply Project. The proposed Project will provide comprehensive piped water supply facilities in the town of Madang for the first time and will contribute significantly to the improvement of public health and sanitation in that town.

2. The Project is a direct outcome of the previous Bank assistance to Papua New Guinea. In November 1976 the Bank approved a loan of \$13.5 million from its Special Funds for the Water Supply Project in PNG.^{1/} The loan, among other things, covered groundwater source studies and detailed engineering design for the town of Madang. Engineering consultants, Binnie & Partners (B&P), were engaged in June 1977 by the Government under this ongoing project. The consultants' Inception Report was submitted in December 1977 for review by the Bank and the Government.

3. Subsequently, a Bank Mission visited PNG in February 1978 to undertake a final review of the findings presented in the Inception Report. An agreement was reached during the Mission's visit between the Government, consultants (B&P) and the Bank Staff consultant/hydro-geologist, that groundwater development for the projected 1986 water demand for Madang was feasible.

4. A Bank Appraisal Mission comprising S. L. Liu (Project Engineer/Mission Chief), M. Faelnar (Counsel), M. Stewart-Hesketh (Financial Analyst) and A. Proctor (Economist) visited PNG from 6 to 15 April 1978. This Report is based on the Mission's findings, discussions with the Government officials, and the consultants' reports.

^{1/} Loan No. 278-PNG(SF)

II. BACKGROUND

A. Water Supply Sector

1. Present Situation

5. It is estimated that only approximately 10 per cent of the total population of PNG has reasonable access to piped water supply. There are presently 28 reticulated water supply systems in PNG. Of these, 21 serve communities with populations of 5,000 or less and 7 serve towns with populations exceeding 5,000. The only comprehensive water supply scheme in the country is in the national capital, Port Moresby, although there are partial schemes at Lae, Rabaul, Goroka and Arawa, and numerous minor schemes in various centers to serve the needs of institutions such as hospitals. The schemes have been developed on a very ad hoc basis with aspects such as a tariff policy being virtually non-existent and revenue collection, extremely variable.

6. The remaining 90 per cent of the nation's population has no access to piped water and therefore, has to depend on private wells, streams and water courses, and rainwater collection. As annual rainfall throughout the country is considerable, roof run-off and rainwater are the traditional means to meet the water supply needs in the towns. However, because of limited catchment area of roofs and limited capacity of storage tanks, particularly in low income group housing, the roof water supply is often insufficient to meet the needs. The people therefore, have to resort to wells and other surface sources for supplementary water, especially in the dry season. In rural areas, wells and rivers and other surface sources provide water supply to almost all people.

2. Sector Organization

7. The Department of Works and Supply (DWS) is responsible for the development of water supply in PNG. The Department of Minerals and Energy through its Geological Surveys Section is responsible for the investigation of groundwater and the same office, through its Bureau of Water Resources, is responsible for hydrogeological studies.

8. DWS is responsible for design, planning, supervision, construction, inspection and maintenance of all public works of Government statutory organizations. DWS assists the Government in the formulation of policy for water supply, sewerage and solid waste disposal and is responsible for subsequent execution and implementation. DWS executes its water supply and sewerage responsibilities through its provincial branches.

9. DWS, based in Port Moresby, is a government department. The organization structure of DWS, shown in detail in Appendix 1, comprises three principal areas (Operations, Technical & Policy, and Supply), each headed by a First Assistant Secretary, reporting to the Secretary. There are two minor areas (Staff Development & Training, and Management Services), each headed by an Assistant Secretary. Three further Assistant Secretaries report to the First Assistant Secretary, Technical and Policy and are responsible respectively, for engineering, architecture and technical services. Water supply falls under the General Engineering Branch, the head of which reports to the Assistant Secretary, Engineering.

3. Finance and Investment

10. The level of investment in the sector during the current decade has averaged about 6 per cent of the national capital works program. There has, however, been a marked increase since 1975/76. For the six-year period 1970/71 to 1975/76 investment averaged only 5 per

cent, but, for the period since then the average has risen to 8.5 per cent with 9.5 per cent budgeted for 1978. Absolute levels of annual investment are shown in Appendix 2.

11. Policy decisions regarding the selection of projects, the determination of priorities and the mobilization of resources are made at the national level. Financing of water and sewerage systems has been wholly internal to date except for the Bank's previous loan for the sector. Apart from the proposed loan, the only other planned foreign financing for the sector is the possible use of Japanese aid funds for a small (less than \$2 million) sewerage system in Goroka.

B. Performance under Previous Bank Loan and Technical Assistance

12. In November 1976 the Bank approved a loan^{1/} of \$13.5 million from its Special Funds, and a technical assistance grant^{2/} of \$165,000 for the Papua New Guinea Water Supply Project - the ongoing project which comprises the following components:

- (i) Provision of water supply facilities and consultant services for detailed engineering design and construction supervision for Lae, Mt. Hagen and Wewak, and groundwater investigation for Lae; and
- (ii) Detailed engineering design, including investigation of groundwater potential in Madang.

1/ Loan No. 278-PNG(SF)
2/ T. A. No. 179-PNG

13. The scope of the Bank's Technical Assistance covers, among other things, the development of an appropriate institutional and organization structure, financial management policy, an appropriate tariff structure and staffing requirements (including training) for an efficient water supply sector in Papua New Guinea as a whole.

14. DWS is the Executing Agency for the implementation of the ongoing project. To assist in the implementation of the ongoing project, engineering consultants, Binnie & Partners, were engaged in June 1977 by DWS. Groundwater investigations have been carried out at Lae and Madang. The investigations have shown that there are adequate groundwater sources to meet the estimated water demand to 1986. The consultants' inception report was submitted to the Government of PNG and the Bank in December 1977 for review and comments. The report provided a review and amendment (see Appendix 3) of the preliminary designs as originally proposed by the Government consultants, Beca Carter Hollings & Ferner (BCHF) in 1976, which formed the basis of the Bank's ongoing project.

15. Due to delay in recruitment of the consultants, the commencement date for implementation of the ongoing project was delayed by approximately four months as compared to the original implementation schedule; the project however, is currently proceeding satisfactorily and no further delay is anticipated. As the project is presently in the early stage of implementation, there is little to report on the progress of loan covenants, particularly those relating to the operational, institutional and financial aspects. However, the extent that loan covenants have become operative, they have been substantially complied with by the Government. The recruitment of Financial/Management consultants under the technical assistance program is now underway. A summary of DWS's compliance with the loan covenants is given in Appendix 4.

III. THE PROJECT AREA

A. Economic Situation in the Project Area

16. Madang has a long history of contact with modern cultures. It was one of the German colonial administration's major centers during the closing years of the last century and has continued as a major center for plantation agriculture since the First World War. The biggest boost to the Province came with the opening up of the New Guinea Highlands in the early 1950's. All goods entering and leaving the highlands were airfreighted from or to Madang, generating very considerable air cargo traffic.

17. Following the opening in 1968 of the Highlands Highway, which linked Lae to the highlands, Madang lost much of its prominence as a major port and trading center. It remains, however, the fourth largest town in Papua New Guinea and appears certain to enter a second growth phase in the near future. While its plantation sector (cocoa and copra) is the strongest of all the mainland provinces and provides the basis to the town's prosperity, the hinterland, unlike those of Morobe and the highland provinces, is virtually undeveloped. Considerable scope therefore exists for the establishment of new industries in these areas, as well as for further processing of the commodities now produced. The major existing industry in the town is a woodchip mill operation which produces mixed tropical hardwood chips for the Japanese pulp market. A coffee mill has recently begun operation and a copra mill has been proposed and appears likely to go ahead. Tourism is also becoming an important activity. The guarantee of adequate water supplies will be an important supporting factor for all these activities.

18. As a transport center, Madang is an important port for the coastal trade on the north coast and still handles a reasonable volume of international cargo as well. Though provincial roads are, in the main, confined to the coast, a low standard road (not all-weather) links Madang to the Highlands Highway at Waterais and this road is being progressively upgraded. The completion of this work will mean that Madang will be linked to Lae, the nation's second largest city, and the highlands where 40 per cent of the population live. The upgrading is expected to be completed in five years.

B. Existing Water Supply System

19. Because there is no reticulated water supply system in Madang at present, a large proportion of the population relies on roof run-off and storage tanks for regular supply. Rainwater, running off roofs, is collected in gutters and directed through spouting to storage tanks either at or below ground level. However, because of relatively small roof catchment areas and ^{1/} limited tank capacities, even the high covenant houses cannot store sufficient water to provide a regular supply during the dry season. During this period the tanks are supplemented with water transported by tanker from public and private wells and other surface sources of questionable quality. Water storage tanks are mainly made of galvanized corrugated iron sheets and require replacement at intervals of approximately four years because of corrosion caused by Madang's proximity to the sea. This is an expensive operation. The lower income group people living in no covenant and settlement housing generally rely on a variety of surface sources and wells for their water supply. However, these supplies are being increasingly polluted in a growing urban environment.

20. There are presently 11 public wells (including two deep wells and nine shallow wells and bores) servicing primarily institutions, schools and the hospital complex, as well as augmenting rainwater during the dry season.

^{1/} See definitions at the front of this Report.

DWS's Provincial Office is in charge of the operation and maintenance of these wells. The Office is staffed with 12 full time and 8 part time staff. Shallow wells (approximately 10 m depth) are constructed into the underlying coral limestone aquifer. The water abstracted from these wells is reported to be very hard and is grossly polluted by wastewater. Saline water exists in the lower depth of the limestone. The recently-constructed Beon water source^{1/} provides potable tankered water supply to institutions and hospitals and for public domestic use to augment the rainwater supply. The Beon source comprises two deep wells, a chlorination facility, a storage tank (1400 cu.m. capacity) and a tanker loading station. The supply capacity is estimated at 900 cu.m. per day. It also benefits approximately 600 people living in the nearby Sisiak Village.

C. Sewerage, Drainage and Solid Waste Disposal

21. There is no reticulated sewerage system in Madang but there are some small institutional systems and a septic tank effluent collection system. Of the total population, approximately 24 per cent have individual septic tank service, 26 per cent have night soil collection service, and the remaining 50 per cent have pit latrines, cesspools, and other rudimentary methods. High cost houses and most commercial, industrial, hotel and government premises are connected to septic tanks. The effluent from septic tanks is discharged either directly into surface drains or through ground soakage. Low cost houses are mostly served by a night soil collection system operated by the Madang Town Council. Night soil is disposed of by oxidation pond treatment. Effluent from pit latrines and septic tanks disposal by leaching lines tends to pollute the groundwater aquifer in the Madang area.

^{1/} See Appendix 10 for its location.

22. Although the Government is aware of the need to improve and install proper sewerage facilities in the town, no immediate plan is envisaged due to the Government's financial constraints. The provision of an adequate sewerage system will be very costly, particularly because in the Madang area, population density is low and the houses are scattered. The Government has undertaken to engage consultants financed from its own sources to carry out the sewerage studies (including Lae, Mt. Hagen, Wewak and Madang), and has assured the Bank that consultant's reports will be provided to the Bank for review prior to implementation.^{1/}

23. Storm drainage is the responsibility of the road section within DWS. Madang is relatively free from flooding except for lower areas around the hospital complex where flooding occurs when high tides coincide with heavy rains. Because of the permeability of the soil (coral limestone) and the topography, all surface drainage is discharged directly into the surrounding sea by natural gravity flow or by percolation into the ground. There are open and covered concrete drains in the central town area, whereas there are only simple open drains in the residential areas.

24. The collection and disposal of solid waste is the responsibility of the Madang Town Council. Solid waste is collected from all households and commercial establishments and disposed of by landfill in areas on the outskirts of the town. Garbage collection charges are levied on all premises. The present collection system is considered to be satisfactory, but, the landfill disposal practice of open dumping without earth cover is insanitary and needs improvement. This condition will be improved soon since a bulldozer has recently been provided at the landfilling site to permit spreading and compaction of garbage and timely placement of earth cover.

^{1/} Loan No. 278-PNG; Side Letter No. 4

D. Population and Water Demand

25. Like most urban areas in PNG, the town of Madang has experienced very high population growth due to migration into town from the rural areas. The population of Madang has grown from 8,800 at the 1966 census to 16,800 at the 1971 census, or an average annual growth rate of 14 per cent. In the same period the average annual rate of growth of population in PNG as a whole was 2.5 per cent. Nevertheless, Madang, which has an area of approximately 1,800 hectares, has a relatively low population density of 12.5 persons per hectare.^{1/}

26. Madang has substantial growth prospects (see Appendix 5). The continuing development of the timber industry, the establishment of other major industries (agricultural processing and light manufacturing), and increased tourist trade in the area, coupled with Madang's natural deep water port facilities, should mean that the town will continue to grow at a high rate in the future. The consultants, using the National Planning Office data, have projected that the population of Madang will reach about 43,000 in 1986. This means an average increase of about 7 per cent per annum over the next 10 years. The Mission considers this to be reasonable. Appendix 6 shows the projected population in terms of the types of houses in which they live. The types of houses are closely correlated with per capita water usage (see para. 27).

27. In the absence of any piped water supply in Madang, it is not possible to use historical data to project water demand. Based on experience elsewhere in PNG, the consultants, following DWS criteria (see Appendix 7) have assumed daily per capita water demand of 40 lpcd for village settlements, 68 lpcd for no covenant houses and 225 lpcd for high and low covenant houses. For the non-residential

^{1/} Based on the 1976 population estimate of 22,500.

(industrial, commercial) requirements, the consultants assumed a consumption rate of 17.7 cu.m./day per hectare for industrial needs and 9.1 cu.m./day per hectare for commercial needs. The Mission considers these assumptions reasonable. Land use information was obtained from the Madang Master Plan (see Appendix 8) in the Urban Study. The Madang Master Plan sets forth in detail the development proposals for the town, including the population distribution and road alignments along which water pipelines will be laid. The total non-residential water requirement for Madang, based on these assumptions, is estimated at 3,330 cu.m./day in 1986.

28. In principle, a piped water supply system should serve as many people as possible. Nevertheless, it would be too expensive to provide piped water service to the entire population in the Project area at one time; accordingly, phased development will be required to supply the central city area (high population density) initially and then later expanded to supply the coastal area north of the present developed area (where the population density is lower). Many houses, and particularly village settlements, are either widely scattered or remote from main supply pipeline routes and would be prohibitively expensive to serve. It is assumed that approximately 75 per cent of the total population in the Project area will be served by 1986 under the proposed Project (for details see Appendix 6).

29. The estimated water supply requirements for the Project area in 1986 are summarized in Table 1 below and details are shown in Appendix 9.

Table 1: Summary of Projected Daily Water Demand

<u>Description</u>	<u>Demand</u> (cu.m./day)	<u>(%)</u>
Residential	4,550	46
Non-residential	3,330	34
Losses & other uses	<u>1,970</u>	<u>20</u>
	<u>9,850</u>	<u>100</u>

E. Water Availability and Quality

30. The Gum River (see Appendix 10) is the major potential source of surface water available in the Madang area. The river has a catchment area of approximately 127 sq. km. Hydrological studies based on the limited available data indicate that the river has adequate dry weather flow (42,000 cu.m./day) for supplying the water required under the proposed Project in Madang (1986 peak daily demand would be 12,300 cu.m./day). However, bacteriological tests carried out by DWS show that the river water is heavily polluted and would need extensive treatment. However, mineral and saline constituents are at normal levels.

31. Hydrological surveys have indicated that groundwater development for the projected water demand is technically and economically feasible. There is sufficient groundwater in Beon/Sisiak area (see Appendix 10) to meet Madang's water supply needs up to at least 1986. The Government's hydrogeologist has indicated that there is a perched^{1/} groundwater basin around the Beon area. He also estimated that the recharge infiltration would be about 13,000 cu.m./day in that area. The Bank staff consultant/hydrogeologist considers that available supply from stored water in both the limestone and sand aquifers would last for several years and has also confirmed that there is sufficient groundwater to meet Madang's water supply needs up to at least the 1986 level. The analysis of groundwater samples taken in the Beon/Sisiak area indicates that the water contains no undesirable or objectionable constituents apart from small amounts of turbidity and iron. Only disinfection treatment (chlorination) would be needed.

^{1/} That is, water held in porous material supported by impervious, basinlike, underground stratum.

F. Development Program

32. Water supply development programs in Madang have been studied and reported on in the past. In 1968 Laurie & Montgomery, consulting engineers, proposed a fully reticulated water supply system using the Gum River as the water source; this was not proceeded with. In 1972 the Madang Urban Study was prepared by Russel D. Taylor & Partners. The study proposed a short term plan to 1976 and a long term development proposal for the water supply; the Gum River source was recommended. In 1974 Beca Carter Hollings & Ferner Ltd., prepared an Investigation Report on water supply schemes for six towns including Madang. This report too was based on the Gum River source. However, it should be noted that the potential groundwater source of supply for Madang was not investigated and assessed until 1976.

33. In 1976 the Bank staff consultant/hydrogeologist recommended the prospect of developing a groundwater source for Madang in connection with the Bank's ongoing project (see para. 12). These recommendations were adopted by the Government. The first priority of the consultants, B&P, who were engaged by the Government under the ongoing project, was to investigate groundwater potential for Madang with the assistance of the Bank's hydrogeologist. The hydrogeological investigations carried out by the consultants indicate that there is an adequate quantity of safe groundwater for Madang.

34. The consultants, B&P, have drawn up a development plan based on their findings, regarding groundwater sources (see para. 33) and proposed that 6 to 8 deep wells be developed to meet the projected 1986 water requirements. Water from the deep wells is to be collected and chlorinated before distribution to the consumers. It is estimated that the groundwater scheme will result in a substantial reduction in the capital investment cost of about \$1.8 million over the alternative Gum River source. The distribution pipelines, as proposed, are based on the results of hydraulic analysis.

Service reservoirs will be constructed near the well-fields from where the water will flow by gravity into the town distribution system. The Government has approved the program proposed by the consultants. The Mission has examined the report and is in agreement with the consultants' proposal.

IV. THE PROJECT

A. Description and Scope of the Project

35. The proposed Project will provide comprehensive piped water supply facilities in the town of Madang for the first time. The Project will include the development of a groundwater supply source capable of meeting the estimated 1986 water demand, construction of transmission mains and distribution system facilities consisting of service reservoirs, mains, consumer connections and meters, public standpipes and fire hydrants. The preliminary design report has been prepared by B&P who were engaged by the Government under the ongoing project (see para. 12), and represents the least cost and most feasible solution to meet the needs of Madang to 1986. The Mission has reviewed the proposed scheme and found that the proposal is acceptable as the basis for the Project.

36. The water for the Project will be taken from a wellfield to be developed between Sisiak Road and the Gum River about 5 km west of Madang Town (see Appendix 10). At least six wells (depending upon the results of the test pumping program now underway) will be constructed extending to depths of about 70 meters in the coral limestone aquifers and underlying volcanic sands. The wells will be designed to meet the 1986 peak daily demand of 12,300 cu.m./day with 50 per cent standby capacity. Electric submersible tubewell pumps will be installed in the wells to pump water to two 3,100 cu.m. service reservoirs at a site close to Sisiak Road. Chlorine will be injected into the pumping main upstream of the reservoir. From the service reservoirs, chlorinated water will gravitate through transmission mains and the town reticulation system to consumers. An assurance has been given by the Government that appropriate measures for pollution control and conservation of the Project water sources (wellfields) will be taken,^{1/} and that an effective water quality control program will be established not later than six months before the estimated date of completion of the Project.^{2/}

^{1/} Loan Agreement, Schedule 6, para. 6.
^{2/} Loan Agreement, Schedule 6, para. 7.

37. The proposed distribution system will be of simple design and of sufficient capacity to provide service from high ground service reservoirs to most of the population by means of house connections and standpipes. Pipelines will be laid to meet expected demands based on the land use plan for the town. Service reservoirs with a total capacity of 6,200 cu.m. amounting to 50 per cent of the maximum daily demand will be provided. The main function of the service reservoirs will be to provide adequate supply to meet demand over periods of varying consumption and to supply water during equipment failure or for fire demand. Necessary fire hydrants will also be installed in the system. The basic criteria upon which the Project design is based are summarized in Appendix 11. The Mission considers these criteria reasonable.

38. Standpipes will be constructed to provide dependable and safe water supply to the low income group houses. It is estimated that about 6,200 people will benefit from these standpipes, which will not be metered. However, the Government and the consultants have both proposed that all house connections will be metered. The Mission is in agreement with this approach. Lack of metering on existing water systems is considered one of the contributing factors to the high per capita consumption levels prevailing in PNG.

39. The principal features of the proposed Project are as follows (see the general layout plan at Appendix 10):

- (i) development of a deepwell field yielding approximately 12,000 cu.m./day of water and laying of well water collection pipelines;
- (ii) construction of water chlorination facilities;
- (iii) construction of two 3,100 cu.m. service reservoirs on high ground;

- (iv) procurement and laying of approximately 7.8 km of transmission mains of 600 mm to 350 mm dia.;
- (v) procurement and laying of approximately 37 km of distribution mains of 300 mm to 100 mm dia.;
- (vi) procurement and installation of hydrants, standpipes and water meters;
- (vii) procurement of miscellaneous items such as motor vehicles,^{1/} meter testing and workshop facilities and construction of a chemical storage warehouse; and
- (viii) engineering services for construction supervision.

B. Cost Estimates

40. The total cost of the proposed Project is estimated at \$8.1 million equivalent of which the foreign exchange component is \$5.4 million or 67 per cent of the total Project cost. The cost estimates are summarized in Table 2 and given in detail in Appendix 12. The cost estimates are based on July 1977 prices including allowance for physical contingencies of 10 per cent and price contingencies of 26 per cent of the Project cost. Price contingencies are provided for the implementation period of the Project (see Appendix 13) and comprise: (i) for materials and equipment: 7 per cent for 1978, 6.5 per cent for 1979 and 6 per cent thereafter; and (ii) for civil works: 8 per cent for 1978, 6.5 per cent for 1979 and 6 per cent per year through scheduled completion in 1981.

1/ For maintenance purpose.

Table 2: Cost Estimates of the Project
(\$'000)

<u>I t e m s</u>	<u>Foreign</u>	<u>Local</u>	<u>Total</u>
A. <u>Civil Works</u>			
Land Purchase	-	14	14
Wells Construction	379	269	648
Civil Construction ^{a/}	264	297	561
Pipelaying	<u>310</u>	<u>1,096</u>	<u>1,406</u>
Sub-total A	953	1,676	2,629
B. <u>Materials & Equipment</u>			
Pipes	1,933	-	1,933
Plant & Equipment ^{b/}	260	17	277
Motor Vehicles	32	-	32
Valves, Meters, Hydrants	<u>304</u>	<u>-</u>	<u>304</u>
Sub-total B	2,529	17	2,546
C. <u>Engineering</u>^{c/} (Construction Supervision)	516	200	716
D. <u>Contingencies</u>			
Physical ^{d/}	331	178	509
Price Escalation ^{e/}	<u>1,071</u>	<u>629</u>	<u>1,700</u>
Sub-total D	1,402	807	2,209
Total (A + B + C + D)	<u>5,400</u>	<u>2,700</u>	<u>8,100</u>

a/ Including construction of service reservoirs, chemical storage warehouse, etc.

b/ Including supply and installation.

c/ Excluding the cost of detailed engineering design fee of \$480,000, which was already financed under the previous Bank loan (Loan No. 278-PNG).

d/ About 10% of base cost.

e/ About 26% of Project cost.

41. The costs of civil works, as estimated by the consultants, are based on the results of their field investigation and engineering design conducted under the ongoing project (see para. 12), and unit prices for similar projects in other places (mainly derived from the consultants' experience in Malaysia, Singapore and Brunei) duly adjusted to the particular local conditions in PNG. It was noted that the detailed designs for the Project were not completed. However, estimates were considered to be good enough for appraisal. The costs of equipment and materials are based on quotations received from manufacturers. The costs of engineering construction supervision are the consultants' estimates based on the length of construction period and manpower requirement and have been reviewed by DWS. The Mission considers the Project cost estimates to be reasonable.

42. In PNG almost all materials and equipment are supplied from foreign sources due to the very limited local production of such items. The main items covered by the foreign exchange costs are tube-wells, pipes and fittings, pumps and motors, water meters, motor vehicles and specialized equipment. For civil works, many construction materials must be imported and PNG will, by necessity, depend heavily on expatriate managerial staff and skilled labor for construction in view of the lack of indigenous managerial staff and skilled labor. Details of the proportions allowed in the cost estimates as foreign exchange costs are given in Appendix 14.

C. Proposed Loan

43. A loan of \$5.4 million is proposed from the Bank's Special Funds resources at 1 per cent per annum for 40 years including 10 years of grace to cover the foreign exchange costs of the Project. Financing from Special Funds can be justified on the basis of country considerations and the nature of the Project.

PNG is currently treated as country eligible to receive a blend of loans from the Bank.^{1/} The Project is socially beneficial and will contribute significantly to the improvement of public health and sanitation in the town of Madang.

44. The Borrower will be the Independent State of Papua New Guinea. The Government has assured that it will make available as needed, any funds required in addition to the proceeds of the loan, for the execution of the Project.^{2/}

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- 1/ A Review of Criteria for Lending from Asian Development Fund, R 83-77, Revision 1 Final, dated 14 September 1977.
- 2/ Loan Agreement, Section 4.02.

V. PROJECT IMPLEMENTATION

A. The Executing Agency

45. DWS will be the Executing Agency for the implementation of the Project. The Project Manager who has been assigned to the ongoing project will also be responsible for this Project.^{1/} He will provide the overall supervision and administration of the Project and will be assisted by an adequate number of qualified technical and other personnel. He will also be responsible for day-to-day liaison with the consultants and other concerned government agencies, and for monitoring the progress of Project implementation.

B. Consultant Services

46. The implementation of the Project will be the responsibility of DWS. However, the services of consultants will be required to assist in the implementation of the Project because of the limited capability of DWS to undertake design and construction works. A consulting firm, Binnie & Partners, has been engaged under Bank Loan No. 278-PNG(SF) in accordance with the Bank's Uses of Consultants, to prepare detailed engineering designs and tender documents (see para. 12). The Government proposes to retain the same consultants for construction supervision and has requested the Bank to consider financing the services of the consultants from the Bank loan. In the event that a contract cannot be successfully negotiated with the consultants, the Government agrees^{2/} to select and engage other consultants in accordance with the Bank's Guidelines on Uses of Consultants. The Mission considers this proposal to be reasonable in the interest of the continuity of Project

^{1/} Loan Agreement, Schedule 6, para. 1.

^{2/} Loan Agreement, Schedule 5, para. 4 (b).

implementation and saving of time; the arrangement is in accordance with para. 4.2 of the Bank's Uses of Consultants. The scope of consultant services will include: supervision of construction, installation and commissioning of project facilities and the training of local staff in the construction, operation and maintenance of these facilities (for details see Appendix 15).

C. Procurement Arrangements

47. The proposed procurement arrangements are similar to those used for the earlier Bank loan. DWS will be responsible for procurement under the Project. Procurement of all goods to be financed out of the proceeds of the Bank loan will be carried out in accordance with the Bank's Guidelines for Procurement (see also Appendix 16). Supply contracts for equipment and materials involving an estimated expenditure of \$125,000 or less equivalent will be awarded on the basis of bids or quotations obtained from a reasonable number of suppliers from more than one eligible member country of the Bank.^{1/} Supply contracts for equipment and materials involving an estimated expenditure of more than \$125,000 equivalent will be awarded on the basis of international competitive bidding.^{2/}

48. All civil works (pipelaying, construction of service reservoirs and chemical storage warehouse) except the contract for deep wells will be awarded on the basis of competitive bidding among prequalified local contractors. This arrangement is considered appropriate in view of the fact that (i) contracts involved are of relatively small size (see Appendix 16) with construction periods spread over two years, and (ii) there are adequate local contractors capable of carrying out the work. The deep well construction,

1/ Loan Agreement, Schedule 4, para. 7.

2/ Loan Agreement, Schedule 4, paras. 5 & 6.

however, is a skilled job requiring specialized equipment and accordingly, contracts for deep well construction will be on the basis of international competitive bidding. All bidders for civil works contracts will be prequalified and contracts awarded in accordance with the procedures satisfactory to the Bank under the Bank's Guidelines for Procurement. For the purpose of withdrawals from the loan account in respect of such civil works, the figures 24, 47 and 58 per cent of the contract value will be applied as the foreign exchange cost to pipelaying, civil works construction and well construction respectively.^{1/}

D. Implementation Schedule

49. The Project implementation would take approximately three-and-a-half years. The Project will be completed and commissioned by the end of 1981. Detailed designs and preparation of tender documents are currently being undertaken by the consultants. A considerable amount of investigation and preliminary design work has already been accomplished. The bulk of materials and equipment required for the Project will be tendered in the early part of the first quarter of 1979 and civil works will be tendered in the third quarter of 1979. The implementation schedule, as agreed between the Government and the Mission, is shown in bar chart form in Appendix 13. In order to monitor the progress of the Project implementation, it has been agreed that regular quarterly reports will be submitted to the Bank.^{2/}

E. Land Acquisition

50. Land acquisition will be required only for service reservoirs which will cover only a relatively small area. Pipelines will be constructed along the shoulders of existing and proposed roads where possible and only limited additional rights-of-way will need to

^{1/} Loan Agreement, Schedule 3, para. 2.

^{2/} Loan Agreement, Section 4.07(b).

be acquired. The Government has given assurance that the necessary land and rights-of-way for the Project will be acquired or made available in sufficient time to avoid delay in the implementation of the Project.^{1/}

F. Project Operation

51. DWS will be responsible for the operation and maintenance of the Project facilities upon completion. The Government has assured the Bank that adequate staff and facilities will be made available to DWS for this purpose.^{2/} Baseline data regarding population, water production and distribution, service connections and inventory of existing facilities for water supply will be established by DWS and periodically provided to the Bank for future assessment purposes.^{3/} Under the Financial/Management technical assistance (see para. 13), special consultants are to be appointed to study and advise on, inter alia, the organization and management for water supply for PNG as a whole, staffing requirements and training programs. The Government has assured that, not less than 12 months before the completion of construction of the Project facilities, it will submit to the Bank a detailed proposal for organizational arrangements.^{4/} In the event that the Government proposes that the operation and maintenance of the Project facilities, or part thereof, should be transferred from DWS to any other body, the Government will consult the Bank in advance to ensure that funding, operation and maintenance of Project facilities will be adequately provided for. Furthermore, any such transfer shall be upon terms and conditions mutually agreed to by the Government and the Bank.^{5/}

-
- 1/ Loan Agreement, Schedule 6, para. 4.
2/ Loan Agreement, Schedule 6, para. 2(a).
3/ Loan Agreement, Schedule 6, para. 10.
4/ Loan Agreement, Schedule 6, para. 2(b).
5/ Loan Agreement, Schedule 6, para. 3.

VI. FINANCIAL ASPECTS

A. Background

52. Financial arrangements for the operation of the Project, together with those for Lae, Mt. Hagen and Wewak, cannot be finalized until completion of T. A. No. 179-PNG. This is expected, inter alia, to determine financial policies for water supply in PNG as a whole. The situation is compounded by the forthcoming reorganization of the Government into a three-tiered structure. Papua New Guinea comprises 19 provinces, each one of which will be given self-determination in the following areas through a Provincial Government^{1/} before the end of 1978: (i) Provincial Affairs, (ii) Health, (iii) Education, and (iv) Agriculture. These functions are currently the responsibility of the National Government. In addition, certain other national functions will be delegated to the provinces. Provincial Government will thus become the third stratum of government in PNG, interposing itself between the present national and local government.

53. Because water supply operations will ultimately cross the local council boundaries in each province, including Madang, the responsibility is likely to become vested in the Provincial Government, possibly either under public health or as a separate delegated national function.

^{1/} In the case of Madang, an Area Authority already operates as the basis for future Provincial Government. The Area Authority comprises 15 elected representatives (from local government within the province) who will remain as the interim Provincial Government for a year following its inauguration. Provincial representatives will be elected after this time.

B. Finance and Accounting

54. DWS at present has no financing accounting and budgetary systems in existence. These systems will be developed under the ongoing technical assistance, that is T. A. No. 179-PNG (see paras. 12 and 13) and will be appropriate to local conditions. In accordance with the provisions of the existing technical assistance agreement, the Government will review with the Bank all recommendations which are agreed upon between the Government and the Bank.

55. There are also insufficient personnel who are trained in public utility general and financial management in PNG. The Government, however, has agreed^{1/} that not less than 12 months before commission of the Project facilities, it will establish a financial and management training program acceptable to the Bank, for personnel who will be responsible for the administration, and in particular, financial management of the Project.

C. Tariffs

56. The consultants, to be commissioned under T. A. No. 179-PNG, will formulate tariff structures for the Project. The structures will take into consideration socio-economic conditions in Madang as well as the future financial viability of the water supply facilities. Above all, the tariff structures will be both simple and appropriate to local conditions. The tariffs will also be set at levels to:

- (i) ensure that the maximum number of consumers will be able to afford their water requirements;
- (ii) discourage waste; and
- (iii) differentiate between domestic and commercial/industrial consumption.

^{1/} Loan Agreement, Schedule 6, para. 2(c).

In this regard, the tariff structures used in the financial projections in this Report (refer to para. 62) meet all of the above requirements. However, because of the possibility of cross-subsidization between this project and other PNG Water Supply Projects and/or government subsidization for one or more of the schemes, the tariffs shown should be considered only as a guide at this juncture.

57. The Government has assured the Bank that water rates will be set at levels which will at least cover all operating and adequate maintenance expenses (including taxes, if any), depreciation and debt service.^{1/} In consultation with the Bank, a review will be carried out by the Government of the water rates to be established at Madang on the completion of the Project facilities. Thereafter, the rates will be reviewed in consultation with the Bank at suitable intervals.^{2/}

D. Billing and Collection

58. Subject to a more definitive policy following the imminent re-organization of the Government (refer to paras. 52 and 53), the collection of revenue for the Project will be the responsibility of the Provincial Government. Technical Assistance No. 179-PNG will also recommend a policy on this matter.^{3/} In the meantime, the Government has assured the Bank^{3/} that all action necessary will be undertaken to ensure that all amounts owed for water services provided will be promptly collected when due and accounts receivables will not be permitted to continue more than 60 days after the date of billing.

59. Although the method of billing consumers using standpipes will also be the subject of T. A. No. 179-PNG, it is likely that a flat monthly charge, based on estimated consumption per capita, will be employed. This charge will be borne by local government, should it not be ^{4/} possible to collect charges direct from the consumer.^{4/}

^{1/} Loan Agreement, Section 4.10 (a).

^{2/} Loan Agreement, Section 4.10 (b).

^{3/} Loan Agreement, Schedule 6, para. 8 (b).

^{4/} Loan Agreement, Schedule 6, para. 8 (a).

E. Auditing

60. Audit policy for the Project (together with Lae, Mt. Hagen and Wewak) is indefinite at this stage because of the formation of the Provincial Government and the uncertainty of where water supply will fall under the proposed new structure. Moreover, the consultants to be commissioned under T.A. No. 179-PNG will recommend an audit policy as an integral part of the overall financial plan for water supply in PNG. In the meantime, it has been agreed that the arrangements established for the other three schemes should prevail for the moment for Madang.

61. The Auditor-General, who is presently responsible for the audit of all national government accounts, will annually audit the accounts of the Project using accepted auditing principles. The Auditor-General will also examine compliance with financial covenants in the Loan Agreement, and recommend remedial measures to improve financial performance.^{1/} Copies of the audit reports together with certified copies of the balance sheets, income statements, and other related financial statements will be submitted to the Bank not later than nine months after the close of the fiscal year to which they relate.^{2/}

F. Projected Financial Performance

62. In the absence of both a tariff structure and historical accounts, the Mission has projected proforma accounts for 1982 to 1988 on the basis of:

- (i) water production and sales based on likely population growth; and
- (ii) tariffs required to maintain the Project on a sound financial basis.

1/ Loan Agreement, Schedule 6, para. 9.

2/ Loan Agreement, Section 4.06(b).

The financial projections have been based on an average water rate of \$0.34 per cubic meter (refer to para. 66) which will meet the Bank's financial covenant that water tariffs should be sufficient to cover all operating expenses, adequate maintenance and depreciation and interest on and repayment of debt (refer to para. 57). The tariffs used are considered both high enough to discourage wastage and low enough to allow a low income user to have a separate connection without unreasonable restrictions on the quantity of water used. Although T. A. No. 179-PNG will result in a more detailed treatment of domestic tariff levels, such an average water tariff sufficient to maintain financial viability of the Madang scheme is considered within the ability of consumers to pay. An analysis of the consumer's ability to pay, shown in Appendix 17, indicates that the average income earner (including temporary, part time and domestic workers) will pay annually approximately \$55 for water or 2 per cent of gross income (as in 1982). Appendix 17 also shows that workers receiving the basic minimum wage will pay only 0.2 per cent of their earnings for water each year.

63. The projected financial performance of the Project covering the fiscal years 1982 to 1988 is presented in Appendix 18 together with major assumptions underlying the projections. The projections are summarized in the following table:

Table 3: Projected Financial Performance
(\$'000)

	<u>1982</u>	<u>1988</u>
Water sales (m.cu.m.)	2.27	3.34
Operating revenue	709	1,014
Operating expenses	(235)	(281)
Operating income	260	505
Operating ratio (%)	63.3	50.2
Return on net fixed assets (%)	3.2	6.5
Debt/equity ratio	66:34	54:46
Debt service ratio (times)	-	4

64. The projections indicate a viable financial operation notwithstanding the absence of any increase in tariffs over the projection period. It should be noted, however, that the financial success of the Project will be totally dependent upon Madang's ability to attract new industry to the proposed reticulation area; approximately 42 per cent of the operating revenue will be earned through the sale of water to industry and commerce.

65. The Mission has investigated this prospect and is satisfied that industry, with water demand commensurate to at least this level, can be attracted to the area after assured water is available. Further information on this subject is contained in Appendix 5.

G. Financial Analysis

66. The financial internal rate of return (FIRR) for the Project is 5.6 per cent, a satisfactory figure for a project of this type. (Refer to Appendix 19 for details of the FIRR computation and underlying assumptions.) Subject to the on-lending terms to be decided by the Government later, in addition to covering operating expenses, depreciation and debt service, it is estimated that sufficient funds will be generated internally by the Project to meet reasonable capital expenditure in the foreseeable future.

67. The Mission considers that the FIRR for the Project is acceptable, taking into account the high cost of developing a new and complete water supply system right from the source to consumers, the level of development and dispersal of population in the town, and the relatively high cost of implementing development projects in PNG, which is characterized by difficult terrain, limited land transport facilities, and dependence on imported products and expatriate personnel.

VII. SOCIAL AND ECONOMIC CONSIDERATIONS

68. Madang is the administrative center of Madang Province and is the fourth largest town in PNG, having a population of 22,500. It is the largest municipality without a public piped water supply system in the country. The proposed Project will provide a comprehensive piped water supply in Madang for the first time. It is expected that about 33,000 people or 75 per cent of the Project area population will be served by 1986, when the Project facilities will be fully utilized. The Project will particularly benefit the lower income groups living in no-covenant houses and settlement houses. At present, they have the least adequate water supplies both in quantity (since they have smaller roofs for run-off and smaller storage tanks or none) and in quality (since they must necessarily resort more to polluted surface water, lacking the money for tankered water).^{1/} Therefore, the public standpipes under the Project will be of substantial benefit to low-income groups by assuring them of adequate supplies of potable water.

69. A single faucet will be provided for each no-covenant house and standpipes will be provided for settlement houses. An average consumption range of 40 to 70 lpcd has been allowed for the lower income groups; this is considered adequate for daily needs and within the ability of the consumers to pay.

70. The social benefits that will be derived from the proposed Project include the improvement of public health and sanitation and increased standard of living of the people. The direct economic benefits include:

^{1/} The economic cost of the rainwater arrangement has been calculated at \$374 per annum for low covenant houses and \$605 for high covenant dwellings, while the proposed reticulated scheme will cost only \$60 and \$103, which results in a net economic benefit of \$314 and \$502 respectively (see Appendix 20).

- (i) attraction of commercial and industrial operations to the Project area and the employment opportunities created therefrom; and
- (ii) cost savings over installing rainwater collection facilities (see footnote page 31).

A secondary benefit will be employment opportunities created and income generated for the labor force required to construct the Project and operate the Project facilities. The Project is expected to create employment opportunities of about 24,000 man days during its construction period, and about 20 permanent staff on completion.

71. PNG has a comparatively high incidence of water-borne diseases, in particular, gastro-intestinal and skin diseases. According to recent studies conducted by the Department of Public Health, areas served by piped water have virtually no outbreaks of cholera, while cholera cases occur in areas where the inhabitants obtain their water from polluted sources. In the case of Madang which depends upon well water and polluted surface sources during dry season, the situation is particularly critical. The town aquifers are seriously polluted. As a consequence, the incidence of gastro-intestinal diseases increase quite substantially during these months. The development of modern and safe water supply facilities in Madang is therefore considered vital to improving the health condition of the town population.

72. The proposed scheme is the least cost method for supplying water to meet the requirements for the next two years. Several alternative sources including surface and groundwater sources have been identified and studied to arrive at the least cost solution. In comparison with the next cheapest alternative, the development of surface water supplies, the proposed groundwater supply scheme would result in a saving of approximately \$1.8 million in capital cost. The proposed Project is also appropriate to both the requirements of and to the local conditions in the Madang area, where there is an acute shortage of technical personnel. The groundwater supply facilities will not require sophisticated equipment and operation.

VIII. CONCLUSION

73. The proposed Project will provide comprehensive piped water supply facilities in Madang for the first time. It is endorsed by the Government as enjoying high priority and will substantially replace the existing uneconomical roof water facilities which are supplemented with tankered water. The Project will contribute significantly to public health and sanitation by eliminating the insanitary private water sources.

74. The Project represents the least cost solution to Madang's 1986 water needs; it is technically sound, financially viable and has strong social and economic justification. The financial internal rate of return on the Project is estimated at 5.6 per cent.

75. The Mission proposes that the Bank provide a loan of \$5.4 million from the Special Funds resources at a service charge of one per cent per annum and a repayment period of 40 years including a grace period of ten years to cover the foreign exchange cost of the Project. The Borrower would be the independent state of Papua New Guinea and the Executing Agency would be the Department of Works and Supply.

76. In addition to the standard provisions and requirements embodied in the Bank's loan documents, agreement has been reached on the following matters for which there is specific provision in the loan documents.

- (i) The Project Manager who has been assigned to the ongoing project will also be responsible for the Project (Loan Agreement, Schedule 6, para. 1);
- (ii) The land required for the Project will be acquired in time (Loan Agreement, Schedule 6, para. 4);

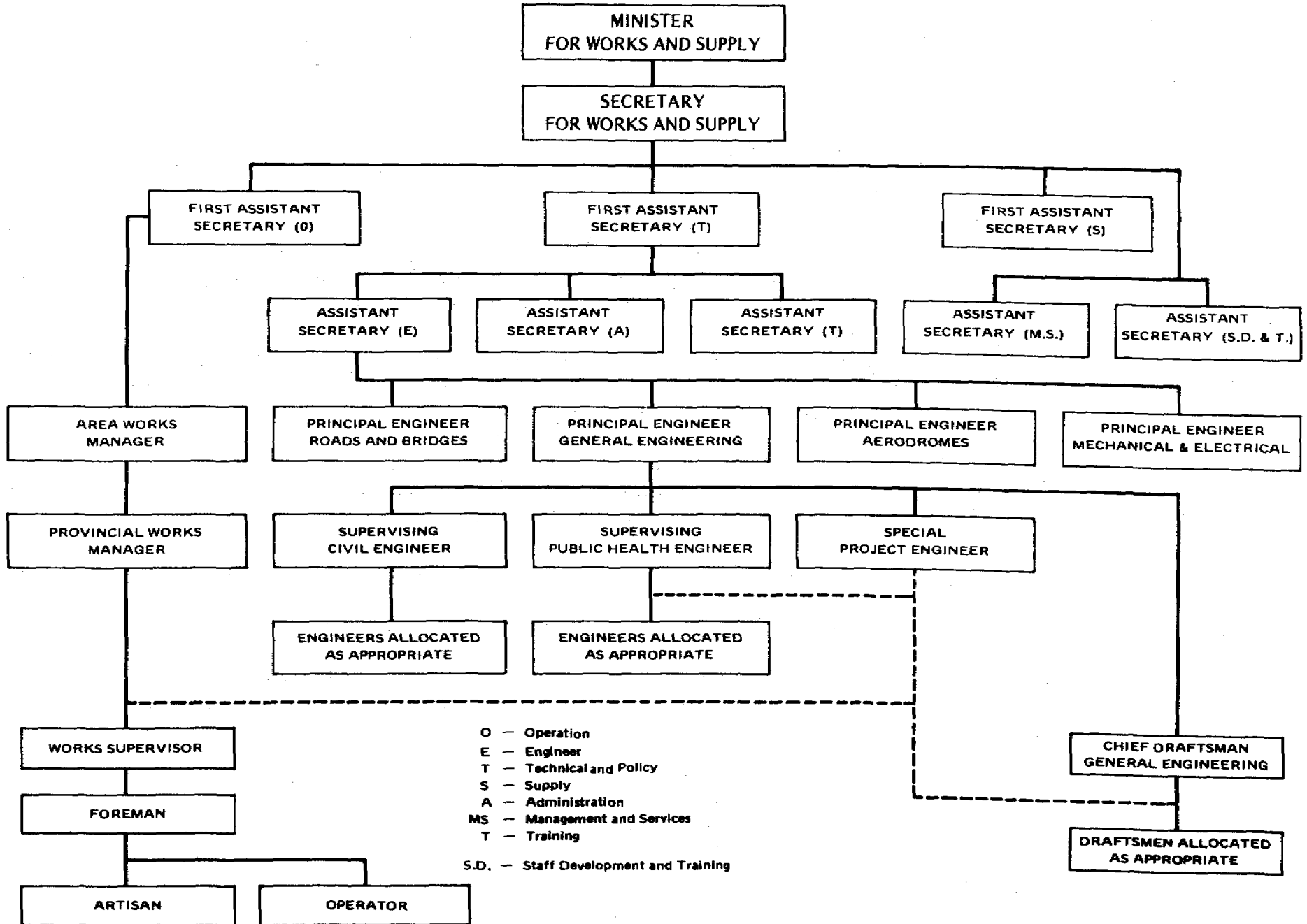
- (iii) Appropriate measures for pollution control and conservation of Project water resources will be taken (Loan Agreement, Schedule 6, para. 6);
- (iv) An effective water quality control program will be established (Loan Agreement, Schedule 6, para. 7);
- (v) Water rates and charges will be set at levels that will be sufficient to cover all operating and adequate maintenance expenses (including taxes, if any), depreciation and debt service (Loan Agreement, Section 4.10(a));
- (vi) Prior to completion of the Project, the Government would consult with the Bank and submit proposals on the organization and management of the Project, and staffing and training requirements (Loan Agreement, Schedule 6, para. 2(b)); and
- (vii) The Government will establish a suitable financial and management training program to be agreed on with the Bank for personnel to be responsible for the administration, operation and maintenance of the Project facilities (Loan Agreement, Schedule 6, para. 2(c)).

A P P E N D I X E S

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DEPARTMENT OF WORKS AND SUPPLY
ORGANIZATION CHART



(Ref. to text: page 3, para. 9)

PAPUA NEW GUINEA
NATIONAL CAPITAL WORKS PROGRAM
INVESTMENT IN WATER AND SEWERAGE SECTOR
(\$ million)

	1971/ 1972	1972/ 1973	1973/ 1974	1974/ 1975	1975/ 1976	1976/ 1977	2nd half 1977	1978	(Estimated) <u>a/</u>		
								1979	1980	1981	
Water Supply	0.59	0.28	0.65	4.00	3.68	4.50	2.11	4.78	8.23	6.62	2.92
Sewerage & Sanitation	0.27	0.47	0.49	0.63	1.04	1.42	0.88	1.10	0.22	0.03	0.03
TOTAL	0.86	0.75	1.14	4.63	4.72	5.92	2.99	5.88	8.45	6.65	2.95

a/ Ongoing expenses for projects approved as of 1978 only.

Source: PNG Budget Papers, Works Program, 1976/77, July/December 1977, 1978

Appendix 3

COMPARISON OF ORIGINAL & REVISED MAJOR DESIGN ELEMENTS

PNG Water Supply Project (Ongoing)

	<u>Original</u>	<u>Revised</u> ^{a/}
1. Population Projection (1986)		
Lae	141,000	157,000
Mt. Hagen	58,100	27,000
Wewak	43,000	39,000
Madang	54,000	43,000
2. Water Consumption (liters per capita per day)		
High Covenant Houses	310	225
Low Covenant Houses	250	225
No Covenant Houses	100	68
Village Settlement	70	40
3. Total Water Demand cu.m./day (average day)		
Lae	48,700	36,500
Mt. Hagen	10,320	4,700
Wewak	8,260	5,500
Madang	14,700	9,850
4. Unaccounted-for water (%)	15	20
5. Minimum residual pressure (m)	7.5	10
6. Maximum day demand/average day demand	1.25	1.25
7. Peak hourly demand/peak daily demand	1.6	1.8

a/ As agreed between the Government, consultants and the Bank during the Bank's Review Mission's visit to PNG in February 1978, and which will form the basis of the final design of the Madang Project.

(Ref. to text: page 5 , para. 14)

COMPLIANCE WITH LOAN COVENANTS
(Loan No. 278-PNG(SF))

<u>Covenants</u>	<u>Status</u>
(a) Engage engineering consultants for carrying out detailed design and construction supervision (L. A. Section 4.03).	Complied with.
(b) Take appropriate and timely action to acquire land required for the Project (S. L. No. 4, para. 4).	Being complied with; steps are being taken to acquire the necessary land.
(c) Establish an independent water quality monitoring committee (S. L. No. 4, para. 8).	Compliance not yet due.
(d) Engage financial and management consultant to conduct a study on water supply organization, management, accounting and tariff (T. A. A. Section 1.01, paras. iii and v).	Compliance not yet due.
(e) Furnish the Bank with Sewerage Study Report (S. L. No. 4, para. 9).	Compliance not yet due.
(f) Set up a national committee authority or other body to formulate and coordinate national policy for local water supply system (L. A. Section 4.6).	Compliance not yet due.

L.A. - Loan Agreement
S.L. - Side Letter
T.A.A. - Technical Assistance Agreement

(Ref. to text: page 5 , para. 15)

Appendix 5

INDUSTRIAL AND COMMERCIAL DEVELOPMENT IN MADANG

1. Madang is the fourth largest town in PNG after Port Moresby, Lae and Rabaul. However, because Rabaul is situated on another island, New Britain, and Port Moresby, the capital, is on the southern coast of the main island, Madang is normally only compared with Lae. Although the towns have similar features, Lae has a number of advantages at this time including:

- larger population;
- new airport of international standard;
- water supply (to be extended as a result of Loan No. 278-PNG(SF)); and
- paved roads to the highlands, which generates traffic through the port of Lae.

2. Madang on the other hand has a natural deep water, sheltered port, and has considerable potential as a tourist center.

3. Madang, however, lacks a reticulated water supply system and this is considered to be the only real obstacle to rapid industrial and commercial growth in the township. Several organizations plan to establish industrial plants (for example, copra processing) in the town when water becomes available. Others have abandoned plans and moved elsewhere because of lack of water supply. The excellent harbour facility is under-utilized because ships cannot bunker fresh water.

4. Madang nonetheless has some industry and its port is quite busy. Industry includes a Japanese wood-chip processing plant, shipbuilding, timber and light manufacturing.

(Ref. to text: page 10, para. 26)

5. Madang is the fourth largest port in PNG with 7.3 per cent of the traffic averaging around 100 shipping movements a year. The harbor depth is an undredged 90 feet adjacent to the wharf and ships such as the "Daihonshu Maru"^{1/} (43,000 tons dead weight, 67,000 tons gross, 600 feet L.O.A.) and "Fairstar"^{2/} regularly berth unaided.

6. Several years ago nearly 80 per cent of highland coffee was shipped through Madang, largely because of the relatively short air link (30 minutes to Goroka) between the two locations. However, with the development of an all-weather road between Lae and the highlands, the proportion of coffee shipped through Madang dropped to less than 1 per cent. When an all-weather road is opened (scheduled 1988) between Madang and the highlands, a larger proportion of the coffee should again be shipped through Madang.

7. Apart from coffee shipments from the highlands, the Madang hinterland has extensive copra (14,000 hectares) and cocoa (4,000 hectares) plantations. There are also 12,500 head of cattle. With a permanent water supply, Madang could become the processing and export center for these agricultural products.

1/ The "Daihonshu Maru" calls regularly to load woodchips from the processing plant.

2/ The "Fairstar" is a passenger vessel with a capacity of 2,500 passengers and crew.

MADANG WATER SUPPLY

POPULATION AND WATER DEMAND PROJECTIONS

I. Population Projection

II. Population Served

Houses Year	<u>(Houses)</u>					I Nos.	Total	<u>(As a percentage of the total population.)</u>					
	H/C Nos.	L/C Nos.	N/C Nos.	V/S Nos.	I Nos.			H/C Nos. (%)	L/C Nos. (%)	N/C Nos. (%)	V/S Nos. (%)	I Nos. (%)	Total Nos. (%)
1982	3,699	6,540	8,010	14,026	2,058	34,333	3,699 (11)	6,540 (19)	8,010 (23)	5,490 (16)	2,058 (6)	25,771 (75)	
1986	4,257	7,700	11,510	16,938	2,595	43,000	4,257 (10)	7,700 (18)	11,510 (27)	6,200 (14)	2,595 (6)	32,254 (75)	

III. Water Demand Projections (cu.m./day)

Year	<u>Residential</u>		<u>Non-Residential</u>	<u>Losses & Other Uses</u>	<u>A. D. D.</u>	<u>M. D. D.</u>
	<u>Connection</u>	<u>Standpipes</u>				
1982	3,383	219	2,623	1,556 (20%)	7,781	9,700
1986	4,304	248	3,330	1,970 (20%)	9,852	12,300

ADD - Average Daily Demand
MDD - Maximum Daily Demand
H/C - High Covenant
L/C - Low Covenant
N/C - No Covenant
V/S - Village Settlement
I - Institutional

Ref. to text: page 10, para. 26)

Appendix 6

Appendix 7

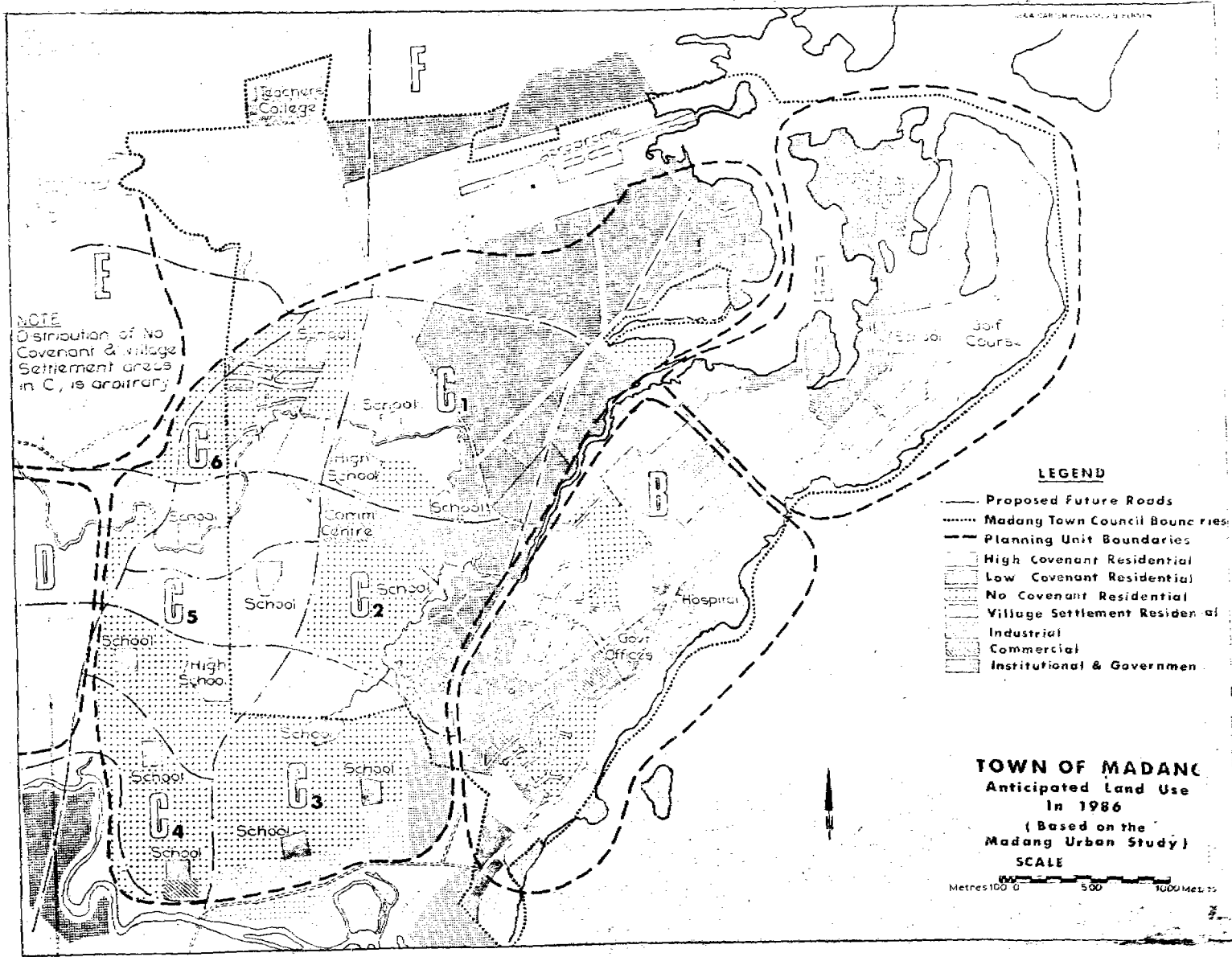
DESIGN CRITERIA FOR DAILY PER CAPITA DEMAND
(liters)

	<u>1980</u>	<u>1986</u>
Houses:		
High Covenant	225	225
Low Covenant	185	225
No Covenant	68	68
Village Settlers	40	40
Barracks	225	225
Hospital Staff	160	160
Hospital Patients	480	480
Boarding Schools	160	160
Day Schools	70	70
Hotels	225	225
Gaols	115	115

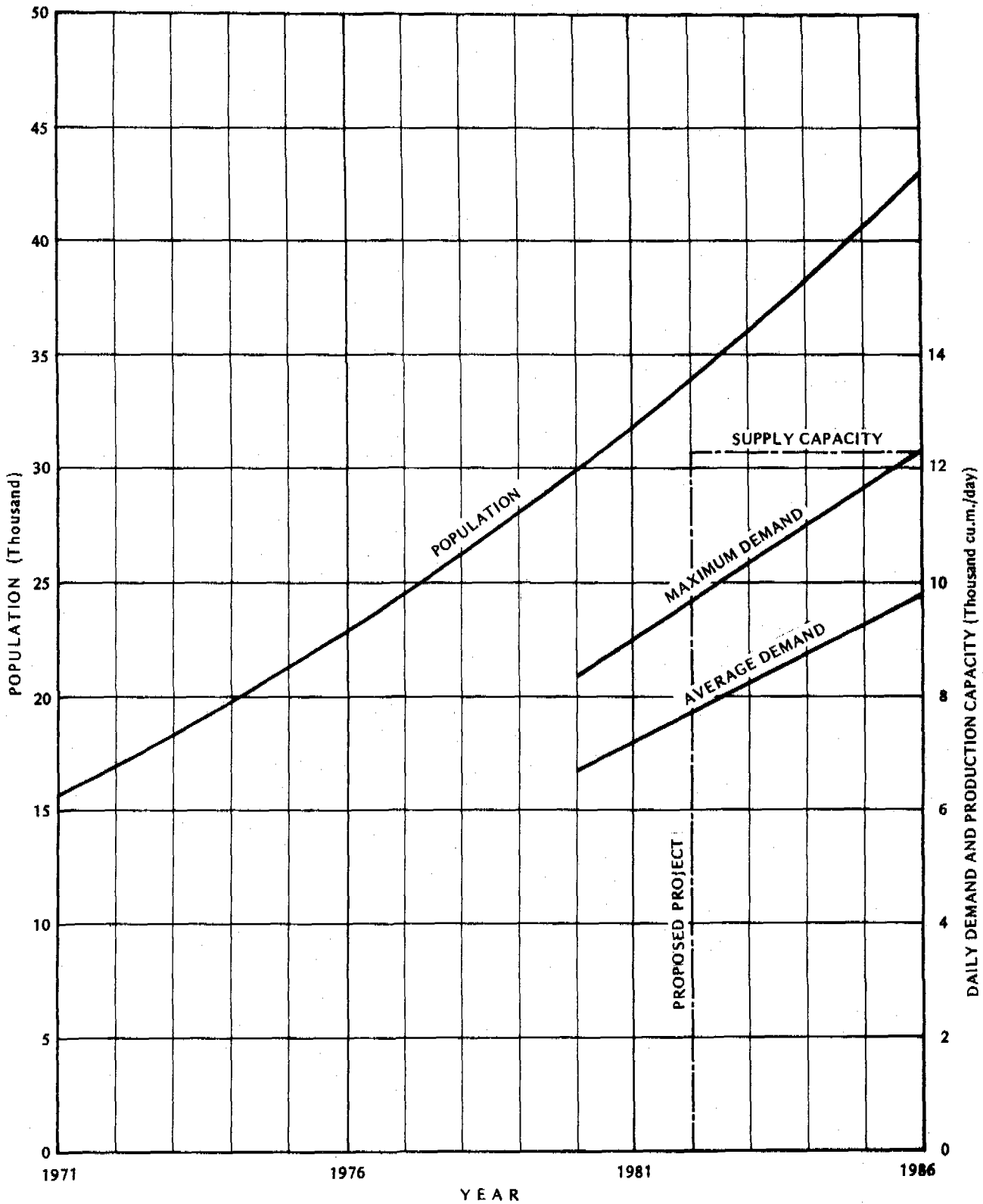
Source: Department of Works and Supply

(Ref. to text: page 10, para. 27)

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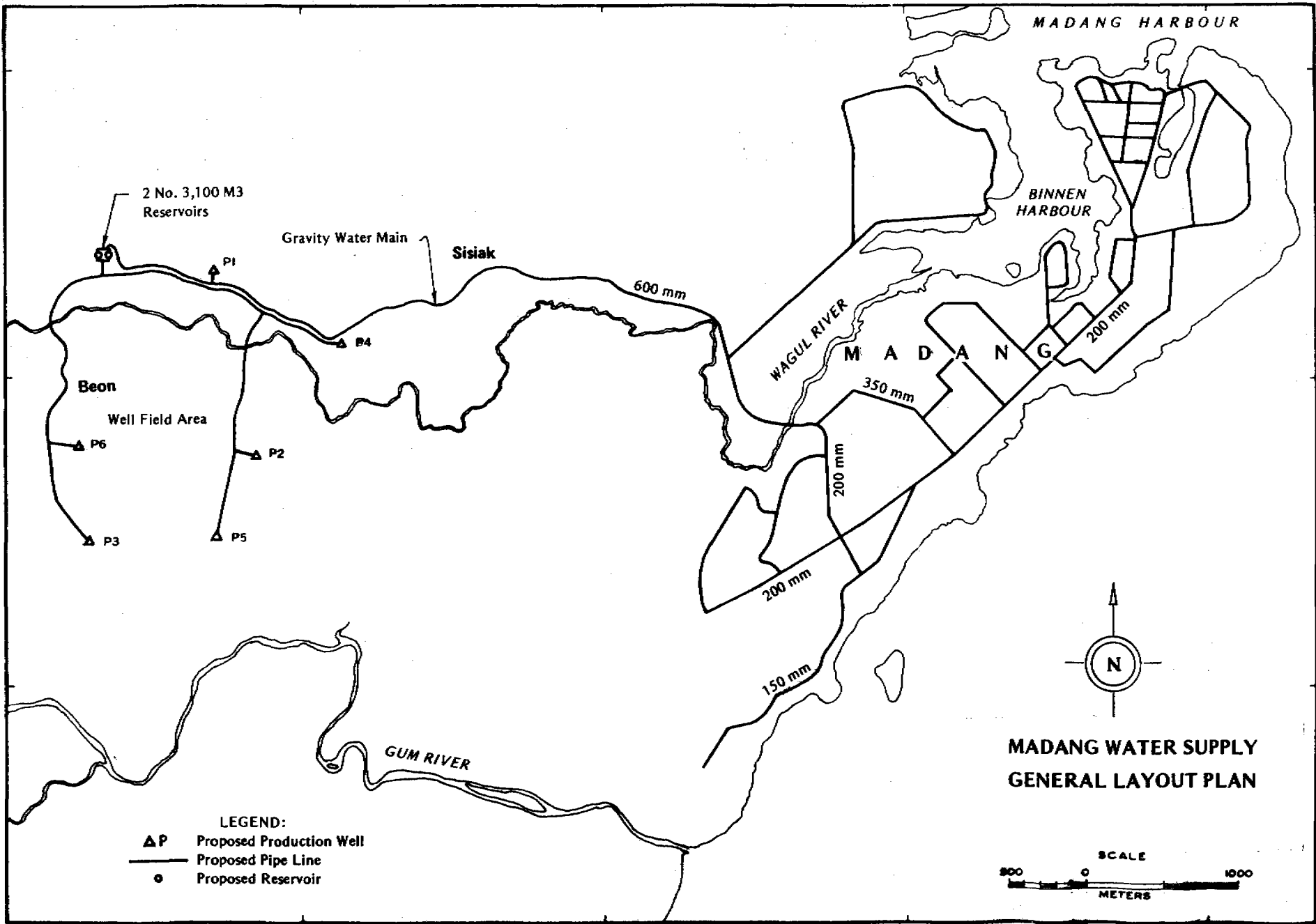


MADANG WATER SUPPLY POPULATION, WATER DEMAND AND SUPPLY PROJECTIONS



(Ref. to text: page 11, para. 29)

(Ref. to text: page 12, para: 30; 13, para: 36; 16, para: 39)



Appendix 11

DESIGN CRITERIA FOR MADANG WATER SUPPLY

Source of Supply	:	Maximum day demand: 12,300 cu.m./day ^{a/}
Water treatment facilities	:	Maximum day demand: 12,300 cu.m./day
Pumping facilities	:	Maximum day demand: 12,300 cu.m./day
Mains: Transmission	:	Peak hourly demand: 22,160 cu.m./day
Distribution	:	Peak hourly demand: 1.8 x max. day flow = 22,160 cu.m./day
Maximum main size	:	Residential area : 80 mm. but smaller pipes will be used to supply isolated consumers
		Commercial Area : 150 mm
Storage capacity	:	50% of maximum day flow
System pressure	:	10 meters head (minimum)

a/ of the 6 wells, 4 will be sufficient to provide the maximum daily demand with 2 standby.

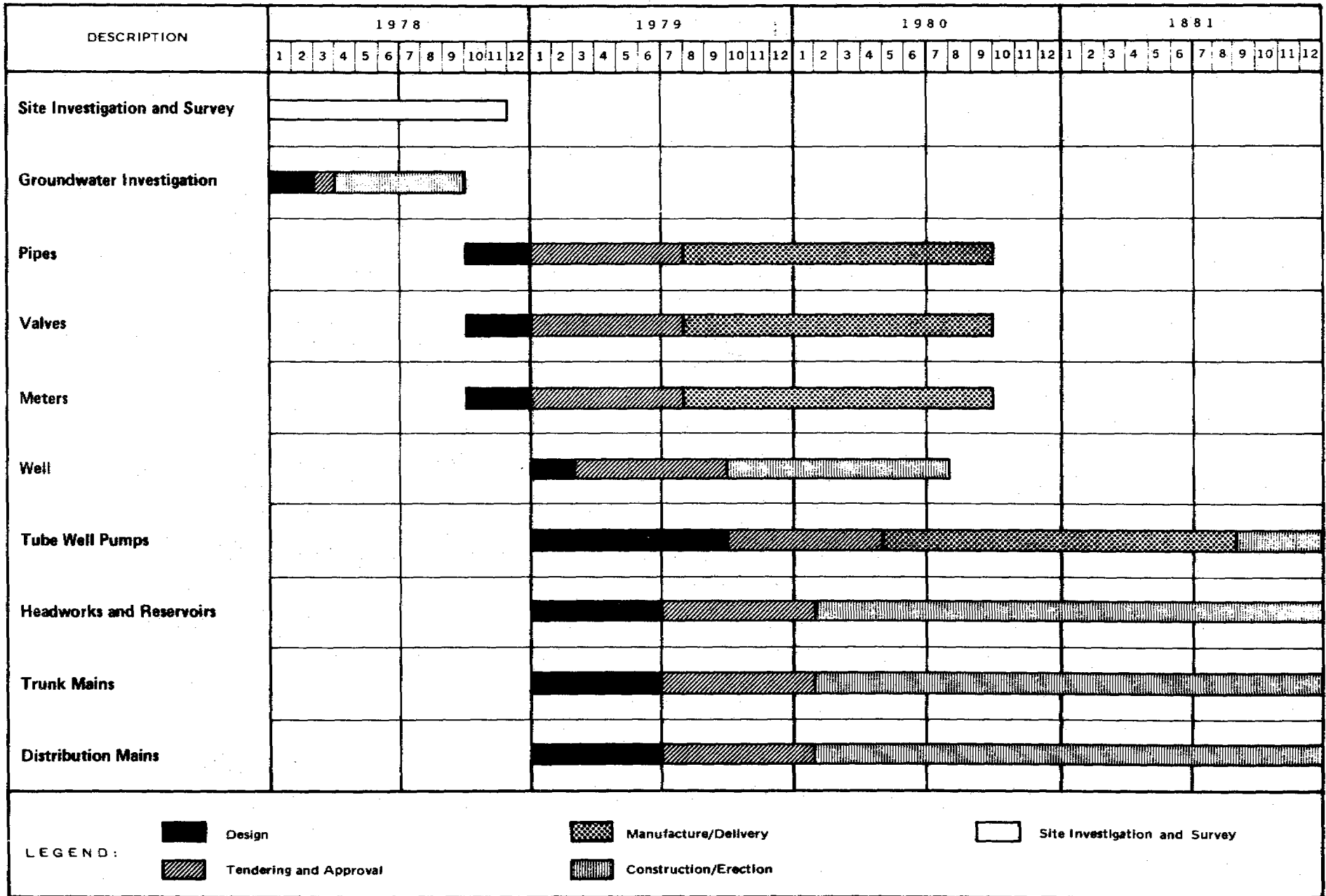
COST ESTIMATES

	<u>Foreign</u>	<u>Local</u>	<u>Total</u>	<u>Foreign</u>	<u>Local</u>	<u>Total</u>
		(K'000)			(\$'000)	
1. Site investigation	5.6	5.6	11.2*	7.8	7.9	15.7*
2. Well field	209.2	154.2	363.4	292.9	215.9	508.8
3. Chemical house	4.7	5.3	10.0	6.6	7.4	14.0
4. Raw water mains						
(supply)	169.9	-	169.9	237.9	-	237.9
(laying)	26.9	85.1	112.0	37.6	119.1	156.7
5. Service reservoirs	177.7	200.4	378.2	248.8	280.6	529.4
6. Distribution trunk						
(supply)	493.1	-	493.1	690.3	-	690.3
(laying)	67.5	213.8	281.3	94.5	299.3	393.8
7. Reticulation pipelines						
(supply)	617.5	-	617.5	858.9	-	858.9
(laying)	90.9	287.6	378.5	127.2	402.7	529.9
8. Valves and fittings	117.3	62.0	179.3	164.2	86.8	251.0
9. Service connection						
(supply)	57.5	-	57.5	80.5	-	80.5
(laying)	13.8	43.7	57.5	19.3	61.2	80.5
10. Meters						
(supply)	39.4	-	39.4	55.2	-	55.2
(installation)	-	24.2	24.2	-	33.8	33.8
11. Standpipes						
(supply)	17.5	-	17.5	24.5	-	24.5
(installation)	4.2	13.3	17.5	5.9	18.6	24.5
12. Hydrants						
(supply)	38.3	-	38.3	53.5	-	53.5
(installation)	9.2	29.1	38.3	12.8	40.7	53.5
13. Transport vehicles	22.4	-	22.4	31.4	-	31.4
14. Meter testing workshop	6.7	4.5	11.2	9.4	6.3	15.7
15. Pumps and motors	142.8	10.7	153.6	200.0	15.0	215.0
16. Chlorinators	12.1	0.9	13.0	16.9	1.3	18.2
Total	2,344.3	1,140.4	3,484.7	3,282.0	1,596.6	4,878.6
17. Cost adjustment for Madang (3.2 %)	75.0	36.5	111.5	105.0	51.1	156.1
18. Physical contingencies	234.5	114.0	348.5	331.1	178.0	509.0
19. Price contingencies	764.8	451.0	1,215.8	1,071.0	629.0	1,700.0
20. Engineering - design	175.1	19.5	194.6*	245.1	27.3	272.4*
- supervision	368.6	143.3	511.9	516.0	200.7	716.7
21. Power supply	25.0	-	25.0	35.0	-	35.0
22. Land	-	10.0	10.0	-	14.0	14.0
23. Surveys	-	10.0	10.0*	-	14.0	14.0*
24. Groundwater investigation	46.6	27.4	74.0	65.3	38.0	103.3
* Fund under Loan No. 278-PNG(SF)	181.4	35.8	217.2	252.9	49.2	302.1
Total fund under the Project	3,852.3	1,916.4	5,768.7	5,400.0	2,700.0	8,100.0

(Ref. to text: page 17, para.40)

IMPLEMENTATION SCHEDULE

MADANG WATER SUPPLY



LEGEND:

Design	Tendering and Approval	Manufacture/Delivery
Site Investigation and Survey	Construction/Erection	

(Ref. to text: page 17
 23. para. 49)

PERCENTAGES ADOPTED IN THE ESTIMATES
FOR
FOREIGN EXCHANGE COMPONENTS

The estimates of the foreign exchange component include both direct and indirect foreign exchange.

<u>Description</u>	<u>Foreign Exchange Component</u> (%)
Wells construction	58
Civil construction (including buildings)	47
Pipelaying (including all fittings and service connections)	24
Pumps and treatment plant equipment (including installation)	93
Supply of pipes, valves, hydrants, meters, vehicles, and equipment for meter testing shop	100
Consultant - design	90
- supervision	71

(Ref. to text: page 19 , para. 42)

SPECIFIC REQUIREMENTS OF CONSULTANTS IN CONSTRUCTION
AND COMMISSIONING STAGES

1. The Consultant will be the Engineer for the Project, responsible to the Government of Papua New Guinea. His functions will include day-to-day supervision, coordination and technical control for contracts and facets associated with the implementation of the Project. The Executing Agency will, however, retain certain powers under the contracts related to such issues as variations, extensions of time, handling of disputes and in particular submission to arbitration. Where such powers are retained by the Executing Agency, the Consultant will submit reports and recommendations in sufficient detail to allow the matter to be adequately assessed by the Executing Agency.

2. It is essential that all supervisory staff keep daily records (diaries) which will form part of the detailed records of the progress of the work. Such records shall be in triplicate, one for the Executing Agency, one for the Consultant's records, and one for the book copy. Such a diary should contain information such as:

- (i) date;
- (ii) details of weather conditions;
- (iii) details of works undertaken by the Contractor, with notes as appropriate on general progress and approach to the works by the Contractor. Note any issues which may be relevant to current or future claims by the Contractor;

(Ref. to text: page 22 , para. 46)

- (iv) interruptions to the work due to weather, strikes, plant breakdowns, materials delay, disturbances, etc.;
 - (v) description of unserviceable plant or equipment including time of breakdown and when plant re-entered service; note items of work delayed due to such breakdowns;
 - (vi) any delays in the supply materials;
 - (vii) instructions or plans given and/or received; name of giver or receiver of documents, as well as the content of important conversations;
 - (viii) any unusual happenings and features of the work; and
 - (ix) notes on testing and measurements made.
3. The examination and assessment of the contractor's proposals and claims.
4. The inspection and supervision of the quality of workmanship and materials as applicable to individual contracts.
5. Carrying out, or arranging for in conjunction with the Executing Agency, the testing of materials, plant and equipment provided under the various contracts. Such testing may be either "on site" or "off site."
6. Ensuring coordination of all aspects of the Project to allow the Project to be implemented in a technically sound and efficient manner.

7. Checking of claims from the Contractors and submitting recommendations to the Executing Agency for payment of such claims.
8. Providing on completion of the Project (or earlier if possible) such detailed drawings and records including "as built" plans as are necessary for further operation and maintenance of the individual schemes, or as reasonably requested by the Executing Agency.
9. Providing assistance and advice in settling disputes or differences which may arise between the Executing Agency and the Contractors.
10. Submitting regular (at least monthly) reports (six copies) on the scheduled and actual progress of the Project and advising the Executing Agency on any serious delays or cost increases and remedial action where appropriate. A photographic record based upon the use of color negative film is required.
11. The checking and commissioning of the Project.
12. The training of selected Papua New Guinea nationals in the techniques associated with the operation and maintenance of the Project, together with aspects associated with the construction.
13. Preparing, or having prepared, simple written instructions and diagrams and maintenance programs suitable for use by Papua New Guinea nationals in the operation and maintenance of the Project.
14. Preparing or having prepared, a list of recommended stocks to be held of chemicals, tools and spare parts for the efficient operation of the Project.
15. Provide technical assistance, if so requested by the Executing Agency, for a period to be later agreed, during the initial stages of the operation and maintenance of the Project.

16. Ensuring that the works associated with the implementation of the Project, in all its phases and facets are carried out efficiently.

17. Other works as necessary for the satisfactory completion of the Consultant Services.

SUMMARY OF PROCUREMENT UNDER PROCEEDS OF LOAN^{a/}

<u>I t e m</u>	<u>Loan Amount (\$ '000)</u>	<u>Procurement Procedure</u>
<u>I. Civil Works</u>		
1. Wells construction	379	ICB
2. Reservoirs and chemical house	264	LCB
3. Pipelaying	310	LCB
<u>II. Materials and Equipment</u>		
1. Pipes	1,933	ICB
2. Plant and equipment	260	ICB
3. Motor vehicle	32	IS
4. Valves and fittings	170	ICB
5. Meters, hydrants	134	IS

ICB - International Competitive Bidding

LCB - Local Competitive Bidding

IS - International Shopping

a/ Excluding amounts for unallocated and consultancy services.

(Ref. to text: page 22, para.47)

ABILITY TO PAY OF DOMESTIC CONSUMERS
FINANCIAL

ANNUAL INCOME 1978 ^K	ANNUAL INCOME 1982 ^{a/}	ANNUAL INCOME 1978 ^{b/}	ANNUAL INCOME 1982	CATEGORY	TYPE OF DWELLING	SIZE OF FAMILY	CONSUMPTION		WATER RATE \$	WATER CHARGES PER ANNUM (1982)	
							PER CAPITA PER DAY (LITRES)	PER FAMILY PER ANNUM (CUBIC METRES)		\$	% EARNINGS
1,550	2,540	2,170	3,560	Basic Minimum Wage	Settlement	6	40	90	0.08	7	0.20
1,980	3,250	2,770	4,550	Laborer	Settlement/ No-Covenant	6	54	120	0.08	10	0.22
2,500	4,100	3,500	5,740	Clerical	No-Covenant	6	68	150	0.08	12	0.21
3,000	4,920	4,200	6,890	Skilled Tradesman	No-Covenant/ Low Covenant	5	126	230	0.24 ^{c/}	41	0.60
3,790	6,150	5,250	8,610	Foreman	Low Covenant	5	185	340	0.25	60	0.70
7,000	11,490	9,800	16,090	Senior Official	High Covenant	5	225	410	0.25	103	0.64
---	---	1,610	2,640	Average Income per family for Madang	---	6	105	230	0.24 ^{c/}	55	2.08
---	---	1,790	2,940	Average income per family (excluding persons with below minimum education) for Madang	---	6	105	230	0.24 ^{c/}	55	1.87

a/ Consumer price index for the period 1972 to 1977 increased from 105.6 to 173.3. It is assumed that this rate of increase will continue until 1982. Therefore, the 1978 earnings have been inflated by a factor of 1.641 to derive 1982 figures.

b/ Converted at K1 = \$1.4

c/ Average domestic water rate (cf. average water rate of \$ 0.34) weighted.

Source: Empirical data plus "Employment, Incomes and Migration in Papua New Guinea Towns", Garnaut, Wright and Curtain, Institute of Applied Social and Economic Research, PNG

Ref. to text: page 29, para. 62)

**MADANG WATER SUPPLY
FINANCIAL PROJECTIONS
(\$ '000)**

	1982	1983	1984	1985	1986	1987	1988
I. SUMMARY OF INCOME STATEMENT							
Water Production (m.cu.m.)	2.84	3.01	3.20	3.39	3.60	3.82	4.05
Water Sales (m.cu.m.)	2.27	2.41	2.56	2.71	2.88	3.06	3.24
Unaccounted-for-water (%)	20	20	20	20	20	20	20
Average Water Rate (cents/cu.m.)	34	34	34	34	34	34	34
Operating Revenue ^{a/}	709	754	800	847	901	957	1,014
Operating Expenses	(235)	(242)	(251)	(259)	(266)	(273)	(281)
Depreciation	(214)	(214)	(214)	(214)	(221)	(228)	(228)
Operating Income	260	298	335	374	414	456	505
Service Charge	-	60	60	60	60	60	60
Net Income (Loss)	<u>260</u>	<u>238</u>	<u>275</u>	<u>314</u>	<u>354</u>	<u>396</u>	<u>445</u>
II. SUMMARY CASH FLOW STATEMENT							
<u>Sources of Funds</u>							
Internal Cash Generation	474	512	549	588	635	684	733
Long Term Borrowing	290	-	-	-	-	-	-
Total Sources	<u>764</u>	<u>512</u>	<u>549</u>	<u>588</u>	<u>635</u>	<u>684</u>	<u>733</u>
<u>Application of Funds</u>							
Capital Expenditure	290	-	-	350	330	-	-
Debt Service	-	60	60	60	60	69	178
Working Capital	474	452	489	178	245	615	555
Total Applications	<u>764</u>	<u>512</u>	<u>549</u>	<u>588</u>	<u>635</u>	<u>684</u>	<u>733</u>
III. SUMMARY BALANCE SHEETS							
Current Assets	528	982	1,473	1,654	1,901	2,520	3,077
Net Fixed Assets	8,344	8,130	7,916	8,052	8,161	7,933	7,705
Total Assets	<u>8,872</u>	<u>9,112</u>	<u>9,389</u>	<u>9,706</u>	<u>10,062</u>	<u>10,453</u>	<u>10,782</u>
Current Liabilities	32	34	36	39	41	45	47
Long Term Debt	5,850	5,850	5,850	5,850	5,850	5,841	5,723
Equity	2,990	3,228	3,503	3,817	4,171	4,567	5,012
Total Equity & Liabilities	<u>8,872</u>	<u>9,112</u>	<u>9,389</u>	<u>9,706</u>	<u>10,062</u>	<u>10,453</u>	<u>10,782</u>
IV. SELECTED RATIOS							
Operating Ratio (%)	63.3	60.5	58.1	55.8	54.1	52.4	50.2
Average Rate Base	8,092	8,237	8,023	7,984	8,106	8,047	7,819
Rate of Return (%)	3.2	3.6	4.2	4.6	5.1	5.7	6.5
Debt Service Ratio (times)	-	9	9	10	11	10	4
Debt Equity Ratio	66:34	65:35	63:37	61:39	59:41	56:44	54:46

^{a/} Less 8 per cent provision for bad debts.

(Ref. to text: page 47, para. 64)

MAJOR ASSUMPTIONS FOR FINANCIAL PROJECTIONS

The financial projections for the Madang Water Supply Scheme from financial year 1982 to 1988 are based on the following assumptions:

I. Summary Income Statement

1. Water Produced and Sold

The average water production and sales for Madang are based on the following data:

<u>Year</u>	<u>Population Served</u>	<u>Demand (c.m./day)</u>		
		<u>Residential Connection</u>	<u>Standpipe</u>	<u>Commercial/Industrial</u>
1982	25,770	3,383	219	2,623
1986	32,250	4,304	248	3,330

Unaccounted-for water is assumed to equal 20 per cent of production.

2. Average Water Charges

The average water rate used for each year of the analysis is \$0.34 per cubic meter, comprising the following tariffs which are based on the consumer's ability to pay:

<u>Category</u>	<u>Proportion of Demand</u>	<u>Water Rate</u>
Standpipes	4%	\$0.08
Residential Connection	54	0.25
Commercial/Industrial	<u>42</u>	<u>0.48</u>
Total/Average	100%	\$0.34

Appendix 18
Page 3

3. Operating Revenue

This comprises water sales less provision for bad debt which is assumed at 8.0 per cent of the total billing amount.

4. Operating Expenses

Operating expenses include salaries and wages, power, chemical, maintenance and administration. Salaries and wages are estimated on the number and type of staff required to perform tasks. Power and chemical charges are calculated on the estimated unit consumption. Maintenance and administrative charges are based on detailed operational items. An annual inflation rate of 8 per cent was used for calculating operating expenses.

5. Depreciation

Provision for depreciation is based on the straight line method for the following Project components with an estimated useful life listed below:

Civil Engineering Structures	:	50 years
Laid Pipes	:	50
Pumps	:	20
Valves, Meters, Taps and Hydrants	:	15

6. Service Charge

Service charge on the Bank loan is 1 per cent per annum with 10 years of grace. It is assumed that local currency costs will be met by a budgetary allocation pending the outcome of T. A. No. 179-PNG when the nature of the executing agency will be determined and following this, the Government's decision on the actual interest rate to be charged to the Project.

II. Summary Cash Flow Statement

1. Long Term Debt

Long term debt comprises only the Project loan; the cost of augmentation of the system can be funded internally when the need arises.

III. Summary Balance Sheet

1. Current Assets

Current assets include cash, inventories, short term investments and accounts receivables. Accounts receivables are assumed at 20 per cent of operating revenue.

2. Net Fixed Assets

Net fixed assets are at book cost less accumulated depreciation.

3. Current Liabilities

Assumed at approximately 10 per cent of accounts receivables.

4. Equity

Equity is equal to the budgetary allocation for capital works plus accumulated income less accumulated losses.

MADANG WATER SUPPLY
FINANCIAL INTERNAL RATE OF RETURN

The following assumptions have been used in the computation of the financial internal rate for the Madang Water Supply Scheme.

1. Project Life

The average life of project facilities is assumed to be 30 years without any residual value.

2. Project Cost

The total cost of the Project facilities will be disbursed as follows:

<u>Year</u>	<u>Amount</u> (\$ million)
1978	0.48
1979	2.60
1980	3.36
1981	1.85
1982	<u>0.29</u>
	<u>8.58</u>

The cost of augmentation has been excluded from the computation because of its indefinite nature. The \$480,000 shown for 1978 includes \$430,000 from the previous Bank loan (No. 278-PNG(SF)) proceeds of which were used for engineering survey work for the Project.

3. Net Revenue

Net revenue is obtained directly from the projected income statement shown in Appendix 18.

MADANG WATER SUPPLY
CALCULATION OF FINANCIAL INTERNAL RATE OF RETURN

<u>Year</u>	<u>Capital Cost</u>	<u>Operating Income ^{a/}</u>	<u>Net Cash Flow</u>	<u>Discounted At</u>	
				<u>5%</u>	<u>6%</u>
1978	0.48		(0.48)	(0.46)	(0.45)
1979	2.60		(2.60)	(2.36)	(2.31)
1980	3.36		(3.36)	(2.90)	(2.82)
1981	1.85		(1.85)	(1.52)	(1.47)
1982	0.29	0.47	0.18	0.14	0.13
1983		0.51	0.51	0.38	0.36
1984		0.55	0.55	0.39	0.37
1985		0.59	0.59	0.40	0.37
1986		0.64	0.64	0.41	0.38
1987		0.68	0.68	0.42	0.38
)	0.73	0.73	5.74	4.67
)	each year	each year		
)				
)				
2010/11	—	—	—	—	—
Total	8.58	20.23	10.97	0.64	(0.39)
		FIRR	=	5.6%	

a/ Including depreciation added back.

ABILITY TO PAY OF DOMESTIC CONSUMERS
ECONOMIC

<u>TYPE OF DWELLING</u>	<u>PRESENT WATER SOURCE</u>	<u>NO.</u>	<u>CAPITAL COST \$</u>	<u>ANNUAL COST \$^{a/}</u>	<u>WATER DELIVERIES DURING DRY SEASON^{b/}</u>		<u>COST \$^{d/}</u>	<u>TOTAL ANNUAL COST \$</u>	<u>ESTIMATED COST PER DWELLING FOR PIPED WATER SUPPLY</u>	<u>NET ECONOMIC BENEFIT PER DWELLING</u>
					<u>CONSUMPTION PER DWELLING CUBIC METERS</u>	<u>NO. OF DELIVERIES^{c/}</u>				
Settlement/ No-Covenant	Barrels, Minor Bore holes, etc.	-	--	--	--	--	--	--	9 ^{e/}	(9) ^{f/}
Low Covenant	Roof run-off into corrugated iron tank	1	280	88	340	17	286	374	60	314
High Covenant	as above	4	1,120	353	410	15	252	605	103	502

Ref. to text: page 31, footnote 1/)

a/ Calculated on the basis of a 4 year life at 10 per cent per annum.

b/ Dry season covers the months of July through September.

c/ Calculated on the basis of - $\frac{\text{consumption}}{\text{load capacity}} - \frac{\text{tank capacity}}{\text{load capacity}}$

d/ Calculated at \$16.80 per load.

e/ Algebraic average based on varying consumptions for settlement and no-covenant dwellings at \$0.08/cubic metre.

f/ Although the low income and poorer categories of people will in future pay for their water, the cost involved is taken by comparison to the social, economic and health benefits they will derive from a reliable, potable water supply.