PART 1 GENERAL

STP	Sewage Treatment Plant
T.A	Technical Assistance
TWL	Top Water Level
UFW	Unaccounted-For-Water
VAT	Value Added Tax
WID	Women in Development
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant (=STP)

PART 1 GENERAL

CHAPTER 1 INTRODUCTION

1.1 Preamble

The Study on Greater Kandy and Nuwara Eliya Water Supply and Environmental Improvement Plan (hereinafter referred to as "the Study") was carried out in accordance with the Scope of Work agreed between the Ministry of Housing and Urban Development (hereinafter referred to as "MHUD") and the Preparatory Study Team dispatched by the Japan International Cooperation Agency (hereinafter referred to as "JICA") on October 2, 1997. JICA had organized the Japanese Study Team (hereinafter referred to as "the Study Team") and dispatched to commence the Study from February 1998. The Study was completed on January 1999 and the entire outcome was compiled into this Report.

1.2 Background of the Study

The Greater Kandy area is located some 120 km from Colombo, capital of Sri Lanka. The Greater Kandy area has a population of 630,000 (1995) with an area of 460 km^2. Nuwara Eliya located approximately 80 km south of the Greater Kandy area has a population of 34,000 (1995) and an area of 12.6 km^2. Both areas are functioning as centers of tourism and local industries in Sri Lanka. Kandy in particular boasts cultural assets and Nuwara Eliya has famous tea plantations.

In recent years, population of the Greater Kandy area has grown rapidly to the point that water demand now exceeds that of water supply capacity. In 1994, the National Water Supply and Drainage Board (hereinafter referred to as "NWSDB") prepared the "Water Supply Master Plan for Greater Kandy" under the assistance of FINNIDA. However, its implementation has been suspended due to financial constraints. A pre-feasibility study of the sewerage system in the area was also prepared by NWSDB, and although the environmental situation is not good because of the lack of a proper sewage treatment system, its implementation, however, has also been suspended.

In Nuwara Eliya, the water supply status is worse than the Greater Kandy area in general because the yield of existing water sources is much less than the present water demand in the dry season. The sanitation system in the area is also poor because of the lack of a proper sewage treatment system.

Because of the aforementioned situation the Government of the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "the Government of Sri Lanka") requested the Government of Japan to grant technical co-operation to conduct the Study. In response to the request of the Government of Sri Lanka the Government of Japan decided to conduct the Study.

Accordingly, JICA, the official agency responsible for the implementation of the technical co-operation programs of the Government of Japan, conducted the Study.

1.3 Objectives of the Study

The objectives of the Study are:

1) To formulate a Water Supply and Sewerage Master Plan up to the target year of 2015,
   a. To review and complement the existing Water Supply Master Plan for Greater Kandy,
   b. To formulate a Master Plan for Nuwara Eliya,
2) To conduct a Feasibility Study for the priority project/s identified in the Master Plan
3) To pursue technology transfer to counterpart personnel in the course of the Study.

1.4 Scope of Work

1) The study involves the preparation of the Greater Kandy water supply system development master plan for the target year of 2015 by reviewing and complementing the existing master plan prepared by FINNIDA. Feasibility Study shall also be conducted for priority projects identified in the master plan.
2) The study also involves the preparation of the Nuwara Eliya water supply system development master plan for the target year of 2015. Feasibility Study shall be conducted for priority projects identified in the master plan.
3) Preparation of the sewerage system development master plan for the Greater Kandy and Nuwara Eliya shall be conducted respectively for the target year of 2015. Feasibility Study shall be conducted for priority projects identified in each master plan.

1.5 Study Area

The study covers the following areas:

1) Greater Kandy area consisting of following:

a. Kandy Municipal Council area
b. a part of Kandy Four Gravets P/S
c. a part of Harispattuwa P/S
d. a part of Akurana P/S
e. a part of Pujapitiya P/S
f. a part of Patha Dumbara P/S
g. a part of Udunuwara P/S
h. a part of Yatinuwara P/S
i. a part of Udapalatha P/S
j. a part of Kundasale P/S
k. a small part of Patha Hewahera

2) Nuwara Eliya Municipal Council area

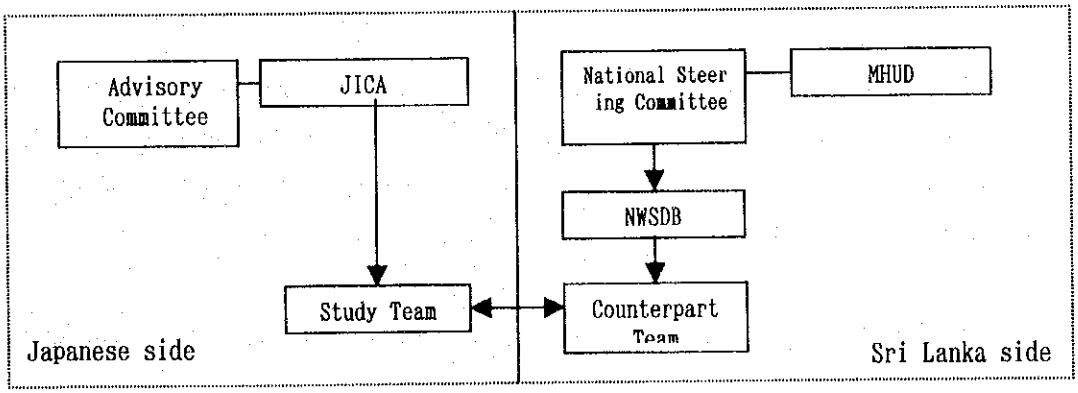
1.6 Target Year

The target year of the master plans is year 2015. However, projections of served population and water demand will be extended until the year 2020. The Target year for the priority projects was set at the year 2005.

1.7 Formation of the Study

1.7.1 General

The Study was carried out in accordance with the Scope of Work agreed upon between the MHUD and JICA. The MHUD had organized the national steering committee and counter-part team, and accomplished the Study in close cooperation with the Study Team. The over-all set-up for the implementation of the Study is as shown below.



1.7.2 Implementation Set-up of the Japanese Side

The implementation set-up of the Japanese side consisted of the Study Team and the Advisory Committee under the general supervision of the JICA headquarters. The composition of the JICA Advisory Committee is shown below:

Mr. Yoshiki Omura	Chairperson,	Development Specialist, Institute for International Cooperation, JICA
Mr. Ichiro Harada	Committee Member Sewerage & Sanitation	Senior Researcher, Public Works Research Institute, Ministry of Construction, Japan
Mr. Atsushi Sato	Committee Member Water Supply	Planner, Water Supply Bureau, Enterprise Agency, Kanagawa Pref.

The composition of the Study Team is shown below:

Mr. Takafumi Kiguchi	Team Leader
Mr. John M. McGill	Water Supply Planning
Mr. Shigeo Sawai	Water Supply Facility Design - 1
Mr. Masaya Goto	Water Supply Facility Design - 2
Mr. Shin-ichi Osaka	Sewerage & Sanitation Planning
Mr. Richard R. Deussen	Sewerage & Sanitation Facility Design - 1
Mr. Toru Yagi	Sewerage & Sanitation Facility Design - 2
Mr. Hidemasa Sato	Geophysical Survey
Mr. James Wilkinson	Hydrogeology
Dr. Giovanni Crema	Environmental Impact Assesment
Mr. Wilfrido Barreiro	Institution / Organization
Mr. Kunimasa Nishigaya	Finance / Administration

1.7.3 Implementation Set-up of Sri Lanka Side

The implementation set-up of Sri Lanka side consists of the MHUD, the NWSDB, NWSDB counterpart personnel, and the National Steering Committee for the Study composed by representatives from authorities concerned. Overall coordination of the Steering Committee was handled by the MHUD.

The Steering Committee was organized by following representatives of relevant authorities.

Ministry of Housing and Urban Development

Mr. V. K. N. Nanayakkara	Secretary
Mr. C. H. de Tissera	Additional Secretary (Technical)
Mr. T. B. Madugalle	Consultant
Mr. Padmasiri Perera	Director (Construction)
Mr. K. T. P. Fernando	Deputy Director (Construction)

Ministry of Finance

Mr. J. H. J. Jayamaha	Director, External Resources
Ms. M. Karunaratne	Director, National Planning

Central Provincial Council

Mr. K. B. Sirisena	Chief Secretary

Kandy Municipal Council

Ms. J. C. Bulumulla	Municipal Commissioner

Nuwara Eliya Municipal Council

Mr. S. D. Piyadase	Municipal Commissioner

National Water Supply and Drainage Board

Dr. N. S. K. N. de Silva	Chairman
Mr. W. A. Karunaratne	General Manager
Mr. K. M. N. S. Fernando	Additional General Manager, Planning and Monitoring
Mr. S. K. H. Perera	Deputy General Manager, Planning and Design
Mr. D. N. J. Ferdinando	Assistant General Manager, Japanese Project Unit
Ms. M. K. Bandara	Assistant General Manager, Planning and Design

Counterpart personnel were shown below.

Mr. P. H. Sarath Gamini	Project Manager/Chief Engineer, Planning and Design, NWSDB
Mr. S. R. Ranasinghe	Engineer, P&D, NWSDB
Mr. H. D. J. Dharmapala	Engineering Assistant, P&D, NWSDB

1.8 Organization of the Reports

The reports of the Study in the English language were compiled in the following five volumes:

- Volume 1 Summary Report
- Volume 2 Main Report (Greater Kandy)
- Volume 3 Supporting Report and Data (Greater Kandy)

- Volume 4 Main Report (Nuwara Eliya)
- Volume 5 Supporting Report and Data (Nuwara Eliya)

The Summary Report presents an abridge overview of the major study results for both study areas, while the Main Reports (Volumes 2 and 4) present the overall results of the Study for each study area. Detailed discussions, appendices, and field data are contained in the Supporting Report and Data (Volumes 3 and 5) for each study area. The organizational structure of the reports requires that certain portions are repeated in different volumes.

CHAPTER 2 DESCRIPTION OF THE STUDY AREA

2.1 General Outline of the Study Area

2.1.1 Administrative Overview and Current Sector Policies and Strategy

The Government of Sri Lanka has adopted the "some (water) for all" global strategy recommendation follows the Water and Sanitation Decade of the 1980's. The current estimate of annual capital investments to achieve this sector's objective by 2010 is in the order of Eight Billion Rupees. Water demand has accelerated with urbanization and economic growth and the Government has adopted medium-term policies and strategies to address this challenge.

To improve the quality of projects, new criteria for assessing the financial viability have been formulated. Water tariffs are gradually being adjusted to reflect real production costs. To increase the operating efficiencies of the various utilities, initiatives towards reducing unaccounted-for-water have been emphasized. The Government has instituted a policy of providing a capital development grant subsidy of up to 50% of project costs in urban areas or 85% subsidy in rural areas. The loan component is provided at the rate of 10% p.a. over 24 years with a 2-year grace period (interest rate reduced from 12% p.a. in June 1998). The Government also seeks to promote and attract the participation of the private sector and community organizations in facilities construction, operation and maintenance. To improve project affordability, the Government has called for the adoption of appropriate and effective low-cost technologies and methods for service provision.

2.1.2 Relevant Sector Legislation

The **National Water Supply and Drainage Board Law (Act No 2 of 1974)**, as amended, established and directed the NWSDB to develop and manage a coordinated national program for water supply and sewerage for the entire country. Significantly, the Law empowers the Board to take over existing systems from local authorities under voluntary or compulsory transfer orders. The Board is also authorized to operate a water and sewerage utility, providing services either directly to customers or through bulk supplies to local authorities, government agencies or any other organization, who can manage the distribution of water. The Board has become the lead agency for planning, design and implementation of urban and rural water supplies, providing technical assistance and services to local authorities.

The **National Environmental Act (Act No. 47 of 1980),** as amended, created the Central Environmental Authority (CEA). The CEA is mandated to protect, manage and enhance the environment; regulate, maintain and control the quality of the environment; and prevent, abate and control pollution. The Act vests broad powers and authority to the CEA and the inter-ministerial Environment Council. The CEA is responsible for formulating policy recommendations affecting natural resources, fisheries, wildlife, forestry and soil conservation. Licenses and permits are required from the CEA for discharging wastes to the environment. The CEA reviews and approves all projects.

2.1.3 Key Sector Agencies

The **Ministry of Housing and Urban Development** has the overall responsibility for promoting, guiding and co-ordinating the development of human settlements, land reclamation and the construction industry. The development of urban centers and the required urban infrastructure, including water and wastewater facilities, is a critical function.

There are several authorities under its administrative control, including the ***National Water Supply and Drainage Board,*** which has decentralized its operations to five (5) Regional Support Centers and several regional and district offices.

Also under the Ministry are:

- the ***National Housing Development Authority*** which is tasked with developing housing projects;
- the ***Urban Development Authority*** which is entrusted with the responsibility for integrated planning and development of socio-economic and physical infrastructure; and
- the ***Town and Country Planning Department,*** which plans (and implements) new town development schemes.

The **Ministry of Health and Women's Affairs** is responsible for the national health policy including the implementation of sanitation and hygiene education programs, and:

- to undertake regulatory functions over water supply provision, solid waste management and pollution abatement, insofar as they affect environmental health conditions;
- to exercise a national sanitation program in co-ordination with the health departments of the various local authorities through its provincial offices; and
- to provide incentives for households to construct hygienic sanitary facilities.

The ***Mahaweli Authority of Sri Lanka*** under the **Ministry of Irrigation** administers the Mahaweli Development Program, and is tasked:

- to lead the integrated development within the river basin;
- to develop several irrigation and hydroelectric power generation projects through dams and barrages along the Mahaweli River;
- to monitor the quality and flow of the river and regulates the withdrawal and discharge of water.

The ***Central Environmental Authority*** of the **Ministry of the Environment** is responsible for water pollution control policies and standards and to undertake a quality surveillance program for regulation and enforcement of policies and standards.

The ***Department of External Resources*** of the **Ministry of Finance**:

- assesses the foreign exchange requirements;
- co-ordinates with external support agencies;
- negotiates for grant and loan financing facilities for priority projects of the various ministries; and
- reviews the utilization of external assistance funds.

- In 1993-94, the Asia Development Bank (ADB) and the United States Agency for International Development (USAID) assisted a project to assess and prepare an institutional strengthening and capacity building plan for the entire water resources sector. This project produced a "*Strategic Framework and an Action Plan for Comprehensive Water Resources Management*". A high-level ***Water Resources Council (WRC)*** was organized to oversee the Action Plan implementation and to co-ordinate resolution of inter-sectoral and intra-sectoral issues. A ***Water Resources Secretariat (WRS)*** was established to support the work of the WRC. In addition, an ***Interagency Co-ordinating Committee (ICC)***, consisting of selected water agency heads, was also organized to ensure the technical soundness of the decisions and actions taken.

2.1.4 Local Administrative Overview

In Sri Lanka, the general administrative or executive structure may be described through three (3) administrative structures.

(1) Central Structure.

The elected ***President*** appoints ***Cabinet Ministers*** (including the Prime Minister) from among the members of Parliament, to head the various ministries. For each of the ministries, a senior official is designated as ***Secretary*** to manage its activities.

(2) Provincial Structure.

The President is also empowered to appoint ***Governors*** for each province. The 13th Amendment to the present Constitution calls for the ***devolution*** of powers and responsibilities to the lower levels of government. ***Provincial Council*** members are elected for 4-year terms to oversee these devolved functions. Following the central-level structure, the Governor appoints Provincial Ministers, including a Chief Minister, from among the Provincial Council members.

(3) Local Government Structure.

1) Pradeshiya Sabha (PS's) or rural local authorities were established by law in 1987. Headed by an elected Chairman, the PS has broad powers and service functions.
2) Municipal Councils (MC's) and Urban Councils (UC's) also established by law, function in urban areas and have similar powers and responsibilities as the PS's.

The ***Divisional Secretary (DS)*** is the key link among the three administrative structures. The DS functions as the Additional Government Agent under the central Ministry of Public Administration, Provincial Councils and Home Affairs. The functions of the Provincial Departments at the Divisional Level are all (with few exceptions) performed by the DS. At the same time, the DS acts as the Assistant Commissioner of Local Government. At the village level, the ***Grama Niladhari*** assists the DS in co-ordinating and delivering the services in one or more villages.

2.1.5 Administrative Composition of the Greater Kandy Study Area

The Study Area is located within the Kandy District of the Central Province. The term *Greater Kandy* is not an officially recognized administrative entity, but it is gaining wide usage among planners and policymakers. First introduced by the NWSDB in its Master Plan, the term *Greater Kandy* has since been redefined by the Urban Development Authority to refer to the Kandy Municipal Council area and other ten (10) PS's areas under the oversight of the Division Secretary. For the purposes of this Study, the key administrative bodies involved are the Kandy Municipal Council, 10 PS's, and the NWSDB.

2.2 Physical Characteristics of the Study Area

(1) Location

Kandy District is situated in the Central Province of Sri Lanka. The other two districts in the Central Province are Matale and Nuwara Eliya. The Districts surrounding Kandy are Matale (to the North), Badulla, Nuwara Eliya, Kegalle and Kurunegala respectively. Kandy District has a land area of about 1,900 km^2.

The main town of the District is also named Kandy. Other major towns in the District are Gampola and Nawalapitiya. Wattegama, Pussellawa, Teldeniya and Kadugannawa are smaller towns in the Kandy District.

(2) Topography

The entire Kandy District is comprised of hilly terrain, with elevation varying from 300m to 2,000m above mean sea level (MSL). The lowest elevations in the district are along the Mahaweli valley.

(3) Geology

The main soil type found in the Kandy District is made up of reddish brown latosolic soil and immature brown loam. The underlying bedrock is mainly pre-Cambrian crystalline rock of the highland series.

(4) Climate

Most of Kandy District is in Sri Lanka's wet zone. The District receives an annual rainfall of 2,000 - 2,500 mm. The average temperature varies between 23.6^{0}C and 26.5^{0}C, and the mean relative humidity varies between 72.2% and 85.8%. The monthly average precipitation varies between 54.7 mm in March and 298.0 mm in November. Monthly precipitation less than 100 mm usually occur in February and March, while there is normally above 300 mm in October and November. Daily sunshine hours vary between 4.3 hours and 8.2 hours.

2.3 Socio-Economic Perspective

2.3.1 National Overview

(1) General

The Government's medium-term goal to sustain economic growth of 7% by 1998 will be far easier to reach with an end to hostilities, which place a continuing damper on the Sri

Lankan economy. Achieving this pattern of growth should ensure progress in reducing unemployment and poverty. Continued strong growth of exports, if sustained over the medium-term at the annual 12% average achieved in 1989-1994, would continue to provide the impetus for growth. This will require further diversification, as tea still accounts for more than 20% of total exports, and garments account for close to another 50%. Tourism, which experienced a major rebound in the early 1990s, can also continue to contribute significantly to growth, especially if Sri Lanka can upgrade its facilities and services to attract tourism with higher value added.

(2) Human Capital

Sri Lanka faces new "second generation" issues that are more typical of middle-income countries. For example, growing demand for higher education has become an increasing burden for already over-stretched resources, and an aging population is creating pressures for more tertiary care with high treatment costs. The government is now putting a strong emphasis on education, with the aim of improving both quality and efficiency.

(3) Strategic Objectives

Sri Lanka's strategic objectives can be summarized as achieving economic growth and poverty reductions, comparable to that of its East Asian neighbors. The Government's goal is to maintain macroeconomic stability and to complete its reform agenda. It aims to carry this out through efficient job creation, export-led growth, further upgrading of the country's human capital, and by protecting the environment.

Stimulating private sector growth through enhancing competition, enabling private sector investment, and creating jobs, is also one of the key targets of the present Government. If policy reforms are forthcoming, international donors will increase their support to Sri Lanka thus strengthening private sector growth, and helping to improve the country's inadequate and poorly maintained physical infrastructure.

2.3.2 Kandy Municipality

In 1989, Kandy was nominated as a World Heritage City. This accolade was earned because of Kandy's Historic, Architectural, Religious, Socio Cultural, and Environmental Heritage.

The ethnic and religious composition of the population varies by area. In Kandy, 79.3% of the population is Sinhalese, while in the Central Province and Sri Lanka as a whole the figures are 65.5% and 74%, respectively. This is mainly due to the traditional land ownership pattern and other socio-cultural reasons. The ratio of males to females is 53:47. There is also more job opportunities for males than females.

The active work force is 49.4% of the total population with 50.6% recorded as dependents. This is mainly due to the number of students in the town area. Although the unemployment rate at 9.6% in Kandy is very low, only about 8% of work force are engaged in permanent employment, while 43% are in temporary employment. This indicates that employees working in Government offices live outside of the town limits. The majority of the daily commuter population belongs to Government workers and the majority of the work force in the town is attached to the private sector.

2.3.3 Greater Kandy Area outside of Kandy Municipality

The Greater Kandy Area consists of Kandy municipality and a part of 10 PS's. Part of the Pradeshiya Sabhas surrounding the Kandy have population densities comparable to that of the Municipality itself. Within Greater Kandy Area but outside of Kandy Municipality, Wattegama and Kadugannawa are administrated by separate Urban Councils, while the remaining area are divided into 10 Pradeshiya Sabhas.

- The ethnic composition of the district population (1995 estimated) is 74.2% Sinhalese, 12.1% Tamils, 12.9% Moors, 0.5% Burghers, 0.3% Others.
- The population density was 669 per km^2 (1995 estimate) (Sri Lanka 279 per km^2).
- The unemployment rate is 19.4%.
- The percentage of cultivated land is Paddy 18.5%, Tea 31.1%, Coconut 5.2%, Rubber 2.3%, Minor Crops 23.5%, Others, 19.9%.
- The food Stamp Ratio is 31.3% (Nuwara Eliya 7.8%), and the Janasaviya Ratio is 11.9% (Nuwara Eliya 7.9%).

2.4 Present and Future Land Use

2.4.1 Kandy Municipality

The present land use pattern in Kandy is as summarized in Table 2.1.

Table 2.1 Present Land Use Pattern in Kandy

Land Use		Extent in Hectares	Percentage	in 1983
01	Residential	1,159.27	46.64	35.38
02	Commercial	58.65	2.35	1.69
03	Industrial	9.91	0.40	0.28
04	Public			
	Government Building	9.91	1.37	5.08
	Religious	41.49	1.67	--
	Educational	60.23	2.43	--
	Health	24.67	0.99	--
05	Roads	172.9	6.96	N.A.
06	Parks and Play Grounds	96.3	3.87	N.A.
07	Vacant Lands including (Mixed crops)	222.49	8.95	N.A.
08	Paddy	66.7	2.68	N.A.
09	Forest Lands	364.18	14.65	N.A.
10	Water Bodies (Including ½ of the river as municipal boundary lays)	174.46	7.02	N.A.
TOTAL		2,485.24	100.00	

Land use issues in Kandy are:

- Expansion of residential activities in high elevation areas and steep slopes and thereby contribution to high degrees of siltation, possible landslides and loss of scenic value on mountain areas.
- Intrusion of commercial activities, such as stores and service garages in residential areas thus resulting in high rents for residential units and loss of privacy in residential areas.
- Intrusion of competing uses such as car sales into residential areas.

2.4.2 Greater Kandy Area outside of Kandy Municipality

(1) Concept

- Provision of a major administration and educational center at Getambe and Ganno-ruwa.
- Provision of a Major Industrial agglomeration at Kundasale, Pallekele, Balagolle and Pallethalawinna area
- Provision of a major commercial and tourism center at Kandy Municipality.

(2) Proposals for Urban expansion (Greater Kandy Area) are as follows:

- Greater Kandy Water Supply Master Plan
- Telecommunication Expansion Program

- Electricity Expansion Program
- Major Highway and Road Proposals
- Township Centers at Digana, Menikhinna, Madawala, Wattegama, Barigama, Muruthalawa and Pilimatalawa
- Water Shed Management and Conservation at Hantana and Hunnasgiriya
- Physical and Environmental Development Plan for Greater Kandy area
- Multi Sector Investment Program for Greater Kandy area
- Tourism Master Plan for Greater Kandy area

2.5 Financial Status of the Study Area

2.5.1 Kandy Municipality

The budget of KMC is divided into two parts - recurrent budget and capital budget. The total recurrent revenue in 1996 budget was Rs. 326 million. The composition of recurrent revenue and expenditure in 1996 budget (Rs. 326 million) is shown below

Recurrent Revenue		**Recurrent Expenditure**	
Revenue Item	Percentage Share	Expenditure Item	Percentage Share
Assessment	4.25	General Administration	18.62
Grant	28.7	Health Care	11.8
Water Supply	26.29	Road & Building	13.09
Other	40.19	Utility	23.87
		Water Supply	26.2
		Welfare	6.17

The first level of budget classification is called a program, while the second level of classification is called a project. In addition to the recurrent budget, a five year capital budget as shown below is estimated in the budget. Except for financial provisions from recurrent expenditures in 1996, all these estimates are lacking an actual financial basis. As internal sources of income is very limited, these levels of capital expenditures are almost impossible without outside assistance.

Table 2.2 Five Year Capital Budget Expenditure Estimate for Kandy Municipal Council

Unit: Rs.1,000

Program	1996	1997	1998	1999	2000	Total Estimate
1. General Administration	2,689	20	20	20	20	2,769
2. Health Services	5,496	1,400	2,200	1,200	800	11,096
3. Physical Planning	9,200	10,000	10,040	9,000	6,404	44,644
4. Water Supply	8,727	29,676	31,655	31,000	35,782	136,840
5. Other Utility	58,461	1,500	2,450	750	500	63,661
6. Welfare Facilities	2,835	0	0	0	0	2,835
Total	87,407	42,596	46,365	41,970	43,506	261,844
Financial Provisions from recurrent expenditure	42,923	0	0	0	0	

A characteristic of the municipal finance is seen on very little internal tax revenues, because tax revenue with an income basis is non-existent. Further, the scale of the capital budget is very small, and upgrading of the infrastructure associated with the growth of population cannot be supported. Also, water supply accounts are not independent business accounts. Water supply is handled within the general administrative affairs account.

2.5.2 Greater Kandy Area outside of Kandy Municipality

The financial status of ten Pradeshiya Sabhas in the Study Area seems to be more or less similar to neighbor municipalities, but their financial difficulties will be worse than for central cities.

With regard to the current water supply of the Greater Kandy Area outside of Kandy Municipality, neither Pradeshiya Sabhas nor Urban Councils has primary responsibility. Generally it is responsibility of the NWSDB to supply residents with water. If the financial basis for the water supply in this area is considered, the financial status of the NWSDB is of more direct concern. As the NWSDB is a nation-wide public organization the financial status of the NWSDB should therefore be considered at the national level.

The current status of NWSDB financial performance is not critical, but nevertheless it cannot be accepted without reservation. In the long term its financial performance will deteriorate if addition investment is made with long-term loans and not accompanied by an improvement in operational efficiency.

Operational efficiency can be improved if the current level of NRW (non-revenue water) and ratio of staff to customers are both reduced. Additionally the water tariff for domestic users will have to be gradually incremented to a level that will recover long-term water production costs. The NWSDB has taken steps in this direction, but further effort is still required.

At present, three Pradeshiya Sabhas are managing their water supply directly. The Wattegama Water Supply Scheme is operated by the Wattegama Urban Council and two Pradeshiya Sabhas (Patha Dumbara and Kundasale) independently from NWSDB. Two Pradeshiya Sabhas (Kundasale and Kandy Four Gravets) distribute water to a part of their residents obtained in bulk water supply from NWSDB.

PART II WATER SUPPLY

CHAPTER 3 CURRENT WATER SUPPLY SYSTEM IN THE STUDY AREA

3.1 Existing Water Supply System

(1) Operating Water Supply Systems in the Study Area

An inventory of operating water supply systems was developed through the course of this development study. FINNIDA Master Plan Report was referred in this compilation and the field survey to water supply systems together with questionnaire survey and interviews was carried out by the Study Team. A summary of this inventory is presented in Table 3.1.

Table 3.1 Summary of Operating Water Supply Systems in the Study Area

Name of Operating Body	No. of Operating Water Supply Systems	Total Production Capacity (m^3/day)	No. of Service Connections		
			Domestic	Non-Domestic	Stand-post
NWSDB	23	28,896	17,428	1,258	500
KMC	1	33,400	14,400	3,100	470
Kundasale	1	13,000*	-	-	-
		576	1,150	50	5
Pallekele (CECB)	1	2,000	490	16	44
Pallekele (Gam Udawa)	1	1,200	66	59	5
Ampitiya	1	1,300	1,159	96	52
Wattegama	1	1,400	829	230	42
Peradeniya	1	545	-	-	-
Menikhinne	1	300	788	33	6
Total	31	82,617	36,310	4,842	1,124

Note: * On-going project

There are a total of 31 water supply systems being operated by different institutions in the Greater Kandy Area. They produce a total of 82,617 m^3/d drinking water to serve for 36,310 domestic connections, 4,842 non-domestic connections, and 1,124 standposts (public faucets).

(2) Water Sources

Existing sources produce a total of about 82,600m^3/d including on-going Hulu Ganga (13,000 m3/d) and Nilambe Oya (11,500 m3/d) schemes. Capacities of the existing water sources range from large surface water sources with complete treatment (33,400 m^3/d from the Kandy Municipal Council treatment facility on the Mahaweli River) to small ground-water extraction schemes (hundreds to 2,000 m^3/d) to even smaller gravity spring sources with limited treatment.

Areas presently served by the existing water supply facilities in the study area are illustrated in Figure 3.1. The present (1997) service population is estimated at 544,320, out of a total population of 644,680. Several smaller water schemes that produce poor quality water or are an excessively expensive to operate, are subject to be abandoned after 2005. Existing supplies to be operated after 2005 have a total capacity of 65,960 m^3/d including the as yet unfinished Hulu Ganga and Nilambe Oya projects.

(3) Transmission and storage facilities

Existing major transmission lines and reservoirs are illustrated in Figure 3.2 and summarized in Table 3.2, while existing and proposed distribution reservoirs are summarized in Table 3.3.

Table 3.2 Summary of Existing Transmission Lines

PVC		DI (Ductile Iron)	
Diameter (mm)	Length (m)	Diameter (mm)	Length (m)
50	1,400	100	750
75	3,000	150	9,280
90	0	200	6,154
110	1,110	250	10,915
140	0	300	2,349
160	14,030	350	6,616
225	7,150	400	11,333
280	1,500	450	2,000
		500	5,800
Sub Total	28,190	Sub Total	55,197
Total		83,387	

Ductile iron pipe is widely used in the transmission lines and smaller diameter of pipes (both PVC and DI) is used for small-scale water supply system. Year of installation of these transmission lines is not available.

There are a total of 34 distribution reservoirs in Greater Kandy with the accumulated storage capacity of 21,225 m^3. The FINNIDA Plan proposed a total of 58 reservoirs to be expanded or newly constructed to attain additional 32,925 m^3 storage capacity.

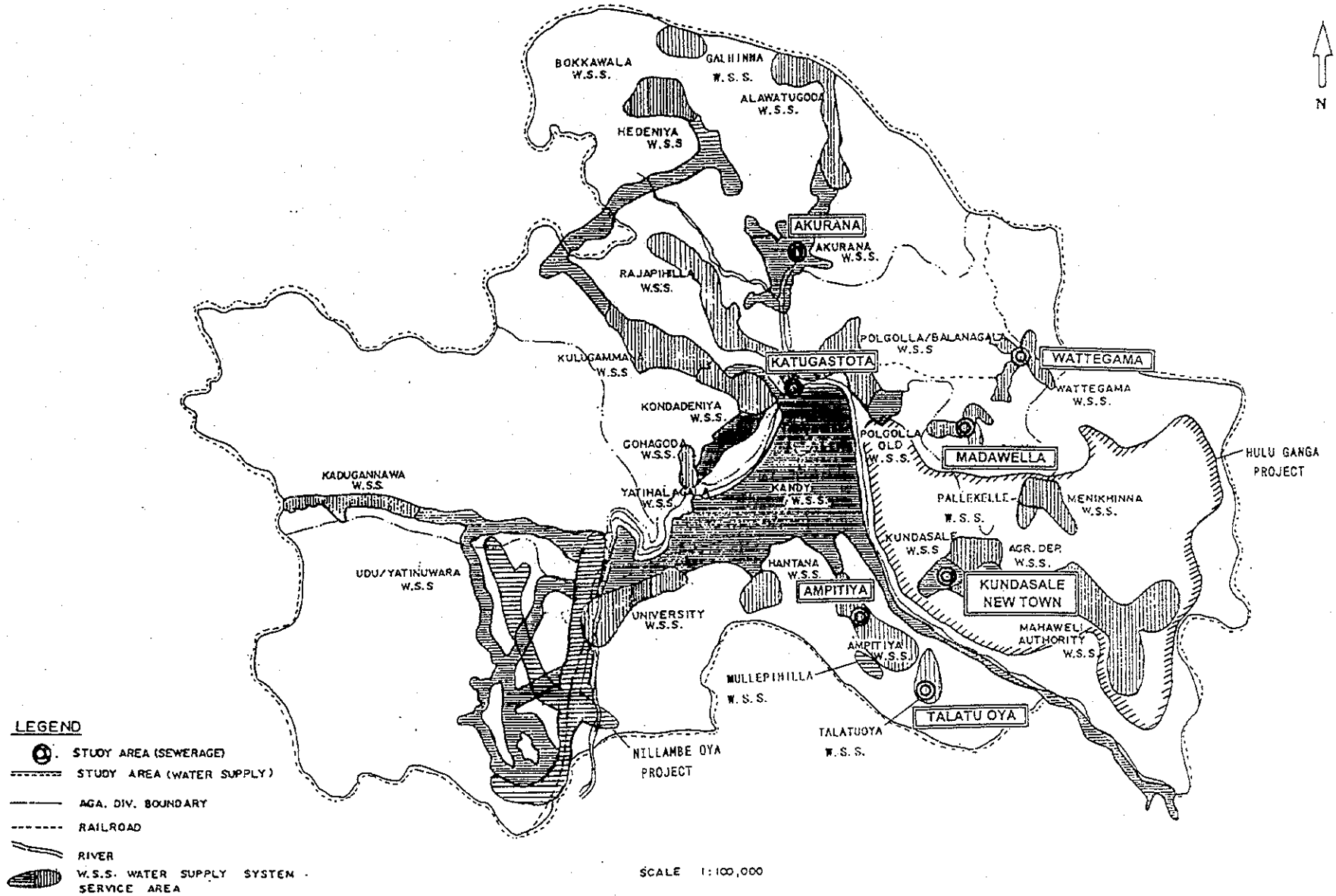


Figure 3.1 Existing Water Supply Systems in Greater Kandy

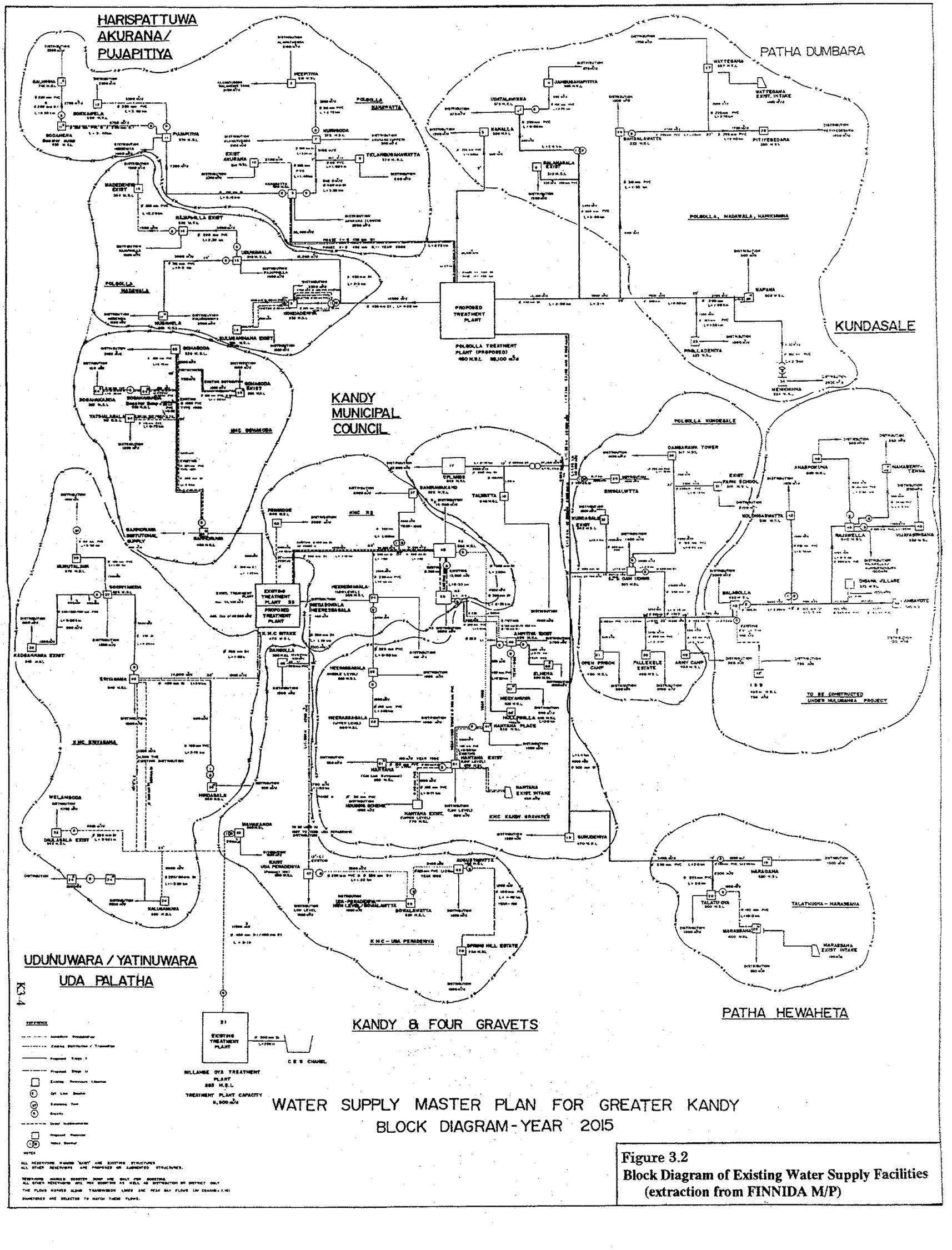


Figure 3.2
Block Diagram of Existing Water Supply Facilities (extraction from FINNIDA M/P)

Table 3.3 Existing and Proposed Distribution Reservoirs in Greater Kandy Area

Service Zone	No. of Distribution Reservoirs		Total Capacity of Distribution Reservoirs (m^3)	
	Existing*	Proposed in FINNIDA Plan	Existing*	Proposed in FINNIDA Plan
Polgolla-Kundasale	5	12	3,420	4,000
Polgolla-Madawale/Menikhina	2	8	600	2,800
Polgolla-Kahawatter	3	6	1,050	5,100
Polgolla-Uduwawala	4	3	1,200	2,250
KMC-Eriyagama	4	5	4,560	4,550
KMC-Gannoruwa	3	3	1,050	900
KMC-R2	4	6	5,044	9,400
KMC-Udaperadeniya	2	7	1,258	1,975
Kandy Four Gravets	7	4	3,043	1,200
Thalathu Oya-Marassana	0	4	0	750
Total	34	58	21,225	32,925

*: Updated by the study team

(4) Recent or on-going water supply improvement projects

Nilambe Oya (Kalugamuwa water Supply Scheme)

Construction was recently (1997) completed on an 11,500 m^3/d water treatment facility on the Nilambe Oya. Treatment facilities include the following:

Aeration - Lime and alum chemical dosing - Flocculation - Rapid sand filtration - - Sedimentation - Chlorination

This plant serves a portion of the KMC- Eriyagama zone. Construction of the transmission mains and reservoirs has also been completed.

Hulu Ganga Project (Kundasale Water Supply Scheme)

Design work has been initiated on the Hulu Ganga project, which is scheduled for completion by the end of the year 2000. The total estimated cost for the project is Rs.300M, Rs.150M of which has already been allocated by the Government. This project will extract 13,000 m^3/d from the Hulu Ganga near Wattakelle Estate and serve a portion of the Polgolla-Kundasale zone. Of the total, 4,000 m^3/d of this supply is slated for the IDB Zone. The remaining 9,000 m^3/d will be used to serve other portions of the Polgolla-Kundasale zone. When demand in the Polgolla-Kundasale zone exceeds the capacity of the Hulu Ganga project, NWSDB plans to supplement the supply with water from the proposed Katugastota water treatment plant.

3.2 Institutional and Financial Status of Water Supply and Sanitation Systems

3.2.1 Kandy Municipal Council

(1) *Functions and Responsibilities.*

At the Kandy Municipal Council area, the Office of the Waterworks Engineer undertakes the production, distribution and operation and maintenance activities to meet the water demands of the city. Although, mainly concerned with operation and maintenance, the Office has also been involved in minor capital development works, such as pipeline extensions and tank relocation.

(2) *Organizational Structure.*

Organizational structure of the Office of the Waterworks Engineer is as shown in Figure 3.3.

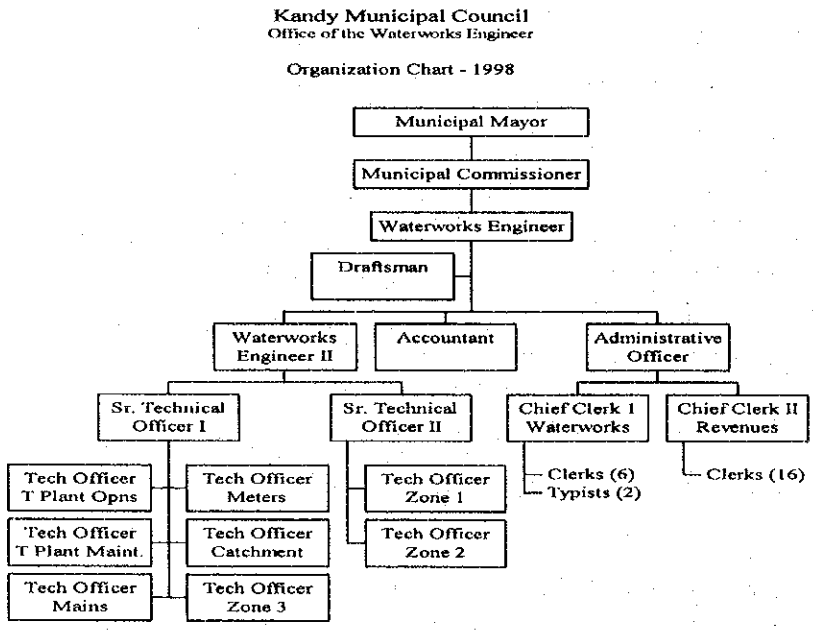


Figure 3.3 Organizational Chart of the Office of the Waterworks Engineer - KMC, 1998

(3) *Staffing Levels and Personnel Administration.*

As of February 1998, the Waterworks office employed 267 staff, including three (3) professional-level staff (2 engineers and 1 accountant); about 156 mid-level or technician-level staff; and 108 laborers. Overall, the staffing ratio is 15.5 staff per thousand connections (which is considered high).

(4) *Customer Base.*

As of 1997, the waterworks system had a total of 17,203 active service connections, of which 14,247 were domestic connections. It also maintains about 517 unmetered stand-

posts and 20 "public bath houses". The official policy is to limit the installation of these public standposts in the future to low-income areas only.

(5) *Getambe (KMC) Water Treatment Plant Operations*

KMC operates a 33,400-m^3/d capacity water treatment plant in Getambe. The actual production is 31,641 m^3/d (operating efficiency, 94.7%). Water production costs could not be determined. No major operating issues were reported although the need for better capacity to deal with chlorine-related emergencies was noted.

The plant is managed by an Officer-in-Charge, assisted by four (4) shift supervisors and a mechanical works supervisor. The staff complement consists of 1 laboratory technician, 8 pump operators, 4 driver/mechanics, 2 electrician, and laborers. Total staffing is 34.

(6) ***Tariff Structure.***

Effective January 1998, a new water rate structure was enforced. The previous adjustment was implemented in 1994; the new rate schedule is a significant increase over the last schedule. In addition, a monthly meter rental fee, depending on the size of the meter is charged. The new rates are:

Table 3.4 Water Rate Schedule - KMC, 1998

Type of Accounts	Consumption (m^3)							
	1-10	11-20	21-25	26-30	31-37	38-44	45-51	>51
Domestic	0.60	1.50	5.50	7.00	7.50	8.00	12.00	15.00
Commer'l	25.0 – 27.0, depending on type of commercial establishment							
Schools	0.00	1.80	6.00	12.00	15.00		20.00	35.00

Table 3.5 Schedule of Monthly Meter Rental Charges - KMC, 1998

Meter Size	Monthly Charge (Rs.)	Meter Size	Monthly Charge (Rs.)	Meter Size	Monthly Charge (Rs.)
6" (150mm)	400.00	2" (50mm)	150.00	3/4" (20mm)	50.00
4" (100mm)	250.00	1½" (40mm)	100.00	5/8" (16mm)	30.00
3" (75mm)	200.00	1" (25mm)	80.00	1/2" (13mm)	20.00

(7) ***Financial Status***

During 1997, the estimated water produced was 31,641 m^3/day; water billed was 18,335 m^3/day. Ratio of **Non-Revenue Water was 42%.** As of June, 1998, outstanding receivables from water sales was Rs. 49,101,828.85. The average collection period (from July 1997 to June 1998) was **8.93 months.** This is considered extremely high and unsatisfactory.

Table 3.6 Billing and Collection Data, KMC - Jan 1997 to July 1998

Month	*Consumption m3*	*Billings Rs.*	*Collections Rs.*	*No of Connections*
Jan-97	509,048	4,638,807.79	3,589,250.44	
Feb-97	517,222	4,664,180.27	3,311,156.27	
Mar-97	602,934	3,815,763.52	2,750,506.97	
Apr-97	589,763	4,202,330.28	2,395,256.97	
May-97	527,385	3,744,130.45	4,874,762.78	
Jun-97	508,361	4,184,092.45	4,849,922.12	
Jul-97	498,533	4,213,131.61	3,853,833.80	
Aug-97	484,547	3,751,335.69	3,443,920.95	
Sep-97	495,864	4,220,435.22	3,084,099.70	
Oct-97	714,991	4,597,333.91	3,488,646.53	
Nov-97	512,392	3,874,227.17	6,431,203.44	
Dec-97	661,721	4,194,229.30	7,304,572.29	17,203
Total	6,622,761	50,099,997.66	49,377,132.26	
Average	551,896.75	4,174,999.81	4,114,761.02	
		Arrears, as of Dec 97:	***40,398,849.71***	***Rs.***
		Avg. Collection Period (1997):	***9.68***	***months***
Jan-98	727,607	6,255,944.03	2,964,751.07	
Feb-98	590,289	6,661,797.28	4,226,085.76	
Mar-98	591,939	8,009,011.00	10,802,808.67	
Apr-98	601,502	7,082,193.46	3,067,649.82	
May-98	597,394	6,970,109.56	4,711,762.75	
Jun-98	574,855	6,163,384.93	6,666,403.05	
Average	613,931	6,857,073.38	5,406,576.85	
% Increase	*11.64%*	*38.63%*	*32.89%*	Month-on-month
		Arrears, as of Jun 98:	***49,101,828.85***	***Rs.***
		Avg. Collect. Period (Last 1 year):	***8.93***	***months***

During the first six months of 1997, Income and Expenses have been reported as shown in Table 3.7.

Table 3.7 Annual Financial Performance of KMC Water Supply Scheme (1997)

Water Production Costs		**Revenues**	
Staff Salary	11,530,812	Rates and Taxes	44,855,181
Chemical Costs	2,838,819	Others	19,313,458
Materials	2,288,938		
Electricity	43,421,183	**Total Revenue**	64,168,639
Repair Cost	1,299,566		
Others	9,119,758	**Gain (Loss)**	(6,330,437)
Distribution Costs	70,499,076		

(8) *Operating Financial Highlights (1997)*

1) Water sales

In 1997, water production was 11,549,078 m^3 and the billed water amount was 6,692,457 m^3. Non-revenue water ratio was 42.05%.

2) Billed and collected amount

The accounts receivables as of the end of 1997 was Rs. 40,398,850 (very high), while total billed amount was Rs. 50,099,998 and collected amount was Rs. 49,377,132. The average collection period was 9.7 months.

3) Expenditure control and budget

As of the end of 1997, both revenues and expenses were below budget at 73.3% and 83.5%, respectively. Loss was Rs. 6,330,437.

(9) *Assessment of Institutional Strengths and Weaknesses*

1) The accounts receivables as of June 1998 total Rs. 49,101,828.85 (very high). The average collection period (arrears/avg. monthly billing) has improved from 9.68 months to 8.93 months; however, this is not indicative of any effort to collect the arrears. The average monthly billing of KMC has increased with implementation of the new water rates in January 1998. There is little motivation or incentive to collect arrears since the operating budget for the waterworks is always assured.
2) Because of the poor collection, the KMC, in effect, heavily subsidized the waterworks operations to about Rs 13.24 M in 1997 alone.
3) Non-revenue water in 1997 was reported to be 42%. At a production cost of Rs. 5.42 per m^3, this is equivalent to throwing away Rs. 2.19 M per month.
4) The operations at Getambe water treatment plant stands out as a fine example of efficiency and should be considered as a possible training resource for treatment plant operations.
5) Overall, there is a need for stronger commercial orientation in the waterworks office and clearer responsibilities for collection efficiency. The linkage between operating budget and collection performance should be established. Technical operations are generally well managed except for the huge non-revenue water losses. Improvements to ensure better operational control through accurate monitoring will be required.

3.2.2 Greater Kandy Area outside of KMC

(1) *Functions and Responsibilities*

In the Greater Kandy area and adjoining area, the NWSDB, through its Kandy Regional Office (under the Regional Support Centre for the Central Province or RSC/C) serves the

population (outside KMC) through about 42 separate facilities or schemes. NWSDB is responsible for the production, distribution, and source development activities to serve the growing demand of the area. The Study Area is under the responsibility of the RSC's Kandy North, Kandy South and Matale districts.

(2) *Organizational Structure*

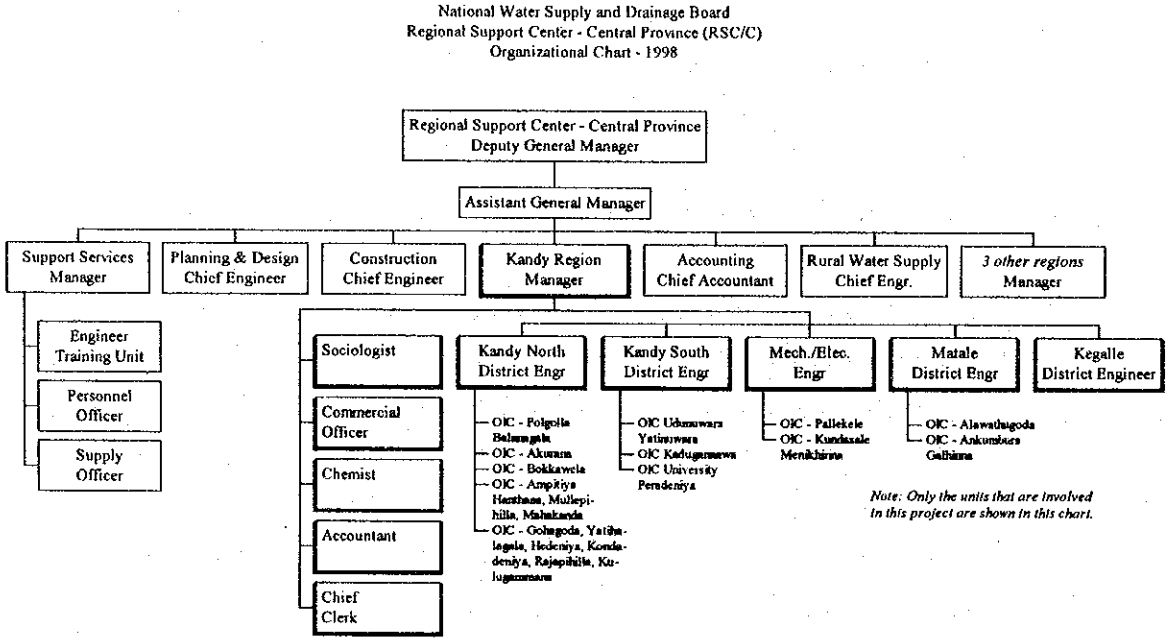


Figure 3.4 Current Organization Chart of NWSDB - Kandy Region

(3) *Staffing Levels*

For the entire Kandy Region, there are 606 existing personnel as of 1997. The staff profile may be described as follows:

Professional & managerial staff,	13
Skilled office workers,	71
Skilled field workers,	303
Laborers,	219

(4) ***Training and human resources development.***

Training within the NWSDB Kandy region is organized and implemented by the Engineer Training Unit (under Support Services) of the Regional Support Centre in co-ordination with the Manpower Training Division (MPTD) at the NWSDB Head Office. Training programs have been conducted for all staff levels. The Table 3.8 shows the number of NWSDB staff trained from the entire Kandy region.

Table 3.8 Number of NWSDB (Central) Staff Trained, 1995-1997

Category	*1995*	*1996*	*1997*
Senior Managers	9	8	13
Middle Managers	156	71	19
Junior Managers/Supervisors	165	175	8
Technical Professional staff	895	701	197
Clerical Grade staff	1,134	68	228
Skilled Grade staff	348	148	38
Office Laborers	21	-	-
Total	*2,728*	*1,171*	*603*

Training, thus far, has been principally related to office management skills, including computer skills and language skills; and water supply operation and maintenance for both urban and rural areas. Training capacity for sewerage and sanitation skills does not exist.

The annual training budget is very low; only Rs. 50,000 was allocated for training activities in 1997 for logistics and participation of staff in external courses for the entire region. The Training Unit relies on project funds (such as the rural water supply project) to pursue its activities. It maintains some audio-visual equipment and relies on a roster of local staff to act as resource persons and facilitators. At present, the Unit is a one-man operation. Clearly, more management support is needed to support the training function. The decline of training activities is very apparent from the table above.

(5) ***Sewerage services***

Sewerage is available only at the Hanthana Housing Project of the National Housing Development Authority. Sewerage (and water) facilities were constructed as part of the project. Under current arrangements, NWSDB monitors its costs for collecting and treating wastewater and bills for the actual costs, plus 30% overhead. On May 1998, the NHDA transferred the sewerage facilities to the NWSDB. Studies are underway to determine how the sewerage bills could be passed on to the households. Water supply to Hanthana is provided by NWSDB and paid for directly by the consumers.

(6) ***Computerization***

Plans are underway to introduce automation and telemetry in eleven (11) of the 42 schemes; completion is expected by this year. Much of the operating and financial information are processed through computers.

(7) ***Customer Base.***

As of December 1997, there were a total of 34,277 direct connections, as follows:

Domestic	30,883	including government quarters
Commercial	1,637	including tourist facilities
Institutional	1,070	
Standpoints	687	

(8) *Tariff Structure.*

The following tables show the recently revised tariffs that are applied to all NWSDB-administered systems nation-wide effective 1 October 1997. Rates for bulk supplies are negotiated separately. In addition, a monthly service charge is levied on all non-domestic connections.

Table 3.9 Water Rate Schedule (Partial) – NWSDB, 1998

Category of Accounts	Consumption. m^3					
	1 - 10	11-20	21-25	26-30	31-40	41-50
Domestic, Gov't Quarters, Schools	25.00 min.	1.80	6.00	12.00	15.00	20.00
Comm'l & Ind'l	Rupees 25.00/ m^3					
Unmetered	Domestic, Rupees 300/month					

Table 3.10 Monthly Service Charges – NWSDB, 1998

Diameter of Connection	Monthly Service Charge
1/2"	50.00 Rupees
3/4"	100.00 Rupees
1" - 2"	200.00 Rupees
2" - 3"	500.00 Rupees
> 3"	1000.00 Rupees

(9) *Operating Highlights*

Revenues and costs for the entire Kandy region are presented and discussed. The data available does not segregate areas covered within the study area and those outside.

1) *Billing and Collection.* Consumers are billed monthly; water bills are paid through selected banks or to the various district and regional offices. The total billing in the Kandy region for 1997 amounted to Rs. 93,016,000; collection was Rs. 90,446,000. Both billing and collection were above the annual target by about 10%.

2) *Arrears from Bulk Supply Accounts.* Two types of connections are provided - bulk and direct. "Bulk" supplies are available for some areas where one organization is made responsible for the water bill based on the bulk meter. Some urban councils, housing authorities, or similar bodies, operate these bulk water supplies. These organizations are responsible for the distribution, billing and collection and maintenance of the subsystem. There are currently nine (9) organizations receiving bulk supplies including urban councils and the University of Peradeniya. A key issue affecting collection per-

formance is the report that more than half of the arrears come from the bulk supplies. Arrears, as of Dec. 1997, are broken down as follows:

Table 3.11 Billing and Collection of Bulk Customers, NWSDB Kandy Region, 1997

1997	Bulk Customers	Direct Customers	Total
Total Billings, Rs.	44,663,821.00	48,358,229.00	93,022,050.00
Total Collections, Rs.	38,781,000.00	51,502,000.00	90,383,000.00
Arrears as of Dec 1997	12,596,159.60	10,302,442.17	22,898,601.77
Avg. Collection Period	*3.38 months*	*2.56 months*	*2.95 months*

Billings for bulk services is nearly half of the total billings; this figure has been steadily rising and will likely surpass direct customer billing in the current year. The bulk customer collection performance, however, lags far behind. The outstanding arrears for bulk accounts is now 55% of the total amount in arrears. Clearly, better management of its bulk accounts and a thorough review of the bulk supply contracts are critical to arrest this alarming trend.

3) *Expense control and budgets.* Expenses are controlled at two levels. Regional support centre level and Kandy District level. Statistics for the Greater Kandy Area do not exist. The costs at the Kandy District level are classified into personnel costs (48.96%), electricity (34.4%), chemicals (9.04%), and so on. All other cost items are less than 3 percent, totaling 7.6 percent. The cost control system is not well developed.
4) *Capital Assets* Capital assets management (financially) is carried out at headquarters level. Regional and District level offices concentrate mainly on operation & maintenance and construction.

(10)***Assessment of Institutional Strengths and Weaknesses***

1) *Staffing.* Current staffing ratio (entire Kandy region) is 17.68 staff per thousand connections. Granting that not all the staff are involved in direct delivery of water services, the current staff ratio may be considered high and should be reduced to about 12, in the immediate-term.
2) *Training.* The NWSDB Kandy region participates in the programs; however, because of budget and staff constraints, training is fast deteriorating. Training capacity for sewerage and sanitation does not exist at either the central or regional level.
3) *Computerization.* Steps will be needed to further integrate the various information subsystems.
4) *Customers.* There are about 20,000 pending applications for service connection on file that have not been acted upon due to the inadequacy of the supply. This is indicative of the urgency of need and demand for improvements.

3.2.3 Independently-Managed Water Systems in Greater Kandy

In an increasing number of towns within the study area, Pradeshiya Sabahs (PS's) and Urban Councils (UC's) have been purchasing water supply in bulk from the NWSDB and managing its distribution to consumers; still others are operating the systems independently of the NWSDB.

(1) At **Wattegama**, the Urban Council independently manages the water system.

1) Customer Base. As of July 1998, the system served 1,058 connections (839 domestic; 208 non-domestic and 1 temple) and 42 unmetered standposts.

2) Organization and Staffing. The office responsible for waterworks operations is a part of the UC. The staff directly involved consists of a Technical Officer, one pipefitter-plumber, and 3 laborers.

3) Tariff Structure. A monthly flat rate of Rs. 50 is charged for all domestic connections; non-domestic connections are charged Rs. 75 for the first 50,000 gallons (or 22.7 m^3). The current practice is to meter non-domestic connections only. The meter is used to determine whether or not the monthly consumption exceeds 50,000 gallons (about 22.7 m^3).

4) Billing and Collection. Between January and June 1998 alone, the waterworks office failed to collect a total of Rs. 255,966.58. Given the minimal operating requirements (gravity system), it is likely that in spite of this very unsatisfactory collection performance, the water utility still manages to generate a cash surplus. Table 3.12 shows the most recent billing and collection data.

Table 3.12 Billing and Collection Data - Wattegama, Jan. – Jun. 1998

Month	Billing	Collection
Jan-98	59,263.50	11,600.00
Feb-98	59,263.50	14,062.00
Mar-98	59,274.00	22,797.50
Apr-98	59,813.50	13,795.00
May-98	59,900.00	16,142.50
Jun-98	61,550.58	24,701.50
	359,065.08	**103,098.50**
	Collection Efficiency:	***29%***

(2) In **Kundasale**, the Pradeshiya Sabha manages the water supply system. The waterworks office buys water in bulk from NWSDB and also operates a small treatment plant (Balagolla) and a production well at Rajawella.

1) Customer Base. As of July 1998, there were 3,970 individual connections (3,588 domestic; 331 non-domestic, and 51 institutional) and 55 metered public standposts. Significantly, the system has 3 major bulk accounts to serve the IDB, Digana Village, and BOI. Both IDB and BOI are industrial estates. The public standposts are metered; bills are settled by the consumer association consisting of about 15 to 20 households per standpost.

2) Tariff Structure. Kundasale has a fairly well-developed tariff structure approved in 1992 which is similar to the MCs. The bulk services to BOI and IDB represent a substantial size of Kundasale's business.

Table 3.13 Water Rate Schedule – Kundasale, 1998

Category of Accounts	Consumption, m^3							
	0-5	6-10	11-15	16-20	21-25	26-10	31-150	>150
Domestic	3.50	4.50	6.00	7.00	8.00	12.00	15.00	500.00
Schools	3.00 per m^3 (with 500.00 deposit)							
Comm'l, Gov't	10.00 per m^3		20.00 per m^3					
Industrial	25.00 (with Rs.2,000 deposit)							
Tourist Hotel	25.00 per m^3 (with Rs.1,500 deposit)							
Standpost	3.00 per m^3 (with Rs.500 deposit)							

3) Billing and Collection Effort. Accounts are maintained by schemes making it useful to assess the difference in unit cost of delivered water between the combined Rajawella-Balagolla systems which are independent of the systems which distribute the bulk supplied water.

The actual expense to KWW to deliver NWSDB-supplied water is 14.16 Rs; however, the actual effective revenue they derive is Rs. 8.15 per m^3 -- an *actual loss of Rs. 6.01* per m^3 *for the NWSDB-supplied water*. Even if KWW can eliminate NRW, the most it will achieve is to reduce their losses to Rs. 4.93 per m^3. Given the current tariff table of KWW which is enforced, the current NRW, the collection efficiency and the consumption pattern of the Kundasale residents, the overall effective revenue derived is Rs.***10.42 per m³***.

4) Organization and Staffing. The billing and collection functions are lodged with the Administrative Branch while a Maintenance Branch handles the technical operations. There are eighty (80) staff deployed for the water system, as follows:

▪ Balagolla Plant	12
▪ Bowser Service	8
▪ Distribution Network	14
▪ Office Staff	4
▪ Laborers	42
Total	80

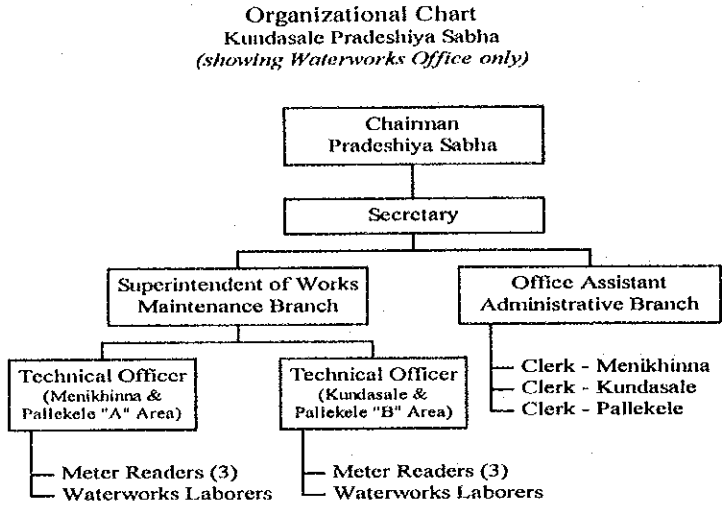


Figure 3.5 Organizational Chart of Kundasale Waterworks Office (KWW)

5) The situation in Kundasale comes about because of deficiencies in the bulk contracts with the NWSDB. The immediate key operational issues for Kundasale are due to the insufficient supply of water from the NWSDB. There was a dramatic drop in volume delivered by the NWSDB from 43,160 cum in January 1998 to 19,461 cum in July 1998 – a 55% reduction in volume delivered. This has caused difficulty in satisfying the demands of the Kundasale residents who have deferred paying for their services. KWW would have immediate benefit from a review of the bulk service contract.

(3) ***General Assessment of Independently-run Systems***

The operating and institutional conditions in Wattegama and Kundasale reflect the general situation of the smaller systems which are managed outside the direct responsibility of the NWSDB.

1) Many of the immediate corrective actions at the PS/UC do not require external financing support. Wattegama is a case in point. With better management and effective collection of water bills, they should be able to raise the funds needed to properly operate, maintain and improve the system on their own. The situation is very similar to the MCs – there are no incentives to improve operational efficiencies. The waterworks office gets its annual budget regardless of collection performance.
2) Since the function of capital improvements continue to reside with the NWSDB, there are very few initiatives by the local authorities to plan out and seek capital financing on their own.
3) The general practice is to remit lump sums to the NWSDB to settle the bills. It is not clear if these payments are proceeds from user charges or an outright appropriation of the PS. The general impression is that remittances of this size had to undergo major

decision-making. It is difficult for this to go on every time a water bill has to be settled. It is suggested that a bank account be set up where all collections are deposited and from which payments to NWSDB can be drawn. A major portion of whatever is collected should be remitted as soon as possible, even weekly.

4) The apparent motivation of the PS's/UC's for preferring bulk arrangements is in effect to subsidize the rates. It is difficult and perhaps presumptive to assume that local leaders are unable to take decisions which may have adverse political implications. However, if the local leaders prefer to take short-term and expedient decisions, they should also be prepared to continue making annual allocations to subsidize operations and maintenance and not expect any dramatic improvements in efficiencies. This situation is ultimately more expensive to its residents.

5) These situations point to a role which NWSDB should play in providing a focussed, systematic and continuing program to provide management and technical assistance and to monitor these independent systems. Effective technical and management advisory services by the NWSDB to the PS's/UC's can readily lead to substantial dividends. These services could point out policy and operating deficiencies and initiate corrective actions.

6) It would also be prudent for NWSDB to make thorough institutional assessments prior to introducing capital improvements with a view towards leveraging the adoption of proper policies and practices before any capital development assistance is provided. The NWSDB's ultimate mandate, after all, is not the construction of systems and facilities, per se, but improved access of people to safe water and wastewater services, i.e., systems which work and are sustainable.

3.2.4 Emerging Policy, Management and Institutional Issues

(1) *General Policy Issues*

1) The NWSDB dominates the sector with a broad set of mandates which ranges from sector policy formulation, project development and construction, operation and maintenance and even regulations (tariff setting, service monitoring, etc). The NWSDB roles as system planner (and implementor), service provider and regulator are starting to conflict with each other. The exercise of regulatory functions is usually vested on a third party to ensure adequacy and fairness of tariffs, compliance with environmental standards, adequacy of service delivery, etc. No one seems to be responsible for independent monitoring to ensure that public utilities for water and sewerage are operating within acceptable standards (water losses, collection efficiency, etc) - and that the people are indeed being served at a fair price.

2) There is a growing fear that in order for capital investments to take place, the NWSDB will take over the systems from local authorities – as was the case in Colombo. These issues are being raised by local officials and should be addressed squarely by the NWSDB.

3) Municipal Councils, Urban Councils, and Pradeshiya Sabhas also share in the responsibility for water and wastewater services within their area of jurisdiction. In Kandy City, the KMC has taken on the operation and maintenance role and the rate-setting function. However, further capital improvements on the system, including major rehabilitation works, are still within the NWSDB role. The NWSDB should continue to review the policies and institutional arrangements, particularly the sharing of responsibilities among the sector agencies, local authorities, user groups, and the private sector. The goal of this review is to ensure that all residents within the Study area have reasonable access to safe water supplies, hygienic sanitation collection, and waste treatment and disposal facilities.

4) *Viability of Sewerage Systems.*

To ensure the financial viability and raise the utilization rate of the new (and proposed) sewerage system, local ordinances requiring commercial and high residential water consumers to connect will be needed to make the sewerage system viable. This can be achieved by a policy decision of the respective Municipal Councils. In addition, a methodology for computing sewerage tariff will have to be formulated based on the cost of operations and other cost recovery policies.

At the Hanthana scheme, for example, the average household water bill comes to about Rs.105 per month. In addition, NWSDB bills the NHDA about Rs.40,000 per month to cover O&M costs for the sewerage services. If these sewerage costs were added on to the water bills (for the 383 Hanthana customers), the sewerage bills would average to Rs.112 per customer -- over 100 percent increase over current service bills. The total service bill per customer would total Rs.215 per month. Being a relatively high-income area, this should not pose a heavy burden to the customers in Hanthana. But this may not be true in other areas.

(2) *Project Implementation Issues*

Conflicts may arise between land use zoning plans and the proposed STP site in Kandy. The involved parties will have to come to an agreement about the construction and operation of a STP in the proposed site. Careful planning of the capital improvement works in water supply is needed in view of the high leakage in the old distribution lines. The interconnection (of the old and the new facilities) should be phased in zone by zone.

(3) Common Financial Issues

1) Arrears from bulk customers is a major cause for concern. This is significant because the current NWSDB policy is towards increased bulk provision in the future. Further studies may be needed to examine the terms and conditions towards bulk supplies to ensure that adequate responsibility and accountability is transferred to the "water distributor" and that NWSDB's financial viability is not undermined.
2) The water tariffs are far below than the level where water production costs are recovered, especially in the water tariffs for domestic users. As a result, capital investment in plant and equipment is assumed to rely not on internal financial sources but on outside aid.
3) NRW is too high.
4) The collection rate is generally too low. Introduction of incentive schemes in water charge collection and outsourcing should be considered.
5) Operational efficiency is low, and financial efficiencies are poor.
6) Water supply accounts are not separated from general administration in municipal council accounting. Water supply accounts needs to be separated and treated like business accounts.
7) Financial reporting systems should be improved.
8) Introduce dual entry bookkeeping system that clearly identifies assets and liabilities. The flow of funds will be easily traced.
9) Introduce cost accounting systems so that the cost of each cost center can be computed.
10) In staff education, financial reporting (dual entry bookkeeping) systems cost accounting system need to be incorporated.

CHAPTER 4 PLANNING FUNDAMENTALS FOR WATER SUPPLY SYSTEM

4.1 Population

4.1.1 Present and Projected Population

A detailed estimate of the 1994 study area population distribution was developed by previous consultants[1]. Although the most recent complete census was carried out in 1981, frequent updates of the census information have been taken up by the Regional Development Division (RDD) of the Ministry of Policy Planning and Implementation. For the Greater Kandy Master Plan population estimate, 1994 RDD data for each Grama Nilidhari falling within the study area was adjusted by comparison with voter registration and housing construction records.

Historical growth rates were derived by comparing the 1981 census information with the estimated 1994 population figures. Projected growth rates were then developed taking into account the relative historical growth rates and physical constraints to growth for each area. More recent population data (1996-1996) were obtained from RDD and a comparison indicated very close agreement with the previous estimates. The population projections developed by the previous consultants have therefore been adopted for the purposes of this study. A summary of total projected study area population is presented in Table 4.1.

Table 4.1 Projected Total Population in Greater Kandy

Area	1997	2000	2005	2010	2015	2020
Kandy Municipal Council	137,400	144,000	153,000	162,000	171,000	181,000
Four Gravets (Part)	56,600	59,000	63,000	68,000	72,000	77,000
Akurana (Part)	44,200	46,000	49,000	53,000	56,000	60,000
Harispattuwa (Part)	69,400	73,000	78,000	83,000	89,000	94,000
Pujapitiya (Part)	45,200	47,000	51,000	54,000	58,000	61,000
Kundasale (Part)	88,400	92,000	99,000	105,000	112,000	119,000
Patha Dumbara (Part)	53,200	55,000	59,000	62,000	66,000	70,000
Patha Hewaheta (Part)	18,400	19,000	20,000	21,000	23,000	24,000
Udunuwara (Part)	70,000	73,000	77,000	82,000	86,000	91,000
Uda Palatha (Part)	3,280	3,400	3,600	3,900	4,100	4,300
Yatinuwara (Part)	58,600	61,000	65,000	69,000	73,000	77,000
Subtotal-Outside KMC	507,280	528,400	564,600	600,900	639,100	683,300
Total	644,680	672,400	717,600	762,900	810,100	864,300

[1] Water Supply Master Plan for Greater Kandy, NWSDB, FINNIDA, 1994

4.1.2 Target Water Supply Service Population

The target service area for the proposed water supply master plan have been identified in the 1994 FINNIDA report as those areas with relatively high population densities (over 1,500 persons per km^2) and high growth and water use rates.

Approximately 30% of the presently served population rely on standposts. Government policy calls for reduction of the standpost service population to 10% by the year 2010. In the Kandy MC service area it appears that the rate of standpost population reduction will be considerably accelerated due to a recent decision by the Municipal Council to retire about 65% of the existing standposts in the near future.

The projected population lying within the target service area boundaries that will be provided with piped water supply under the proposed improvement project is summarized in Table 4.2. The projected composition of the water service population in Greater Kandy (direct connection and standpost service) is illustrated in Figure 4.1.

Table 4.2 Target Water Supply Service Population in Greater Kandy

Area	1997	2000	2005	2010	2015	2020
Kandy Municipal Council	135,000	144,000	153,000	162,000	171,000	181,000
Kandy Four Gravets (Part)	54,400	58,000	62,000	67,000	71,000	77,000
Akurana (Part)	41,600	44,000	48,000	52,000	56,000	60,000
Harispattuwa (Part)	67,000	70,000	76,000	81,000	87,000	92,000
Pujapitiya (Part)	21,600	24,000	26,000	28,000	30,000	32,000
Kundasale (Part)	83,820	87,300	93,800	99,500	106,000	113,000
Patha Dumbara (Part)	41,460	42,900	46,000	48,400	51,600	54,700
Patha Hewaheta (Part)	8,360	8,600	9,400	10,600	12,000	14,000
Udunawara, Yatinuwara & Udu Palatha	91,080	95,400	101,600	110,900	119,000	126,200
Subtotal-Outside KMC	409,320	430,200	462,800	497,400	532,600	568,900
Total	544,320	574,200	615,800	659,400	703,600	749,900

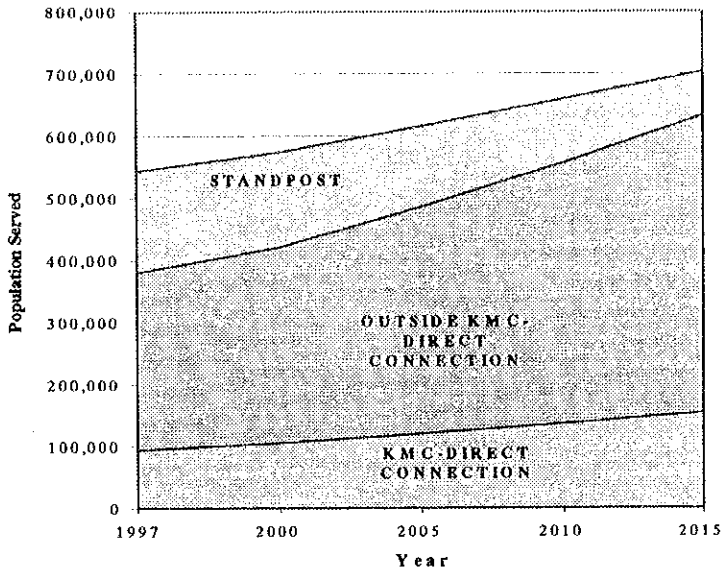


Figure 4.1 Water Supply Service Population in Greater Kandy

4.2 Design Quantities

4.2.1 Non-revenue Water

Billed water quantities for the Kandy MC system for 1997 indicated an average water use of 18,335 m^3/d, while the total water production was 31,641 m^3/d. This results in non-revenue water of 42% of the total production. The 1994 FINNIDA report, which was based on 1993 records, indicated that non-revenue water at that time was 45%. This 3% decrease represents a welcome although modest improvement within a four year period.

Non-revenue water figures for areas outside of the KMC vary from 18% to 70%. The better managed systems have an average NRW of 28%, while the average for the less well managed systems average almost 48%.

Present levels of non-revenue water are unacceptably high and reduction to a more reasonable figure, say 25%, should be given the highest possible priority in any water system improvement project. The water demand projections in the FINNIDA report assumed that non-revenue water would be constant over the planning horizon at 38% of total production.

A major modification was made to the FINNIDA demand projection to reflect the design philosophy of the present study. It was assumed that NRW would be reduced from its' present level of 42% to 25% by 2015. Given the high cost of the proposed new water sources, it would be prudent to reduce overall demand with a vigorous NRW reduction program, in con-

cert with the development of new sources of supply. The impact of this modification on projected demand is substantial, as shown in Table 4.3.

Table 4.3 Comparison of Projected Water Demand for Greater Kandy

Year	Population Served	FINNIDA Demand including NRW (m^3/d)	Revised Demand including NRW (m^3/d)
1997	544,320	113,190	110,041
2000	574,200	125,250	119,474
2005	615,800	139,700	122,856
2010	659,400	157,950	133,365
2015	703,600	175,900	141,647
2020	749,900	192,500	159,730

It is recognized that reduction of non-revenue water, particularly in an older system, can be a lengthy and difficult process and it is not possible to estimate when during the planning period savings from a non-revenue water reduction program will actually occur. The potential savings from reducing the current high levels of non-revenue water represent, in effect, a new water source equal to 17% of the total demand. Reduction of non-revenue water should be considered as a potentially inexpensive alternative water source whenever the development of new sources are being contemplated.

4.2.2 Unit Water Use

Approximately 30% of the presently served population both in KMC and outside of KMC rely on standposts. Allowing for the standpost service population, the average supply in the study area is as follows:

Kandy Municipal Council	206 lpcd
Outside of KMC	181 lpcd
Greater Kandy Average	195 lpcd

Although the unit supply rates inside and outside of the KMC are within 10 % of each other, they are the result of two very different service connection policies. KMC policy has been to provide connections to all applicants irregardless of the supply situation, while NWSDB has pursued a policy of denying new connections where supplies were judged to be inadequate. The result of these differing policies has been that KMC currently has very few outstanding applications for service connections, while NWSDB has a backlog of about 20,000 applica-

tions. This implies that the difference between supply and actual demand in the present KMC service area is greater that indicated by the average unit supply figure noted above. Unit water demand rates used to estimate future demand have therefore been adjusted to take this difference in service connection policy into account (see Table 4.4). Because of the different assumptions regarding NRW, the projected per capita rates used for the current study are substantially lower than those used in the FINNIDA report (see Table 4.5).

Table 4.4 Per Capita Water Demand Rates in Greater Kandy

KMC (lpcd)	1997	2000	2005	2010	2015
Domestic	99	101	108	115	121
Non-domestic	55	58	61	65	69
NRW	112	115	95	81	63
Total	266	274	264	261	253
Outside KMC (lpcd)					
Domestic	76	78	82	90	98
Non-domestic	29	30	32	36	41
NRW	76	78	64	57	46
Total	181	186	178	183	185
Greater Kandy (lpcd)					
Domestic	82	85	89	96	104
Non-domestic	35	37	39	43	48
NRW	85	88	72	62	50
Total	202	210	200	201	202
NRW %	42	42	36	31	25

Table 4.5 Comparison of Per Capita Water Demand Rates for Greater Kandy

Unit Water Demand (lpcd)		
Year	FINNIDA	Revised
1997	208	202
2000	218	210
2005	227	200
2010	240	201
2015	250	203

As can be seen from Table 4.5, unit water demand rates for domestic and non-domestic use have been projected to increase substantially over the planning period (22 to 41%). At the same time, NRW rates are expected to decrease by over 40%, resulting in a leveling out of total unit demand rates over the planning period.

4.2.3 Projected Water Demand

Projected water demand for the study area is summarized in Table 4.6 and illustrated in Figure 4.2.

Table 4.6 Projected Water Demand in Greater Kandy

KMC Demand (m^3/d)	1997	2000	2005	2010	2015
Domestic	13,365	14,570	16,500	18,610	20,730
Non-domestic	7,425	8,352	9,333	10,530	11,799
NRW	15,120	16,560	14,535	13,122	10,773
Total	35,910	39,482	40,392	42,282	43,263
Outside KMC Demand (m^3/d)					
Domestic	31,306	33,556	38,156	44,766	52,253
Non-domestic	11,717	12,906	14,689	17,965	21,631
NRW	31,108	33,556	29,619	28,352	24,500
Total	74,131	80,018	82,464	91,083	98,384
Total Greater Kandy Demand (m^3/d)					
Domestic	44,671	48,100	54,680	63,396	72,944
Non-domestic	19,142	21,258	24,022	28,495	33,430
NRW	46,228	50,116	44,154	41,474	35,273
Total	110,041	119,474	122,856	133,365	141,647

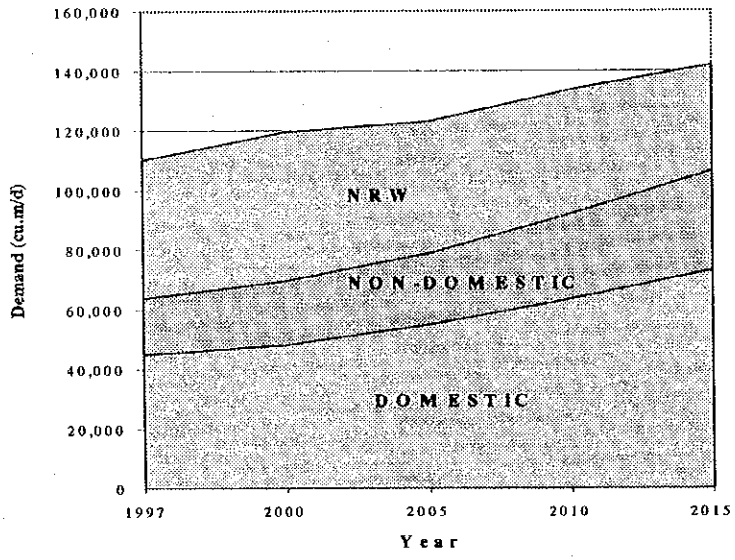


Figure 4.2 Projected Water Demand in Greater Kandy

CHAPTER 5 WATER SUPPLY SYSTEM LONG-TERM DEVELOPMENT PLAN

5.1 Policy for Planning

The long-term development plan for the Greater Kandy Area was developed under the following planning policies:

- The plan covers such facilities from water intake up to distribution reservoirs to meet with the design capacity in target year 2015, while physical planning of distribution pipelines is excluded due to insufficiency/limited availability of required data, as out of scope in this Study. Costs required for new distribution pipelines connecting new reservoirs and the existing distribution network are estimated at some extent.
- Continuous water supply through the day shall be assured even in dry season so that the consumers can avail of satisfactory water supply service.
- The existing water sources shall be used continuously through the future, unless a significant problem arises.
- New water supply system shall be connected with the existing system in order to minimize the project cost for transmission/distribution system.

5.2 Conditions for Facility Planning

5.2.1 Water Source

(1) Conditions of existing water sources

Topographic conditions of Kandy municipality and its surrounding area are mostly continuous steep small mountains with shallow bedrock, and flat lands are seen in the limited areas.

The existing water supply system is utilizing both groundwater and surface water (the Mahaweli River and its tributaries), with their total capacity of about 58,000 m^3/day, excluding the on-going Hulu Ganga and Talatu Oya scheme. The source capacity ranges from large scale surface water with a complete water treatment (33,400 m^3/day of the Kandy Municipal Council treatment facility on the Mahaweli River) to small scale groundwater extraction schemes (hundreds to 2,000 m^3/day) and to even much smaller spring sources with limited water treatment.

Tributaries of the Mahaweli River have remarkable decrease of river flow during the dry

season causing limited intake amount through the year. The Mahaweli River has also same seasonal change of flow rate, especially in drought season and shows shifting of streamline by season resulting interference to water intake. Major existing water supply systems utilizing surface water are shown below.

Table 5.1 Existing Water Sources of Surface Water

Name of Water Supply System	Name of River for Water Intake	Intake Amount (Water Supply Volume)
KMC	Mahaweli Ganga	33,400 m^3/day
Kalugamuwa	Nillambe Oya	11,500 m^3/day (9,000 m^3/day to GK)
Kundasale (on-going)	Hulu Ganga	13,000 m^3/day
Udu/Yatinuwara	Mahaweli Ganga	4,600 m^3/day
Pallekele (CECB)	Mahaweli Ganga	2,000 m^3/day
Polgolla	Mahaweli Ganga	1,500 m^3/day

In the remote area, groundwater is an important water source, although the supplied amount is insufficient to meet with the water demand. Most of existing wells, extracting groundwater from aquifers above the bedrock layer, have been encountering problems, such as decrease of yield, deterioration of water quality, mismatching of well design/pump specifications with hydrogeological conditions, and over pumping beyond safe yield.

It is recommended that several smaller water schemes that produce poor quality of water or an excessively expensive to operate shall be abandoned after 2005. The existing supplies that will continue operation after 2005 have a capacity of 65,960 m^3/d including the as yet unfinished Hulu Ganga and Talatu Oya projects, and 65,040 m^3/d for the target years 2015.

(2) Study on new water source

Water sources to be developed for augmentation of supply capacity is the balance between demand in the target year and existing water sources to be used continuously. It was calculated at 104,940 m^3/d as shown in Table 5.2.

Table 5.2 Required Water Source Development

Description		Calculation	Adopted
Maximum Daily Demand in 2015 (120% of daily average demand)	(a)	169,980 m^3/day	–
Existing Source to be Used Continuously	(b)	65,040 m^3/day	–
Required Development	(a-b)	104,940 m^3/day	110,000 m^3/day

Taking account of the above mentioned locality of groundwater characteristics, the groundwater development is deemed suitable as one of measures for small scale water supply system, but not applicable for wide-area water supply system covering Greater Kandy area.

Considering the magnitude of water demand at 110,000 m^3/day, the target source of surface water is focused on the Mahaweli River. In utilization of its surface water, an assurance of continuous water intake even in drought season is prerequisite. FINNIDA report mentioned that 180,000 m^3/day, as weekly average intake amount from the Mahaweli River, is possible even during the drought season.

Daily flow rate data were collected and reviewed for the period of 11 years (1987-1997) from the Department of Irrigation and Water Management Secretariat of Mahaweli Authority. In order to attain reliability of water source evaluation, WMSMA data being deemed dependable are primarily referred to. Actual intake amount will be about 160,000 m^3/day including new Water Treatment Plant, the existing KMC Water Treatment Plant and the Kalugamuwa Water Treatment Plant (which was not operated during the field survey period). Based on the past performance evaluation, sufficient intake amount could be secured during past years, except for 1992. It shall be noted, however, that abnormal drought year may cause restriction of supply amount and therefore the existing groundwater sources shall be retained for their effective utilization. NWSDB, the executing agency of the water supply project, has secured water right from the Mahaweli Authority for utilization of 180,000 m^3/day from the Mahaweli River.

For groundwater development, the Study mainly focused on potentiality in Greater Kandy area and did not cover identification of possible yield at individual sites due to constraint on time and available data including test well boring. In the long-term plan, therefore, any groundwater development plan except several existing groundwater sources is not planned to avoid vagueness of availability. However, survey and investigation on groundwater development are deemed indispensable to secure stable water source both in quantity- and quality-wise, which may be located in shear zones running through the area.

Through above mentioned water source evaluation, the new water source was determined to be surface water of the Mahaweli River.

5.2.2 Location for Water Intake and Water Treatment Plant

(1) Location of Intake Facility

The Mahaweli River is flowing with the shape of arc from southwest to southeast passing along northern boundary of KMC, large water demand area. At the southwest of KMC, there is an intake facility of major existing water treatment plant of KMC, while at the northeast, there is the Polgolla Dam being utilized for irrigation and power generation and flow rate is drastically decreased at downstream.

The new intake point is located in the upper stream to minimize total pumping head and to attain economical performance.

There is a solid waste dumping site on the left bank of the river, which is opposite side of the northwest part of KMC, which is about 600 m upstream from the proposed site of water treatment plant. The location of new intake facility is selected at 400 m upstream of said dumping site, so as to avoid water pollution by leachete from the dumping site flowing into the river.

(2) Location of Water Treatment Plant

The proposed water treatment plant (110,000 m^3/day) requires about four to five ha of land area. Due to scarcity of unused plain land near the demand center of the Study area and distance from the proposed intake site, the location of the new water treatment plant is subsequently restricted. The proposed treatment plant is therefore located at the paddy field in Kondadeniya nearby the Mahaweli River. This site has gentle slope with sufficient area.

5.2.3 Water Treatment Facility Design Criteria

(1) Peak Factor for Maximum Day Demand

The maximum day demand is generally computed to conducting "Peak Factor" which is defined as the ratio of the maximum day demand to the average day demand.

Due to absence of actual consumption data in Kandy area, the Kalu Ganga Water Supply Study (Nov. 1994, JICA) and past performance data in other countries are referred to. The recommendable peak factor is then calculated to be about 1.2.

(2) Design Capacity

For determination of design capacity of the treatment facilities, water use in the treatment process and unpredictable losses were estimated at 5 percent of the nominal treatment capacity, based on the experiences of other treatment plants.

(3) Treated Water Quality

Treatment at the new water treatment plant should be planned to satisfy the drinking water quality standards of Sri Lanka.

5.2.4 Transmission and Distribution Facility

(1) General

Friction Formula used in the design of pipelines: Hazen-Williams Formula

Maximum flow rate 3.0 m/sec

Optimum pipe diameters are employed taking account of capital and O&M costs for both pipeline and pumping facility.

(2) Transmission

Pipe Material: Ductile iron pipe (DIP) for diameter 250 mm or larger
Unplasticized polyvinyl chloride (uPVC) pipe for dia. less than 250 mm

Internal lining: Cement mortar lining (DIP)

Peak Factor: 1.2 (times of daily average demand)

(3) Distribution reservoir

Storage capacity of reservoir: more than 6 hours of the maximum daily average demand

5.3 Considerations for Optimum System

5.3.1 Number of Water Treatment Plants

The Kundasale project was commenced by NWSDB after the FINNIDA study. In the project, a new plant with a supply capacity of 13,000 m^3/d will be constructed to serve the area located north of Mahaweli River in the eastern zone.

In addition, the site for new Katugastota plant in FINNIDA M/P was cancelled due to difficulty of land acquisition. Thus, new candidates site for the treatment plant (hereinafter

referred to as "the Katugastota plant") was found at 3.5 km west of the former site.

Because of above mentioned change of basic conditions for the examination assumed in the FINNIDA M/P, need of re-examination was raised and a new arrangement of service zones was examined. In the re-examination of the system, two alternatives were prepared in terms of allocation of required treatment capacity. Alternative 1 is a two-plants system plan consisting of the existing KMC and new Katugastota plants, and Alternative 2 is a three-plants system plan consisting of the existing KMC, new Kandy and new Katugastota plants.

Taking account of characteristics for each aspect, especially costs and O&M, Alternative 1 was recommended, as shown in Table 5.3.

Table 5.3 Comparison of Integrated and Separate Supply Systems

Description	Alternative 1 Two Plants Plan	Alternative 2 Three Plants Plan
Treatment Plant	110,000 m^3/d - New Katugastota Plant (33,400 m^3/d - Existing Kandy Plant)	20,000 m^3/d - New Kandy Plant 90,000 m^3/d - New Katugastota Plant (33,400 m^3/d - Existing Kandy Plant)
Number of Facilities, O&M (for new facility)	- Intake facility 2, - Treatment plant 2. Advantageous	- Intake facility 3, - Treatment Plant 3 Disadvantageous
Required Site Area	- about 4.4 ha (for new WTP)	- about 1.8 ha + 3.9 ha (for new WTP)
Present Land Use of the Site	- New Katugastota plant Paddy Field. Free from flooding.	- New Kandy plant Paddy field. Vicinity of future governmental administrative complex. Along the river and fear of flooding. Require 2.5m high earth-filling. - New Katugastota plant Same to Alternative 1
Intake and Raw Water Conveyance	- New Katugastota plant 2.2 km long conveyance to avoid contamination from the garbage dumping site. From impoundment of the Polgolla Dam. Stable water level except 5 year interval 1 month long maintenance period.	- New Kandy plant Existing KMC plant intake tower can be utilized. But, weir for intake during low water level period is necessary. - New Katugastota plant Same to Alternative 1
Transmission	- Longer transmission line to Kandy Four Gravets.	- Each plant locates near the center of respective service zone.
Direct Construction Cost (Million Rs.)	6,618	7,504
O & M Cost (Mil. Rs. per Year)	230	245

5.3.2 Type of Intake Facility

Fluctuation of water level in the Mahaweli River at this location is being caused by the Polgolla Dam ranging from 438.9 m amsl (above mean sea level) to 440.7 m amsl except during the period of maintenance work of the dam and the diversion conduit. Water in the Polgolla Dam impoundment is drained for one month once every five years for the said maintenance purposes. Structure of the intake facilities is decided taking account of the low water level caused by the maintenance work (riverbed 446m amsl) and high flood level (446.4 m amsl).

The proposed intake point has regular depth of about 2 m by damming by the Polgolla Dam. The intake facility is designed as an open inlet taking into advantageous conditions that the river flow has straight streamline and riverbed is mostly flat. The bottom slab of intake facility is designed at 2 m lower than the present riverbed, which is assumed to be the original height of riverbed before accumulation of sediments.

The study area has meteorological characteristics having high rainfall intensity in a short period and river flow is rapid enough to flush out sand and mud. It seems that the turbidity of the Mahaweli River has increased to more than 1,000. Raw water turbidity after sedimentation at the existing KMC plant is around 10 in the dry season and about 40 to 50 in the rainy season. However, it increases to more than 100 at a frequency of about 10 times a year, sometimes reaching a maximum near 300. In order to protect intake pump and to prevent inflow of sand and mud into conveyance pipeline, grit chamber should be planned just after the intake facility. Though the dam impoundment itself acts as a grit chamber when normal operational water level of the dam is maintained, silt and sand may flow into the intake facility when water level drops during said maintenance period.

By application of grit chamber, worn-out of intake pump will not occur. Thus, normal type pump is considered for water intake. One-staged pumping facility can send raw water to the new Katugastota water treatment plant, unlike two-staged pumping at the existing KMC water treatment plant.

Alternative intake methods, such as intake tower, intake weir and infiltration gallery, were also studied, but not adopted in this plan.

Silt and sand accumulated at water intake and intake conduit will be removed by a bulldozer when streamline needs to be cleaned. If silt and sand accumulate rapidly, sand pump will be

applied for removal. Accumulated silt and sand in grit chamber shall be removed manually by emptying one of two chambers or by means of sand pump.

5.3.3 Type of Treatment Facility

Because of high turbidity, the coagulation-sedimentation and rapid sand filtration method is applied for the Katugastota treatment plant, as same as the existing Kandy plant. The available site area is about 6.3 ha in total. Required area for the plant is about 3.2 ha excluding the area needed for the backwash water treatment facilities. The site is located above the high river water level and will not be flooded.

Water quality examination of the Mahaweli river shows contamination to some extent by non-treated wastewater discharges from human activities, such as Free-NH_3, NO_2, Total Coliform, and E. Coli. As mentioned above, raw water turbidity increases to several hundred or more than 1,000 in a short period with a wide range variation. The existing KMC plant uses the Pulsator type system developed by a French manufacturer. However, it is not functioning well, because the upward flow and temperature increase caused by sunlight. They raise the flock layer and coagulated flock flows out from the outlet troughs. In the study, the horizontal flow sedimentation tank is recommended because it is easier to adjust for fluctuation of turbidity and water temperature allowing a relatively easy operation.

5.4 Phasing of Project Implementation

The water supply condition in the study area is different in respective water supply scheme. The KMC system shows rather good performance, while other local schemes show worse performance. On the other hand, funding requirement for the implementation of the whole project is deemed to be too large for both local financial source and foreign lending agencies. In this regard, it is recommend to adopt staged implementation of the project. In this respect, phasing of construction plan for the long-term development and the prioritization are prepared.

5.4.1 Phased Development Plan

Water demand and shortage of supply capacity in target years are estimated under the daily maximum basis as shown in Table 5.4.

Table 5.4 Water Demand and Shortage of Supply Capacity

Unit: m^3/day

Category	2005	2015
Water Demand	147,430	169,980
Supply Capacity	65,960	65,040
Shortage of Supply Capacity	81,470	104,940

Based on the above computation, the total design capacity of the proposed Katugastota Water Treatment Plant was decided to be 110,000 m^3/day.

Taking into account of the magnitude of fund requirement and allocated 15 years of project period, it would be appropriate to divide the project period into three phases. It is also recommended that the total capacity of proposed Katugastota water treatment plant should be also divided into three phases. The capacity to be augmented in each phase was equalized to make the investment size uniformly.

In order to construct the total development capacity in three phases, a development capacity in each phase is recommended to be 1/3 of 110,000 m^3/day or 36,670 m^3/day. The water supply capacity of the new treatment plant will be augmented every five years with 1/3 of total capacity. In the second phase another 1/3 of the required development capacity shall be constructed by the year 2010 and the remaining 1/3 shall be constructed by the year 2015. Figure 5.1 shows the relationship between water demand and supply capacity of the system.

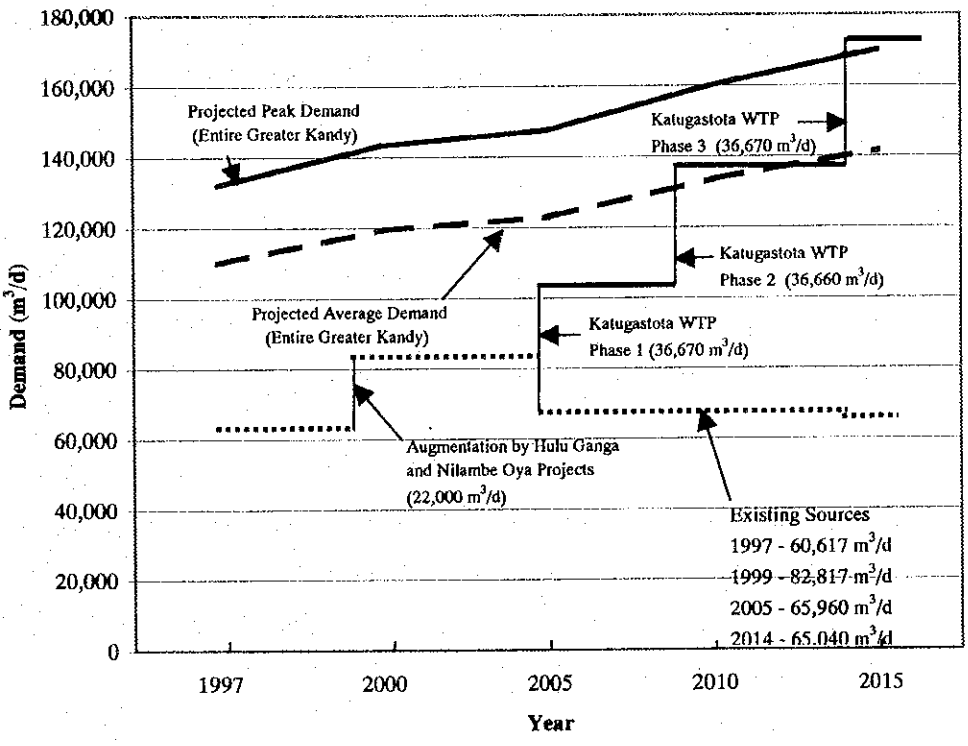


Figure 5.1 Greater Kandy Water Demand vs. Supply Capacity

Shortage of water supply to the total water demand in 2005 is 44,800 m^3/d for daily maximum demand or 20,270 m^3/d for daily average demand. However, this shortage will be gradually decreased along with progress of project. In the year 2015, after completion of the project, supply capacity will exceed the water demand.

5.4.2 Priority of Service Areas

The proposed Katugastota water treatment plant will supply 36,670 m^3/day as the first phase project, however it is not sufficient to fulfill the water demand of the whole Greater Kandy. The capital cost for development of transmission and distribution system is also limited. Hence, phased construction program shall be applied not only for treatment plant, but also transmission and distribution system. The pipelines and reservoirs shall be developed to cope with treated water quantity. Because of this reason, needs of prioritization of service area arise.

The study team conducted a survey for current water supply conditions such as duration of water interruption. Surveyed area covers 11 districts including KMC and the fringe areas. KMC, Udunuwara, and Yatinuwara areas enjoy water supply approximately 20 hours a day, while other eight areas are only 12 hours a day or less. In qualitative analysis taking account of the population and water supply hours, KMC, Harispattuwa, and Kundasale are suffering from lack of water supply. KMC, Kandy Four Gravets, Harispattuwa, and Kundasale are ranked at "A" and Akurana and Patha Dumbura are ranked at "B", respectively. Detailed priority area is selected.

KMC has an existing water treatment plant (33,400 m^3/day) taking raw water from Mahaweli River. This plant is currently forced to supply water to the surrounded area, due to insufficient treatment capacity. KMC is categorized to be the highest priority area because it is highly urbanized and has the largest number of population with a 25% of a total population in the study area.

Kandy Four Gravets is located adjacent to KMC being developed as a bed-town of KMC with increasing population. The water supply is dependent on small-scaled surface water supply system which suffers water shortage in dry season. Kandy Four Gravets is categorized to be high priority area.

Harispattuwa is developing as a bed-town of KMC and increasing its population same as Kandy Four Gravets. Water is supplied by Gohagoda, Kondadeniya, and Kulugamana water supply systems. Kondadeniya and Kulugamana, still suffering from lack of water supply, are prioritized.

A part of Kundasale is at present supplied by the water supply systems of Pallekele, Menikhina, etc. A water supply expansion project has been planned to take raw water from Hulu Ganga River. The project aims at covering most of entire area of northern part of Mahaweli River by the year 1999, although the project implementation schedule is delayed now. Therefore, priority of Kundasale is not so high. On the other hand, southern part of Mahaweli River, Ampitiya and Muluphilla, where KMC water supply system formerly covered and presently it is quitted due to lack of water, is still kept in high priority area

Akurana is ranked at B. However, main water supply systems, Kahawatta and Kurugoda, which withdraw groundwater, suffered with decrease of pumpage due to increasing drawdown of groundwater. Thus, Akurana should be highly prioritized.

Although Patha Dumbara is ranked at B, they may not have stable groundwater. Katugastota is developing as commercial area and Kahalla, Balanagala, Bangalawatta, and Pihilladeniya are to be developed as residential area. Among them, Kahalla and Balanagala suffered with water shortage. Therefore, Patha Dumbara is prioritized.

An increased water demand of 36,400 m^3/d in 2005 shall be supplied from the proposed Katugastota water treatment plant. Necessary transmission pumps, transmission pipelines and distribution reservoirs shall also be provided by the year 2005.

5.5 Preliminary Design of Facilities

Proposed facilities in the study are presented in Table 5.5. Although phased implementation is planned, there are facilities to be constructed in phases, to be constructed fully in initial stage, or being difficult to be constructed in phases. The Development Plan of the Greater Kandy Water Supply System and the Layout Plan of the new treatment plant are presented in Figures 5.2 and 5.3 respectively.

Table 5.5 Construction Plan of Facilities

Phase				Phase 1	Phase 2	Phase 3	Total
Service Area	Including Service Area in Existing WTP (KMC, Kaluganuwa, Kundasale)			Study Area except for a part of Pujapitaya, a part of Yatinuwara	Study Area except for a part of Pujapitaya	Entire Study Area	Figures in each phase show the total figure at the end of each phase.
Demand for Proposed WTP	Average Daily Water Demand		m^3/d	30,560	61,100	87,450	
	Maximum Daily Water Demand		m^3/d	36,670	73,330	104,940	
Intake Facility	Location			Gohagoda			
	Capacity		m^3/d	38,500	77,000	115,000	
	Facility			Intake Mouth, Grit Chamber, Elec../Mech. Equipment			
Conveyance Facility	Capacity		m^3/d	38,500	77,000	115,000	
	Conveyance Pipe	DI ϕ 800~900 (partly parallel)	m	Pressurized 600 Gravity 1,600 (800mm)	Pressurized 600 (900mm)	-	
Treatment Facility	Location			Katugastota			
	Treatment Capacity		m^3/d	38,500	77,000	115,000	
	Nominal Capacity		m^3/d	36,670	73,330	110,000	
	Treatment Method			Coagulation-Sedimentation-rapid Filter			
	Facility			Receiving Well, Sedimentation Basin, Rapid Sand Filter, Clear Water Reservoir, Wastewater Storage Tank, Sludge Lagoon, Chemical Dosing Equip., Elec./Mech. Equip., Buildings			
Transmission Facility	Capacity		m^3/d	36,100	73,300	108,600	(Total)
	Transmission Pipe	PVC ϕ 75~225	m	23,745	26,610	52,050	102,405
		DIP ϕ 250~900	m	18,400	30,289	37,795	86,484
	Transmission Pump		Stn.	9	9	15	33
Distribution Facility	Reservoir		No.	20	12	27	59
	Distribution Pipe		L.S.	1	1	1	1