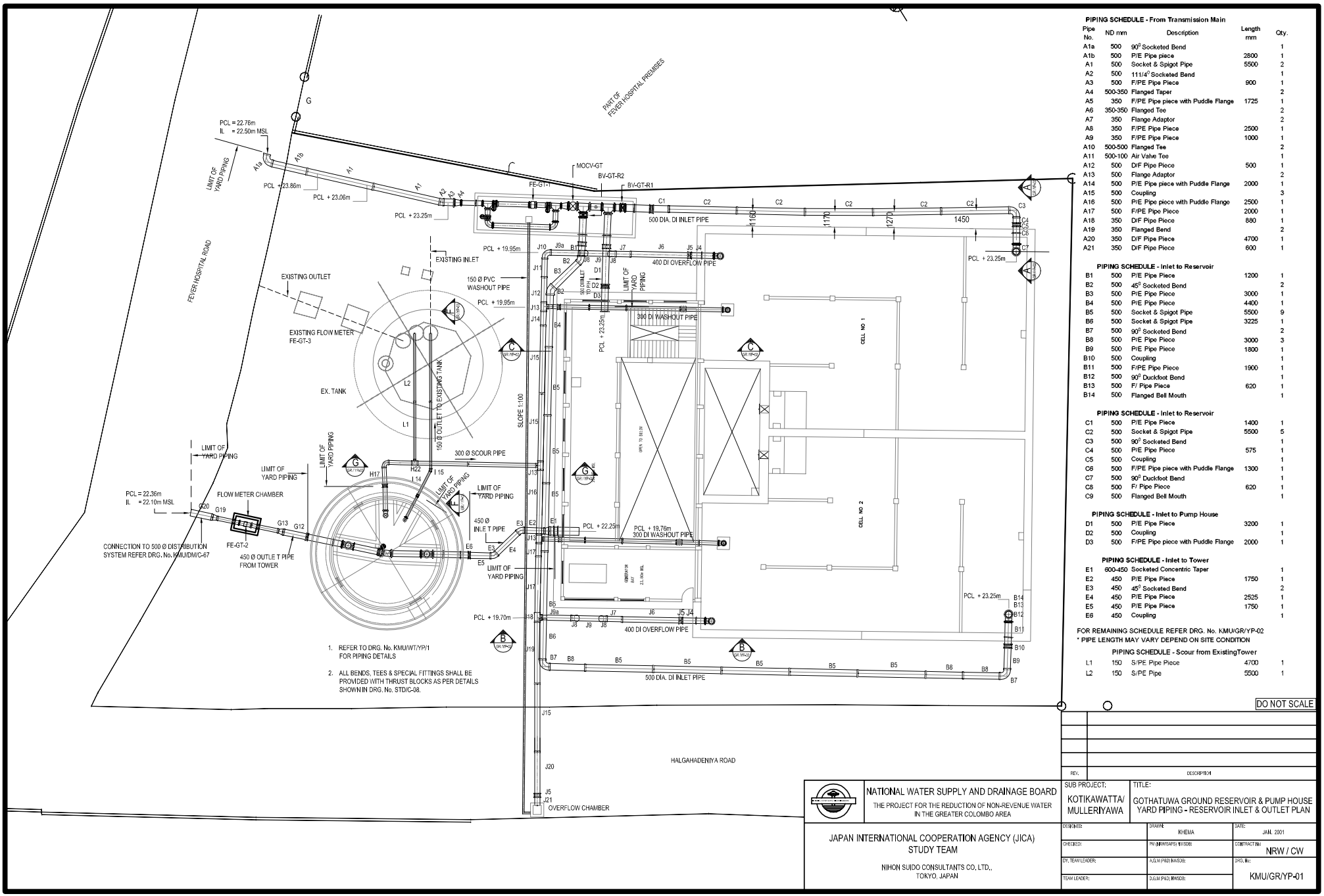


PIPING SCHEDULE - From Transmission Main

Pipe No.	ND mm	Description	Length mm	Qty.
A1a	500	90° Socketed Bend		1
A1b	500	P/E Pipe piece	2800	1
A1	500	Socket & Spigot Pipe	5500	2
A2	500	11¼° Socketed Bend		1
A3	500	F/PE Pipe Piece	900	1
A4	500-350	Flanged Taper		2
A5	350	F/PE Pipe piece with Puddle Flange	1725	1
A6	350-350	Flanged Tee		2
A7	350	Flange Adaptor		2
A8	350	F/PE Pipe Piece	2500	1
A9	350	F/PE Pipe Piece	1000	1
A10	500-500	Flanged Tee		2
A11	500-100	Air Valve Tee		1
A12	500	D/F Pipe Piece	500	1
A13	500	Flange Adaptor		2
A14	500	P/E Pipe piece with Puddle Flange	2000	1
A15	500	Coupling		3
A16	500	P/E Pipe piece with Puddle Flange	2500	1
A17	500	F/PE Pipe Piece	2000	1
A18	350	D/F Pipe Piece	880	1
A19	350	Flanged Bend		2
A20	350	D/F Pipe Piece	4700	1
A21	350	D/F Pipe Piece	600	1

PIPING SCHEDULE - Inlet to Reservoir

B1	500	P/E Pipe Piece	1200	1
B2	500	45° Socketed Bend		2
B3	500	P/E Pipe Piece	3000	1
B4	500	P/E Pipe Piece	4400	1
B5	500	Socket & Spigot Pipe	5500	9
B6	500	Socket & Spigot Pipe	3225	1
B7	500	90° Socketed Bend		2
B8	500	P/E Pipe Piece	3000	3
B9	500	P/E Pipe Piece	1800	1
B10	500	Coupling		1
B11	500	F/PE Pipe Piece	1900	1
B12	500	90° Duckfoot Bend		1
B13	500	F/ Pipe Piece	620	1
B14	500	Flanged Bell Mouth		1

PIPING SCHEDULE - Inlet to Reservoir

C1	500	P/E Pipe Piece	1400	1
C2	500	Socket & Spigot Pipe	5500	5
C3	500	90° Socketed Bend		1
C4	500	P/E Pipe Piece	575	1
C5	500	Coupling		1
C6	500	F/PE Pipe piece with Puddle Flange	1300	1
C7	500	90° Duckfoot Bend		1
C8	500	F/ Pipe Piece	620	1
C9	500	Flanged Bell Mouth		1

PIPING SCHEDULE - Inlet to Pump House

D1	500	P/E Pipe Piece	3200	1
D2	500	Coupling		1
D3	500	F/PE Pipe piece with Puddle Flange	2000	1

PIPING SCHEDULE - Inlet to Tower

E1	600-450	Socketed Concentric Taper		1
E2	450	P/E Pipe Piece	1750	1
E3	450	45° Socketed Bend		2
E4	450	P/E Pipe Piece	2525	1
E5	450	P/E Pipe Piece	1750	1
E6	450	Coupling		1

FOR REMAINING SCHEDULE REFER DRG. No. KMU/GR/YP-02
* PIPE LENGTH MAY VARY DEPEND ON SITE CONDITION

PIPING SCHEDULE - Scour from ExistingTower

L1	150	S/PE Pipe Piece	4700	1
L2	150	S/PE Pipe	5500	1

DO NOT SCALE

REV.	DESCRIPTION

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

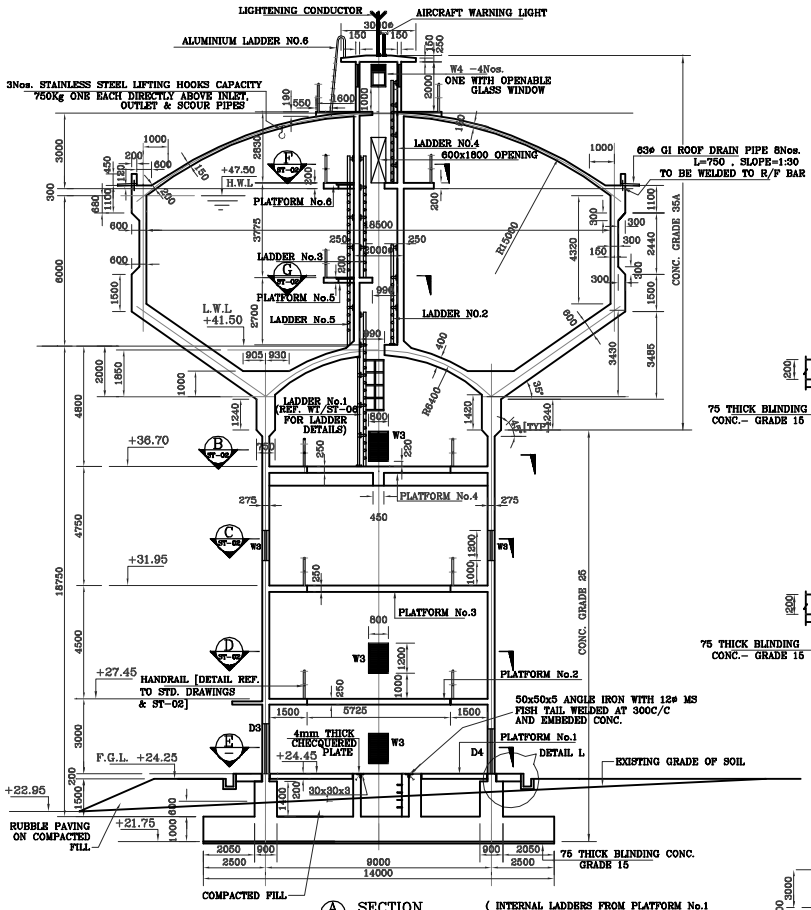
SUB PROJECT: KOTIKAWATTA/ MULLERIYAWA

TITLE: GOTHATUWA GROUND RESERVOIR & PUMP HOUSE YARD PIPING - RESERVOIR INLET & OUTLET PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM

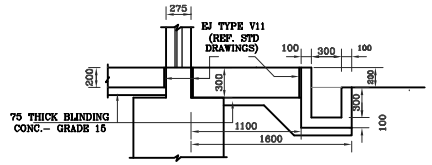
NIHON SUIDO CONSULTANTS CO., LTD.,
TOKYO, JAPAN

DESIGNED:	DRAWN: KHEMA	DATE: JAN. 2001
CHECKED:	PM (NWS&DB) NWSDB:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D) NWSDB:	DRG. No.: KMU/GR/YP-01
TEAM LEADER:	D.G.M (P&D) NWSDB:	

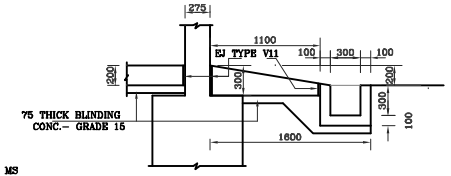


A SECTION
[SCALE:- 1:100]

(INTERNAL LADDERS FROM PLATFORM No.1 TO PLATFORM No.4 ARE NOT SHOWN FOR CLARITY)



DETAIL L
[SCALE:- 1:25]



DETAIL X
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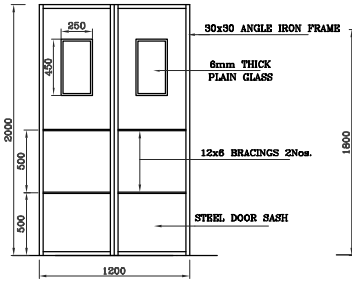
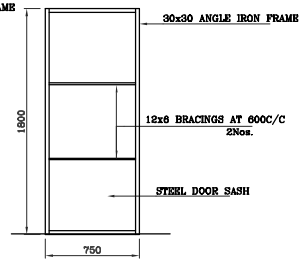


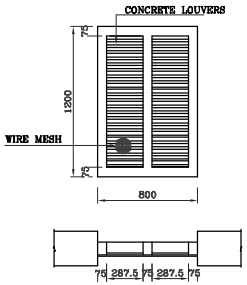
D3 - 1No.

(D3) -1200x2000 STEEL DOOR
3 Nos. STEEL HINGES [TO BE FABRICATED AS RICOURED]
1 No. MORTICE LOCK
2 Nos. TOWER BOLTS



D4 - 1No.

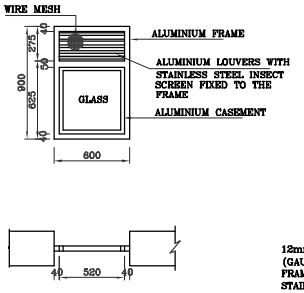
(D4) -750x1800 STEEL DOOR
3 Nos. STEEL HINGES [TO BE FABRICATED AS RICOURED]
1 No. MORTICE LOCK
1 No. TOWER BOLTS



W3 - 8Nos.

(W3) -800x1200

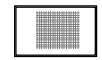
CONCRETE WINDOW WITH FIXED CONCRETE LOUVERS WITH STAINLESS STEEL WIRE [BSW GAUGE 16] 12x12 MESH OUTER FACE.



W4 - 4Nos.

(W4) -600x900

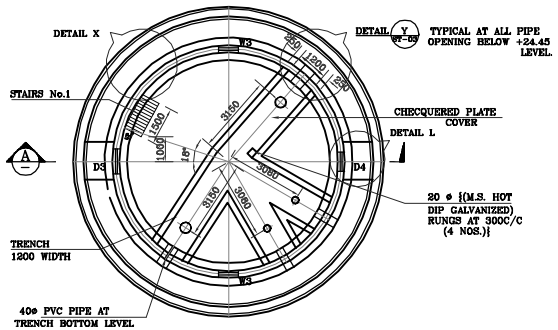
GLAZED ALUMINIUM WINDOW WITH FIXED ALUMINIUM LOUVERS & STAINLESS STEEL WIRE [BSW GAUGE 16] 12x12 MESH ABOVE OUTER FACE. OPERNABLE GLASS WINDOW OR FIXED GLASS WINDOW AS SHOWN ON TOWER DWGS.



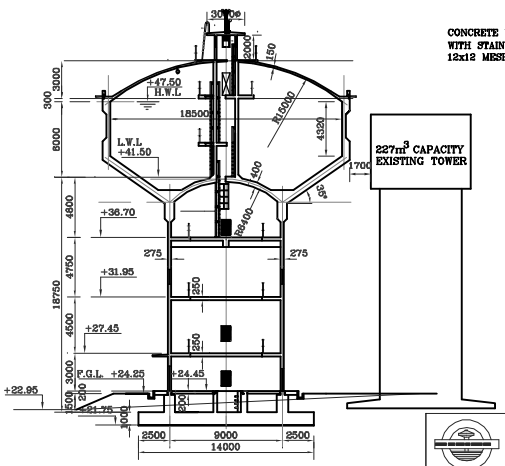
WIRE MESH

12mmx12mm STAINLESS STEEL (GAUGE 16) WIRE MESH FRAMED ON 10mm x 5mm STAINLESS STEEL FLATS

DETAILS OF DOORS & WINDOWS



E SECTION
[SCALE:- 1:100]



VERTICAL SECTION THRO ℄ OF NEW TOWER & EXISTING TOWER
[SCALE:- 1:200]

NOTES :-

1. FOR STANDARD NOTES AND DETAILS REFER TO STD DRAWINGS.
2. SAFE BEARING PRESSURE - 250kN/m².

DO NOT SCALE

REV.	DESCRIPTION

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

SUB PROJECT: KOTIKAWATTA-MULLERIYAWA

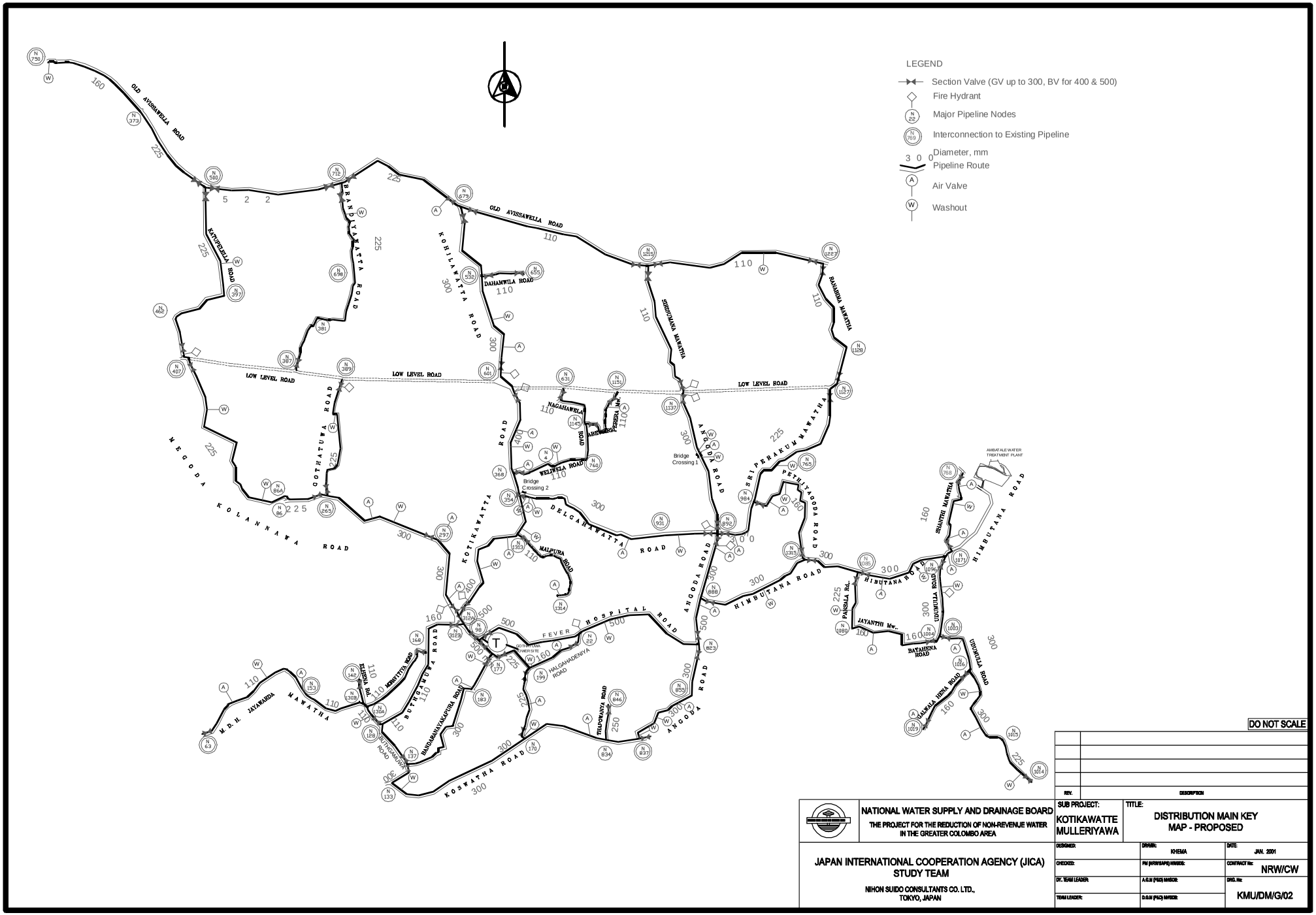
TITLE: TOWER - 1500m³ CAPACITY GENERAL ARRANGEMENT

SHEET 1 OF 2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM

NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN

DESIGNED	DRAWN: RUKMANI	DATE: JAN. 2001
CHECKED	PM (NRW&AFS/NWSDB)	CONTRACT No.: NRW/CW
DY. TEAM LEADER	AGM (P&D) NWSDB	DRG. No.: KMU/WT/ST-01
TEAM LEADER	DGM(P&D) NWSDB	


LEGEND
Section Valve (GV up to 300, BV for 400 & 500)
Fire Hydrant
Major Pipeline Nodes
Interconnection to Existing Pipeline
Diameter, mm
Pipeline Route
Air Valve
Washout
OLD AVISSAWELLA ROAD
KATUPELLA ROAD
BRANDIYAMATTA ROAD
KOHILAWATTA ROAD
DAHAMWILA ROAD
SIRIDAMMA MAWATHA
RANABIMA MAWATHA
LOW LEVEL ROAD
NAGAHAWELA ROAD
ABEYWEERA MW.
ANGODA ROAD
SRI PERAKUM MAWATHA
PETHIYAGODA ROAD
MEEGODA KOLANNAWA ROAD
GOTHATUWA ROAD
WELIWELA ROAD
Bridge Crossing 1
Bridge Crossing 2
DELGAHAWATTA ROAD
KOTIKAWATTA ROAD
MALPURA ROAD
HOSPITAL ROAD
FEVER HOSPITAL
HIMBUTANA ROAD
SHANTHI MAWATHA
AMBATALE WATER TREATMENT PLANT
PANNALA RD.
JAYANTHI MW.
BAYAHENA ROAD
UDUMULLA ROAD
KALAHULA DERA ROAD
M.D.H. JAYAWARDA MAWATHA
ELERENA RD.
KERUTTUWA ROAD
BUTHGAMUWA ROAD
BANDARANAYAKAPURA ROAD
HALGAHAOENIYA ROAD
THALPOTAWATTA ROAD
KOSWATTA ROAD
DO NOT SCALE
REV.
DESCRIPTION
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA
SUB PROJECT:
KOTIKAWATTE MULLERIYAWA
TITLE:
DISTRIBUTION MAIN KEY MAP - PROPOSED
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN
DESIGNED:
DRAWN: KHEMA
DATE: JAN. 2001
CHECKED:
PM (NRW/SAPI) NAMES:
CONTRACT No: NRW/CW
DY. TEAM LEADER:
A.G.M (P&D) NAMES:
DRG. No: KMU/DM/G/02
TEAM LEADER:
D.G.M (P&C) NAMES:

CHAPTER 4

4 NRW REDUCTION ACTION PLAN

4.1 BACKGROUND

The scope of JBIC loan includes the following components with respect to the reduction of Non Revenue Water (NRW).

(a) Implementation of the two contracts: (1) Contract for Leak Repair Works and (2) Contract for Low Income Settlement Environmental Improvement
(b) Procurement of materials and equipment for NRW reduction under the Contract for Civil Works

The Terms of Reference (TOR) of the JICA detailed design study includes:

(a) Preparation of tender documents for the above two contracts
(b) Review existing conditions and recommend action plans for:
    - Public standposts
    - Illegal connections
    - Apartment buildings
(c) Review existing conditions and make recommendations for improvement to the NRW reduction management system:
    - Meter Repair Workshop
    - Meter Reading and Capacity Development of Meter Readers
    - Billing and Collection System
    - Inventory and Information Management System
(d) Implementation of pilot projects in three low income settlements in CB1 area
(e) Implementation of a NRW reduction pilot project in CB1 area
(f) Preparation of Water Awareness Mass Media Campaign Program
(g) Make recommendations on the locations and specifications of water meters to be required for NRW monitoring of CB1 area

4.2 CONTRACT FOR LEAK REPAIR WORKS

This contract includes the repairs of 2,340 leaks in distribution mains and 9,000 leaks in service mains. These numbers were estimated by JBIC as being approximately halves the numbers of leaks currently repaired by NWSDB and CMC during a period of one year and a half (18 months).

For the implementation of this contract, the study team prepared the following report and documents.

(a) Design Report on the Contract for Leak Repair Works
(b) Prequalification Documents for the Contract for Leak Repair Works
(c) Tender Documents for the Contract for Leak Repair Works

The design report discusses the approaches and methodologies used for estimating the volumes of work and materials to be required for this contract. The design report also includes a recommended implementation plan for this contract. The duration of the contract is estimated to be approximately 2 years. It is recommended that the entire work in this contract be implemented in several contracts each to be awarded to a contractor at an interval of every 6 months or so.

The prequalification documents specify minimum qualification criteria as well as criteria for evaluation of applications. It is recommended that prequalification be conducted only once at the outset, and a contractor be selected each time from a pool of the initially prequalified contractors.

Prototype tender documents have been prepared by the study team for use by NWSDB for selection of contractors. The contract will be a unit-price contract in that the contractor will be paid for actual works performed based on the unit prices quoted by him in his tender. It is recommended that all couplings and other pipe materials required for leak repairs be furnished to the contractor by NWSDB, and the contractor provides only labor and construction equipment.

4.3 CONTRACT FOR LOW INCOME SETTLEMENT ENVIRONMENTAL IMPROVEMENT

This contract includes water supply improvements to approximately 30 low income settlements in CB1 area by providing individual connections in exchange for disconnecting standposts.

It is estimated that about half of the population of CMC live in settlements numbering 1,624, most using free standpost water. The standposts are generally in poor condition, many having been tampered with, particularly in low pressure areas, and leakage of water is both obvious and serious. The residents seem not to care about damage or wastage, a major factor probably

being that the supply is free. The NWSDB policy is to provide subsidised individual household connections settlement by settlement, and to remove the standposts.

For the implementation of this contract, the study team prepared the following report and documents.

(a) Design Report on the Contract for Low Income Settlement Environmental Improvement
(b) Prequalification Documents for the Contract for Low Income Settlement Environmental Improvement
(c) Tender Documents for the Contract for Low Income Settlement Environmental Improvement

The design report discusses approaches and methodologies used for estimating the volume of work and materials to be required for this contract. The design report also includes a recommended implementation plan for this contract. It is strongly recommended that NWSDB use NGO and the consultant for construction supervision to facilitate the implementation. The duration of the contract is estimated to be approximately 2 years. It is recommended that the entire work in this contract be also implemented in several contracts, each to be awarded to a contractor at an interval of every 6 months or so.

The prequalification documents specify minimum qualification criteria as well as criteria for evaluation of applications. Prequalification should be conducted only once at the outset, and a contractor be selected each time from a pool of the initially prequalified contractors.

Prototype tender documents have been prepared by the study team for use by NWSDB for selection of contractors. The contract will be a unit-price contract in that the contractor will be paid for actual works performed based on the unit prices quoted by him in his tender. All pipe materials required should be furnished to the contractor by NWSDB, and the contractor provides only labor and construction equipment.

4.4 PILOT PROJECT FOR REDUCTION OF NON-REVENUE WATER

4.4.1 Background

NRW in Colombo comprises several components, such as public standposts, apartment buildings, illegal connections, leakage and meter-related losses. In the past, several studies attempted to estimate respective proportions of such NRW components, but none of them

successfully provided any convincing results supported with adequate data or measurements. Nonetheless, knowing actual conditions of NRW is the very first and important step toward any improvement, and it is also imperative for planners to develop effective action plans for NRW reduction. Originally, this pilot project was not included in the scope of the JICA study but was later added by JICA for this reason.

The pilot project was implemented within a short timeframe of 3 months from September to December 2000 with a view to focusing on the actual NRW conditions within a relatively small area in CB1. Although it is too early to draw any final conclusion from this pilot project study alone, the study is thought to provide a more clear and real perspective on the current NRW situations in Colombo than any other previous studies succeeded before.

The pilot project area is situated in the southeast of CB1 area, bounded by Stace Road on the north, Grandpass Road on the west, De-Was Lane on the south and the Pancikawatta Canal on the east. The area encompasses approximately 9.1 ha of land comprising commercial, residential and institutional uses, and accommodates 27 tenement gardens. The total number of households within the pilot project area is estimated to be 978, including 560 in tenement gardens. Assuming that the average household size is 5, the overall population density is estimated to be as high as 537 persons per ha.

Findings from the pilot project are as follows:

i) There are a total of 413 registered customers within the pilot area, of which:
   - 45 customers (11.0%) are disconnected for non-payment or other reasons
   - 225 customers (54.4%) are billed based on meter reading
   - 143 customers (34.6%) are billed based on an estimated consumption, as their water meters are not readable

ii) 90 standposts were found (water meters were installed at 87 standposts in the pilot project)

iii) 38 leaks were detected (27 were repaired in the pilot project)

iv) 126 illegal connections were detected. They exist in several clusters.

4.4.2 Conclusions and Recommendations

Conclusions derived from the pilot project are as follows:

i) 66,800 m3 of water is distributed monthly into the pilot project area

ii) 9,500 m3 of which (14.2%) is billed by NWSDB

iii) 57,300 m3 (85.8%) is unbilled due most probably to the following reasons
   - 10,000 m3 (15.0%) being lost at standposts
   - 2,100 m3 (3.1%) being lost by inaccurate meter reading

- 1,000 m3 (1.5%) being lost by estimated billing
- 15,000 m3 (22.5%) being lost through illegal connections
- 29,200 m3 (43.7%) being lost through leakage

iv) As far as this pilot area is concerned, the priority should therefore be set in the following order:

- 1st priority - reduction of leakage
- 2nd priority - reduction of illegal connections
- 3rd priority - disconnection of standpipes through provision of individual connections

This pilot project was conducted within only a small sample area in CB1. It is therefore too early to and discuss the overall NRW situations in CB1 or in CMC by simply extrapolating the outcome of the pilot project. Nonetheless, the pilot project has revealed that the seriousness of NRW problem is not uniform throughout the entire CB1 or CMC area but is different drastically from one place to another depending on the nature and complexity of the area.

The study team recommends that NWSDB conduct at least 4 similar pilot projects in CB1 and 5 in each of CB2 and CB3. Outcomes of those 15 pilot exercises should be systematically analyzed and action plan and priority should be determined. It is highly probable that action plan and priority may vary from one billing district to another.

4.5 PILOT PROJECTS IN LOW INCOME SETTLEMENTS

4.5.1 Implementation of Pilot Project

The pilot projects were intended for the implementation of water, sanitation and drainage improvements, to be conducted with a view to testing options, interpreting and sharing lessons that emerge, and making these available beyond the pilot projects themselves. The final output from the pilot projects was to be the formulation of an Implementation Manual, for planning and implementation of further projects in low-income settlements in CMC in general.

An NGO (Sevanatha) was appointed to assist with the settlement selection process and to carry out Baseline Surveys. At the time of selection, the broad proposal for the re-location of settlement dwellers in CMC to High Rise Buildings was known. A list of designated sites (to be re-located) and non-designated sites was available, but there was no programme to indicate when re-locations were likely to take place. The pilot sites were selected by the following method:

i) Recommendation of suitable sites by NWSDB and NHDA
ii) Selecting a short-list of six for further investigation by Baseline Surveys
iii) From the result of the Surveys, selecting three sites considered most suitable

The three projects were all located in the Colombo North area of CMC within the NWSDB billing district of CB1, and were:

i) 323 Aluth Mawatha
ii) 312 Madampitiya Road
iii) Kadirana Watta - Stage II

The same NGO was then appointed to carry out Community Attitude Surveys on 100% of the households at each selected settlement. This confirmed the suitability of the sites for upgrading of facilities, and the willingness of the people to participate in the projects. The major task of the NGO was to ensure that a viable institution was in place which was fully representative of the community, and could co-ordinate fully the participation of the community in all aspects of the project. The CDCs (Community Development Councils) and the residents were drawn into the project by the Community Facilitation and Institution Building process developed by the NGO, resulting in Community Action Planning Workshops to finalise the community action plan and integrate with the provision of improvements by the agencies. The NGO also provided a link between the community and NWSDB to facilitate the somewhat complex system of applying for individual household connections.

In parallel, the study team developed the project design through a series of regular meetings with the agencies and landowner, attended by the NGO to provide the link with the community. Layout drawings and cost estimates were presented by NWSDB for water supply, CMC for sanitation and drainage.

The end result of the service design exercise was that water supply was a relatively easy task as conversion to household connections in settlements is a regular feature of the routine work carried out by the NRW Reduction Unit of NWSDB. The community would provide labour for all excavation and backfilling, resulting in an average cost per household for the reticulation system of about Rs 2,200. This cost would be recovered in 2-3 years by the income from the new connections and the reduction in NRW.

However, sanitation and drainage costs both worked out at over ten times the cost for water, despite the existence of sewers to common and household toilets and some substantial existing drainage works in both 323 Aluth Mawatha and 321 Madampitiya. The systems proposed were conventional sewers connected to the main sewerage system and precast pipes and

covered half round channels for drainage, all to be carried out by contractors. In a situation where neither the landowners nor the CMC are able to finance these works, it has to be concluded that such systems proposed would be entirely donor dependent and not sustainable for the large number of settlements.

Whilst alternative solutions were being sought, such as the drainage works being carried out by the community, and the possibility of installing a shallow sewer system at Kadirana, the news was received that all three sites had recently been earmarked for re-location to High Rise Buildings within the next 2-3 years.

This called for a review of the projects. It was concluded that at 323 Aluth Mawatha and 312 Madampitiya Road, the existence of a high proportion of household water connections before the project (mostly illegal), together with a high number of household toilets, made it unnecessary to upgrade the sewerage system. In addition, it was concluded that the extensive existing drainage works would suffice for the few remaining years before re-location. In short, the completion of individual household water connections would have little or no effect on the environment.

Kadirana Watta – Stage II is the only settlement that is likely to suffer environmental problems with the installation of household water connections, since there are no paved roads or drains, and sanitation is by means of poorly constructed communal pit latrine toilets located some distance from the houses. It is proposed that the CDC/NGO approach the landowner, SLLRDC, for financial assistance for community construction of low cost drainage works and communal toilet improvements.

4.5.2 Conclusions and Recommendations

A general policy on upgrading of settlements must be developed through the MUDCP, involving, at least, STP/REEL, NHDA, USIP, NWSDB and CMC, and efforts should be made to co-ordinate action plans with the donor community.

The pilot projects have achieved much and clearly show that settlement upgrading in CMC, particularly in Colombo North, is unique in that the High Rise Building programme must be considered first. A firm policy on how to proceed with upgrading of water connections and at the same time avoiding negative impacts on the environment must be adopted. Low cost solutions must be considered for any necessary upgrading of sanitation and drainage in settlements to be re-located, and permanent solutions are only required for the 90 settlement identified by NHDA in CMC (41 in CB1) for upgrading on a permanent basis.

The pilot projects confirmed the procedure of the use of an NGO for strengthening of CDCs and the development of the community attitude towards participation. Affordability and willingness to pay for household connections was evident, but a follow-up procedure must be adopted by NWSDB to ensure that meters are read monthly and bills issued on time, and that the public are educated on the correct economic use of water. A follow-up is also required from the NGO to ensure that the remaining toilet taps are used sensibly and economically and the community takes responsibility for the condition of the taps and the water system in general.

As of 1st December 2000, only 312 Madamadpitiya Road had been completed. Out of 120 households only 5 remain to be connected, and all standposts, except those used for communal toilets had been removed. All illegal connections were legalised. Unfortunately, water pressure is insufficient to all houses and this may be due to the installation of the nominal design of 75mm and 50mm diameter pipelines in a low pressure area.

At 323 Aluthmawatha the pipe laying was complete, but had not been connected to the distribution system. Work had not commenced on the household connections but it is anticipated that this settlement will achieve the same success as 312 Madampitiya.

Construction work at Kadirana Watta – Stage II, was limited to pipe laying in the inner lanes. The main pipeline from the distribution system had yet to be laid and work had not commenced on the household connections. This is a particularly difficult site with very low pressure and this will not be resolved until the new 600mm diameter main to Ellie House is commissioned. In addition, some environmental work will be necessary to the drainage. SLLRDC are to be approached to assist the community with drainage and to upgrade the common toilets that are in poor condition.

As regards the policy for implementation of further individual household connection in the CB1 area of CMC, the total number of settlements is estimated to be 781, broken down as follows:

STP Classification	**No. of Settlements by Type**			**Total No. of Settlements**	**Total No. of Households**
	Shanties	Slums	Relocated		
Non-Designated	16	87	2	105	3,192
Designated	70	568	38	676	30,291
Combined Total	86	655	40	781	33,483

Source: STP/REEL

To speed up project implementation it is recommended that NWSDB commence work now, through the Project Implementation Unit (PIU), to establish a policy for the upgrading of settlements in CMC, particularly in the CB1 area. Identification of the settlements by a desk study followed by site visits will enable allocation of the settlements to three methods of implementation, as follows:

Implemented by	Settlement Status	Extent of Upgrading
NWSDB Direct Labour Works	Designated	Individual Connections, little or no Environmental Work
By Contracts through current JBIC Loan	Designated	Individual Connections, some environmental improvement works
Further Loans by JBIC and/or other Donors	Non-Designated	Individual connections, full Water Supply Sanitation & Drainage Works

NWSDB intend to complete connections in all settlements by the year 2003, which is an ambitious target with over 33,000 connections to provide in three years. In accordance with the High Rise Building Programme, about 30,000 households will re-locate at sometime, leaving about 3,000 households in 105 settlements to be upgraded or re-located elsewhere. NHDA has identified 90 settlements in the whole of CMC for permanent upgrading, 41 of which are in Colombo North.

It is recommended that NWSDB continue as planned with household connections in settlements, and take responsibility for the minor environmental improvements that may be necessary following the installation of household connections. The work will involve about 25,000 connections.

At the same time, about 5,250 connections will be installed by contract through the JBIC loan. The work will include any environmental works necessary.

The 41 Settlements in CB1 for permanent upgrading should be the subject of further loans, through MUDCP as they will include full sanitation and drainage works, and these can be implemented in a similar manner to the settlement improvements carried out under the Pilot Project of the Kula Ganga Project.

4.6 WATER AWARENESS MASS MEDIA CAMPAIGN

4.6.1 Background

At the commencement of this Study it was strongly felt that any attempt to obtain a significant reduction to NRW was likely to fail if it was implemented without the support and participation of the general public, most of whom are registered customers of NWSDB. This initial feeling has been confirmed by the findings of the Study, as many of the components of NRW are directly related to the public use of water.

One of the most significant element of NRW is through the supply of free water by standposts, mainly in settlements, and whilst projects are planned to provide individual connections thus eliminating, or at least substantially reducing standpost supplies, the awareness of the public must be raised by education. Other components of NRW such as illegal connections, meter related errors, and free supplies to apartment blocks are all matters where the understanding and co-operation of the public is required to find effective and sustainable solutions.

In the Inception Report (January 2000) of this Study, the implementation of a continuous, systematic campaign through mass media, such as TV, radio and newspaper was recommended as it was felt necessary to increase the awareness and understanding of the public. Such a campaign would need to be carefully programmed in advance and implemented step by step on a theme-by-theme basis.

Subsequent discussions between the study team and NWSDB revealed that NWSDB also believed that public support was necessary if the goal of a substantial reduction in NRW was to be achieved, and that there was a need therefore for preparing a mass media campaign programme aiming specially at the public in CMC as the target.

Initially, the formulation of the mass media campaign programme was not included in the original scope of the JICA study, but later added by JICA for these reasons.

4.6.2 Questionnaire Survey

There is need therefore for a comprehensive campaign to raise awareness on a variety of subjects, and since the public are to be involved it was felt that their views must be sort to give accurate indicators of the components to be included in a Water Awareness Mass Media Campaign. Accordingly, a questionnaire was designed and 1,000 customers were selected for interview from the computerised records of NWSDB. All customers were located in CMC

where the NRW problem is the worst, and the selection covered 700 low, medium and high domestic water users, and 300 non-domestic users covering all the categories of the NWSDB tariff system. About 90% of the interviews were successfully completed.

This survey provided the information for the components and activities to be addressed in the Water Awareness Mass Media Campaign to achieve the main objective of a substantial reduction of NRW.

The main objectives to be addressed by the campaign are:

i) Conservation of Water
ii) Increased Awareness and Understanding
iii) The Need to Avoid Misuse of Water
iv) The Need to Pay for Water

4.6.3 Conclusions and Recommendations

The report detailing the Water Awareness Mass Media Campaign includes a concept for the overall management of the campaign, recommendations for implementation, an implementation programme together with preliminary cost estimates and is attached as Appendix 4C-2 to the Main Report. The programme adopts a step by step, theme by theme approach for a long-term campaign which may be repeated as necessary, and can be varied to suit the particular needs of NWSDB at any given time.

On World Water Day in March 2000, statements were made by the highest political and government leaders that the active participation of the customers is required on almost all aspects of water supply. It is considered that the relevant Government Ministries and Agencies, particularly NWSDB, must have a genuine belief that the involvement of the public is desirable and welcome as well as just necessary. This is a key issue to the success of the campaign which is estimated to require Rs 3.5 million for capital costs and Rs 11.5 million for running costs over a three year period.

At this estimated overall cost of Rs 15 million at Rs 5 million per year, the financial return which should result from a successful campaign, would be far in excess of the cost. For example, it is estimated that a reduction of NRW from say 40% to 35% would result in a minimum annual return of about Rs 33 million of increased revenue.

The degree of success in reducing NRW in such areas as standpost water, illegal connections

and the like, will depend to a large extent on the active co-operation of the public and this should be forthcoming from a successful Water Awareness Mass Media Campaign.

4.7 NRW REDUCTION ACTION PLAN

4.7.1 Existing Conditions

In Colombo, NRW emanates from a variety of reasons. They are broadly categorized as follows:

(1) Tenement Garden Standposts
(2) Wayside Standposts
(3) Apartment Buildings
(4) Meter-related losses
(5) Leakage
(6) Illegal Connections

In 1998, the SAPS study conducted by JBIC estimated the respective percentages of NRW components as shown below.

Item	CMC	Outside CMC	Greater Colombo
Water produced (million m3/month)	7.82	7.55	15.37
Water billed (million m3/month)	3.34	4.69	8.03
System Leakage	28%	28%	28%
Tenement Gardens Consumption	19%	1%	10%
Wayside Standpost Consumption	-	-	-
Illegal Connections outside TG	5%	4%	4%
Metering Errors	3%	3%	3%
Wastage in Housing Schemes	2%	2%	2%
Total	**57%**	**38%**	**47%**

NWSDB currently estimate NRW and UFW every month. Estimated figures for October 1999 are as follows:

Consumption (m3/month)	CMC	Outside CMC	GC
Non Priority (A)	2,064,742	3,978,798	6,043,540

Priority (B)	1,406,066	1,418,115	2,824,181
Standposts (C)	338,287	784,203	1,122,490
Consumption TG(D)	1,147,000	0	1,147,000
Total (A+B+C)	3,809,095	6,181,116	9,990,211
Total (A+B+C+D)	4,956,095	6,181,116	11,137,211
Total Supply(Q)	8,237,980	8,025,479	16,263,459
NRW: Q-(A+B+C)	4,428,885	1,844,363	6,273,248
NRW (%)	**53.76**	**22.98**	**38.57**
UFW: Q-(A+B+C+D)	3,281,885	1,844,363	5,126,248
UFW (%)	39.83	22.98	31.52
NRW (m3/day)	147,629	61,479	209,108

Source: NWSDB

Although the figures are different, both NWSDB and the SAPS Study estimated that NRW in Colombo was more than 50%.

4.7.2 NRW Reduction Unit

The number of staff in the NRW Reduction Unit totals 38 made up of 28 permanent employees and 10 contract labourers. The Unit covers the whole of Greater Colombo, with no one assigned specifically to the CMC area. The Organisation Chart for the Unit is given in Figure 4-9. This Unit of NWSDB is capable of carrying out all its own construction works, but it does encourage public participation for connections in tenement gardens, where excavation and backfill is carried out by the new customer thereby reducing the cost of the connection.

The annual budget for the Unit for normal operation and maintenance, including staff salaries, is Rs 6 million. In addition to this, there is a special grant from the government treasury used solely for improvements in tenement gardens and apartment buildings to reduce NRW. Last year the grant was Rs 10 million, but this has been reduced to Rs 5 million for this year and for the year 2001.

Under normal circumstances, CMC carry out new connections, but the improvements to individual connections in tenement gardens and apartments are done by NWSDB as special projects

The overall objective of the Unit is to reduce NRW to 40% in Greater Colombo by 2000 and to 30% in CMC by 2003. The current target for the Unit is to reduce NRW by 2 to 3% in the CMC area in 2000.

4.7.3 Tenement Garden standposts

The type and number of standposts in tenement gardens are shown in the Table below:

Type	No.
Ordinary Standposts	3,000
Standposts for Washing	1,716
Standposts for Toilets	471
Total	5,187

Source: NWSDB at early 2000 (Note: NWSDB have recently revised these figures)

NWSDB has in total over 13,000 standposts throughout Sri Lanka in the various towns supplied, with over 5,000 in CMC and over 2,000 in the Greater Colombo (GC) area. Standpost water is charged for in all locations except CMC and GC where it is given free of charge with the GM's approval. The standposts are generally in poor condition, many having been tampered with, particularly in low-pressure areas, and leakage of water is both obvious and serious. The residents seem not to care about damage or wastage, a major factor probably being that the supply is free. Water consumed at standposts is taken into account as wholly NRW.

The NWSDB policy is to provide subsidised individual household connections settlement by settlement, and to remove the standposts. However, whilst the drinking and bathing taps can be removed, it is not possible to disconnect the toilet taps, which must remain for basic health reasons until such times as individual sanitation facilities are available to all. In 1999, NWSDB worked in 45 tenement gardens, completing 28.

For the short-term action plan, the policy of metering all standposts is recommended since the programme of installing individual connections may take many years to complete. To illustrate this, last year's programme, with the budget and other resources available, resulted in 1,517 connections, whilst the estimated total number of connections required in CMC is about 60,000.

The contribution to NRW by tenement garden standposts is considerable and every avenue should be explored to reduce the level. For instance, where Community Development Councils (CDCs) exist and are functioning, it should be possible to involve the communities in maintaining the standpost supplies after they have been refurbished, or at least reporting any faults. By 1998, 630 CDCs had been formed under the guidance of the CMC, and whilst all

may not be active now, it would be a considerable boost to standpost management if they could lend assistance.

The JBIC also recognised the problem of NRW from the free standpost water in settlements, by including pilot projects in three low-income settlements, and allowing for contract works to install individual household connections and remove standposts in a number of settlements. The pilot projects, described earlier in this report, have lead to the formulation of an action plan to tackle the standpost problem in all of the settlements.

However, this is a lengthy process and it is recommended that immediate action be taken to repair and meter all standposts. NWSDB estimate that about one third of the standpost losses are due to leakage from the taps (6%) and this can be eliminated quickly as well as providing accurate information on the free water consumption.

4.7.4 Wayside standposts

The number of wayside standposts in Colombo City are shown in the Table below:

Area	No.
CB1	341
CB2	85
CB3	342
Total	768

Source: NWSDB at early 2000

Whereas the approximate number of standposts is known, there are no plans showing the exact locations. Standposts are not attended; therefore the use of water from this source cannot be controlled. It is known that standposts are being used for such purposes as car washing, often on a commercial basis. Consumption per standpost is estimated by NWSDB at 11.5 m3/day from random metering carried out some time ago. Water is free to the users but the estimated consumption is charged to CMC, hence water from this source is not considered as wholly NRW. It is nonetheless recommended that these standposts be located, mapped and recorded. This will indicate those standposts which can be removed, and the repair and metering process will also eliminate leakage and provide for accurate billing.

4.7.5 Apartment buildings

The number of old apartment buildings still being provided with free water is estimated to be

176 (120 owned by CMC and 56 by NHDA). For some time now, NWSDB has been tackling the problem of NRW by attending to obvious leakage from overhead tanks and by the installation of individual meters.

More recently, NWSDB has installed bulk meters to 38 of the blocks, but in the absence of a viable policy to charge the tenants or the owners of the blocks, this only serves to quantify the NRW more accurately. This is being followed by a plan to install individual meters, which is a complicated task as the buildings are old, of various designs, and do not lend themselves to easy conversion. However, the buildings can be classified by age, and NWSDB intend to rapidly produce sketches of the 6 or 7 types of buildings and these will go out to tender for conversion (labour only contracts, materials procured by NWSDB).

Immediate action plans recommended are as follows:

- Prepare a list of existing apartment blocks, including information on piping conditions
- Install individual meters and repair all defective float valves and piping
- Review and make necessary amendments to plumbing legislation
- Enforce strict control on plumbing and maintenance at new apartment buildings

Details of the procedures recommended are as follows:

1) The first step is to investigate the current situation regarding ownership and management of all apartment blocks, and draw up a comprehensive list of all details relevant to the installation of individual meters.
2) Installation of meters on the outer wall of apartment buildings should be promoted, but in case of apartment buildings without enough space for meter installation, a water charge system through a bulk meter should be considered.
3) Since there are no formal regulations on design standards for plumbing installations, NWSDB should draw up suitable systems to be followed by the developers to facilitate individual meter installation and minimise future NRW. This should be followed by formal legislation for apartment buildings constructed by the private sector to ensure compliance with regulations. Strict control should be enforced at all times
4) Those responsible for the building of future apartment blocks must be made aware of the requirement for individual metering and should produce design layouts in accordance with the Board's regulations, the current building standard ordinance and related regulations, if necessary. Any necessary amendments to current legislation should be considered, if the required control is not contained therein.

4.7.6 Meter-related Losses

Currently this component includes, among other problems, the losses of revenue resulting from the following reasons:

- Meter malfunctioning including under-registration
- Non-existence of water meter
- Meter reading/recording error
- Meter is not registered therefore not billed

There are no records to indicate the scope of the problems, but they are known to be significant. There are many reasons within these basic problems, some of which are detailed below:

1) Where meters are installed:
   - Meter function is deteriorated
   - Meter is broken
   - Access is impossible due to the meter being buried or hidden
   - Meter is unreadable, not read, or not read correctly

2) Where meters are not installed:
- Estimation of consumption
- Lack of standard of estimation of meter reading

Water meter will often display lesser amount of water than the actual due to the moving parts wearing out. It is desirable to replace all of the meters systematically (for instance, 8 years is used in many countries). Meters may be repaired or replaced depending upon the economics. Installation methods must be improved to ensure that meters are accessible and will not be damaged.

Tracing of unmetered connections must be an on-going job using records and information from meter readers. It is essential that unmetered connections be converted as soon as possible and bills be issued based on meter reading.

A reasonable percentage of genuine error is unavoidable. There are two preventative measures which may be taken. One is improvement of the ability of meter readers by regular training sessions, and the other is adequate inspection of meter readers' performance, which currently does not take place. These matters must be progressed quickly.

A certain number of meters have never been transferred to the NWSDB computerised system since the facilities were taken over from CMC. In addition, there are still errors in registering

new connections, which are done by CMC with the details sometimes not being transferred. A matter of serious concern is the length of time taken from installation to the issue of the first bill. This can take up to six months and must be resolved quickly by improved management systems.

4.7.7 Leakage

System leakage exists extensively in the large pipe network of Colombo, which comprises of over 500 km distribution mains, mostly made of cast iron, and a total of 73,500 registered service connections.

In Colombo, old cast iron pipes laid in the late 1800's and early 1900's are still being used as part of the distribution pipe network. In terms of length, they account for approximately 22% of the total length of distribution mains. Nearly 80% of the cast iron mains are more than 50 years old. Almost all of these cast iron pipes are not provided with protective lining and laid with insufficient cover; thus they are quite vulnerable to internal corrosion and to external traffic loading.

The majority of leaks in distribution mains are currently repaired by CMC while only few are attended by NWSDB. In 1999, a total of 1,581 leaks were repaired by CMC. Whereas no detailed information on the repair work is available, it is known that the leaks comprised 852 from pipe barrels, 449 from pipe joints, 71 from hydrants and 209 from valves.

Both CMC and NWSDB currently repair leaks in service connection pipes. In 1999, they repaired collectively a total of 948 leaks in service lines.

At present, neither CMC nor NWSDB conducts any positive leak survey; they initiate their repair work only upon receipt of reports or complaints from customers.

There are probably thousands of leaks in the CMC distribution system, and this will continue for some considerable time to come until the very old, largely cast iron pipes are replaced. NWSDB or CMC do not have a comprehensive leak detection system, and leaks that are repaired are often done badly and leak again. An effective and larger leakage section must be created with appropriate detection equipment and a plan developed to tackle the problem area by area. Random repairs must at the same time be carried out on all visible leaks that are reported.

The JBIC recognised the seriousness of leakage as a top priority item, and include a contract for Leak Repair Work. This contract includes the repairs of 2,340 leaks in distribution mains

and 9,000 leaks in service mains to be carried out over a period of two years. It is recommended that NWSDB, while implementing this contract, also continue with NRW reduction pilot exercises in various parts of the city. It will help NWSDB determine the priority areas where leakage is most serious and, as such, a drastic reduction may be achieved within a short timeframe if the problem is properly addressed.

4.7.8 Illegal connections

In Colombo, illegal connections can be categorized into the following types.

- Illegal connections in tenement gardens and apartment buildings
- Illegal connections outside tenement gardens and apartment buildings

Many of the former types of illegal connections are publicly known to exist and as such their locations can easily be identified. NWSDB has not been able to take any effective actions against illegal connections in tenement gardens.

The latter type of illegal connection exists elsewhere in the service area, but their locations are not immediately identifiable. NWSDB currently takes action against illegal commercial and industrial connections, but little or no action is taken against illegal domestic connections.

As a result of tracing non-domestic illegal connections, about Rs 10 million of revenue has been collected from industrial and commercial defaulters over the last 3 years. In 1998, 78 customers were prosecuted, with 10% of revenue earned being paid as an incentive to the team. The normal procedure where illegal commercial and industrial connections are discovered is as follows:

1) They are given 14 days to produce documentary evidence that they have an account
2) If the connection is illegal they are given a letter to pay the penalty
3) They are given 14 days to pay
4) If they refuse to have the connection legalized, they will be disconnected

It is recommended that two squads be formed for the Illegal Connection section of the NRW Reduction Unit, one being for domestic and the other for non-domestic customers.

Each squad should have its own staff and close and co-operative links must be developed and maintained with the meter readers assigned to an officer's particular area of control.

Training of meter readers is required to ensure that they are all aware of the high level of responsibility they have and that their mission is not just "meter reading", but a valuable and essential part of the control of NRW.

It is considered that the illegal connection reduction should be carried out within the same framework as leakage and meter related losses. The NRW reduction pilot project carried out by the JICA study team has highlighted the problem of illegal connections, and a policy and action plan should be developed by NWSDB in accordance with the outcome of the JICA pilot project as modified by the additional findings that will come from the recommended future pilot block exercises.

The numbers are likely to be far higher than first thought, and a concentrated effort must be made to eradicate this serious component of NRW. This must be done without external intervention, and will be assisted by the implementation of the Water Awareness Mass Media Campaign.

4.7.9 Recommendations on the Way Forward

It is difficult to prioritise the components of NRW in an action plan since only limited information on the actual conditions of NRW is available at present. However, as an indicator the SAPS Report figures based largely on estimates, and the JICA pilot project on only a small sample area in CB1 are compared in the table below:

Comparison of NRW Components

Component	SAPS Report (1998)	JICA NRW Reducton Pilot Project (2000)
Leakage	28%	43.7%
Illegal Connections	5%	22.5%
Tenement Garden Standposts	19%	15.0%
Meter Related Losses	3%	3.1%
Estimated Billing	N/A	1.5%
Apartment Buildings	2%	N/A
Total	57%	85.8%

The comparison clearly demonstrates that the NRW problem is not uniform throughout the city, but is different considerably from one place to another depending on the nature and complexity of the area.

As stated earlier in this report, it is recommended that NWSDB continue with a further four NRW reduction pilot exercises in CB1, followed by five in CB2 and five in CB3. It can be guaranteed that the carrying out of pilot exercises provides the best insights into the full range of NRW components and will provide management with information to action NRW reduction programmes over the full range of the problems as they occur in different parts of the city.

4.8 METER REPAIR, BILLING, COLLECTION, AND INVENTORY MANAGEMENT SYSTEM

4.8.1 Meter Repair Workshop

The Central Meter Repair Workshop is operating far less than its present capacity in that capacity utilization rate is as low as less than 40 percent. On the other hand, Chinese meters have been dominant in procurement of small sized meters. Buying a new Chinese meter costs almost equal to the repair cost of a defective meter. The cost comparison data are as follows:

- A new KENT domestic meter: Rs. 1,500.
- A new Chinese domestic meter: Rs. 750.
- Average repair cost of a defective meter: Rs. 653.
- Repair cost of a Chinese meter (replacement of working chamber and counter): Rs. 450.

Judging from the above, the following recommendations are derived:

- Keep repairing KENT meters as long as they are recoverable and repairable (necessary parts are available).
- Buy Chinese meters as the number of repairable KENT meters decreases.
- However, since the purchase price of a new Chinese meter is already approximate to the repair price of a KENT meter, Chinese meters may be purchased at any time.
- Repair Chinese meters when they start getting defective.

Based on the above recommendations, a simulation analysis was conducted to assess the required capacity of the Central Meter Repair workshop and the capacity utilization rates from the year 2001 through 2005. This analysis indicated that the repair capacity would need to be increased by 31 percent, and that such an increase could be achieved by deploying 2 additional repairmen and purchasing some repair tools.

4.8.2 Meter Reading and Billing System

The meter reading and billing system in CMC area was studied for each of priority customers and non-priority customers separately. Table below summarizes problems identified and the recommendations for improvement.

Problems	Recommendation
Control over meter readers' performance	• Establish a new meter reader inspection section outside Area Office
Estimated reading for non- priority user	• Establish a special reading team for nighttime and weekend reading • Introduce self-reading system + periodical check by NWSDB • Introduce a penalty for dishonest or negligent reading + revise the piece rate • Modify the list of 25 reasons on the reverse of billing form and use information obtained more efficiently
Computation error of spot billing	• Promote maximum use of calculator by providing meter readers with a board having a built-in calculator • Enable the data processing system to isolate meter reader's error + Increase the piece rate + Introduce a penalty for miscomputation
Meter reader's capability	• Increase the number of training courses, focusing on (1) practical ways of reading difficult meters and reducing miscomputations, and (2) ethics • Introduce uniform • Equip meter readers with a set of tools

4.8.3 Collection System

The collection system in CMC area was analyzed. Problems identified and the recommendations for improvement are summarized in Table below.

Problems	Recommendation
Lower collection efficiency on non-priority customers	• Strengthen unpaid bill tracing and delinquent user handling • Introduce automatic transfer from customer's bank account
Rebates and surcharge	• Decrease rebate rates and finally abolish them • Apply late payment surcharge more stringently

4.8.4 Inventory Management System

The reorganization of Central Stores will be implemented in 2001. The Central Store,

currently accommodating 10 stores in an area of 6 acres of land, is located at a place approximately 2 kilometers from the Head Office. The reorganization project is to construct buildings, drains, internal roads and storm water detention pond for the Central Stores Complex. The new stores complex, composed of 7 stores, will replace 9 out of the 10 existing stores.

Another milestone to be achieved shortly will be the introduction of a new computerized database system and networking between the NWSDB Head Office and the Central Store. The database system will cover inventory management and purchase management. In the first phase, only stocks stored at the Central Store will be covered in the database system. Stocks stored at other regional stores may be integrated at a later stage after confirming smooth operation of the database system. The networking will interconnect between the two buildings in the Head Office and the Central Store thereby providing the Head Office with access to the database system.

In order to establish an effective and workable inventory management system, it is recommended that NWSDB make further efforts to clarify or pursue the following points.

- Simultaneous preparation of slips and computer database by one time of input
- Revision of stock code
- Development of stock level guideline
- Separation of Transit Store, RSC Store, and Groundwater Store
- Improvement of physical verification procedure
- Creation of separate unit for redundant items & disposal
- Consideration on safety of stores personnel
- Conceptual design of chemical store

4.9 NRW MONITORING SYSTEM FOR CB1

The methodologies proposed by NWSDB for monitoring of NRW in CB1 were given to the study team for review and recommendation. The proposal indicates that NWSDB will install a total of 11 flow meters, comprising 5 permanent bulk meters and 6 insertion type flow meters. Two of the 5 permanent bulk meters are to be connected to the telemetry system. In addition, NWSDB also plan to install 2 boundary valves to isolate the distribution system in CB1.

A task team comprising study team members and a representative of the NRW Reduction Unit examined each and every location where a flow meter or a boundary valve is proposed to be installed to confirm:

- Exact location of flow measurement
- Diameter, material and function (transmission or distribution) of the pipe
- Type of water meter to be used for flow measurement
- Provision of tapping and meter chamber

This examination confirmed that the locations proposed for flow meters and boundary valves are generally appropriate for the purpose of flow measurement and isolation, although there are still some outstanding works, which have to be completed, corrected or confirmed before NWSDB can actually start the flow measurement.

In conjunction with the use of insertion type flow meters at 6 locations, NWSDB requested that the study team calibrate one of the insertion flow meters currently owned by NRW Reduction Unit to verify if they can satisfactorily be used for flow measurement.

On June 21, 2000, the study team and NRW Reduction Unit conducted jointly the calibration of one of the insertion type electromagnetic flow meters owned by NRW Reduction Unit. A potable ultrasonic flow meter owned by the study team and the NWSDB's insertion meter were installed immediately adjacent to each other on a 30-inch steel trunk distribution main from Dehiwala at the Pmankada Bridge, and the flow was measured by both meters for a continuous period of 30 minutes. The results indicated that the difference in the readings of the two meters was so nominal that it is well within the tolerance of meter accuracy recommended by the manufacturers.

Although there are still some outstanding works to be completed by NWSDB as described, the methodologies and water meters proposed for monitoring are considered to be generally satisfactory. However, to increase the accuracy of the monitoring, confirmation on the existence of service connections in the areas between the points of flow measurement and the boundaries of actual CB1 billing area may be necessary.

4.10 MATERIALS AND EQUIPMENT FOR NRW REDUCTION

With only limited information available on the actual conditions of NRW, it is difficult to estimate the types and quantities of material and equipment that are really required for NRW reduction. However, as has been illustrated in the NRW reduction pilot project, leakage, illegal connection and tenement garden standpost are the three key areas where efforts and resources should be exerted by NWSDB.

Except for leakage reduction, domestic water meters will be required for the correction of illegal connections and for the conversion of standposts in tenement gardens. The total number of domestic water meters (Diameter 15 mm) required for such improvement is estimated at 38,000 for CB1 area.

The study team tested many different types of leakage detection equipment currently available in the market. They include ordinary leak detector, correlator, electromagnetic leak detector and helium gas tracer. In Colombo, any equipment designed to pick up the sound and vibration from the leak is not effective due to the current low pressure in the distribution system. On the contrary, the Helium Gas Tracing Method was found very effective although helium gas is somewhat expensive. Most of the 38 leaks found in the NRW reduction pilot project were detected by the study team through visual inspection. It is therefore suggested that Helium Gas detection method be used only at those places where a leak is known to exist but its exact location cannot be identified. It is recommended to procure one unit of Helium Gas Tracer under this project. Helium Gas is locally available in 8 m3 containers for a price of Rs.20,000 per container before GST and other taxes.

CHAPTER 5

5 REHABILITATION & REINFORCEMENT OF MEDIUM AND LARGE DIAMETER PIPE NETWORK IN CMC AREA

5.1 BACKGROUND

The scope of JBIC loan includes the following improvement works to the medium and large diameter network in CMC.

- Rehabilitation of pipelines (length: 28.45 km; diameter: 10" to 30")
- Reinforcement of pipe network (length: 8.8 km; diameter 300 mm to 500 mm)
- Rehabilitation and replacement of valves and installation of valve covers

The scope of the JICA detailed design study is to conduct leakage survey and pipe assessment in CMC, formulate most effective rehabilitation and reinforcement plans, and prepare detail designs for the proposed improvement plans.

5.2 EXISTING WATER DISTRIBUTION SYSTEM

In CMC water in mainly supplied by four service reservoirs located at Ellie House, Maligakanda, Dehiwala and Jubilee. Water from three treatment plants at Labugama, Kalatuwawa and Ambatale is conveyed to these service reservoirs through a numbers of transmission mains by gravity and pumping. Water from the reservoirs is then fed into the distribution system by gravity.

Most of the existing transmission mains are interconnected each other in a very complex way. They also serve many distribution mains en route before they reach the service reservoirs. In some transmission mains, the supply pressure is already too weak by the time they reach the reservoir, and hence they bypass the reservoir feeding directly the distribution system. The table below shows the current source of water received at each of the four service reservoirs.

Service Reservoir	Source of Treated Water
Maligakanda	Labugama WTP, Kalatuwawa WTP and Ambatale WTP
Ellie House	Ambatale WTP
Dehiwala (CMC Reservoir)	Kalatuwawa WTP and Ambatale WTP
Jubilee	Ambatale WTP

Hydraulic characteristics of the four service reservoirs that currently supply CMC are as follows:

Service Reservoir	Maligakanda (Old & New)	Ellie House	Dehiwala (CMC Reservoir)	Jubilee
Capacity (m^3)	50,000	36,300	17,700	15,800
HWL (above MSL)	29.9 m	28.0 m	27.9 m	36.6 m
LWL (above MSL)	19.9 m	22.9 m	23.6 m	27.4 m

Water level settings at the existing service reservoirs are generally low with their bottom water levels being in the range of between 19.9 m at Maligakanda and 27.4 m at Jubilee. Given the friction loss required for distribution, there is no adequate head available for maintaining a reasonable level of residual dynamic pressure (1.0 to 1.5 bars) in the distribution system.

Water distribution system in Colombo is unique in that old cast iron mains dominate the distribution system. Records available from NWSDB in early 2000 indicated that more than 95% of the existing water mains in CMC were cast iron mains. A majority of these cast iron mains were installed more than 70 years ago without any internal lining system. Most of them were installed at a relatively shallow depth when traffic load was much lighter than today.

With these old cast iron pipes still being actively used elsewhere in CMC, leakage and encrustation in the distribution system appear to be inevitable. The already problematic situations will surely aggravate in years to come. It is strongly recommended that NWSDB take this problem seriously, prepare a program and time schedule for replacement of old cast iron mains, and implement it before it is too late.

5.3 LEAKAGE SURVEY

The majority of leaks in distribution mains are currently repaired by CMC while only few are attended by NWSDB. In 1999, a total of 1,581 leaks were repaired by CMC. Whereas no detailed information on the repair work is available, it is known that the leaks comprised 852 from pipe barrels, 449 from pipe joints, 71 from hydrants and 209 from valves.

Both CMC and NWSDB currently repair leaks in service connection pipes. In 1999, they collectively repaired a total of 948 leaks in service lines.

At present, neither CMC or NWSDB conducts any positive leak survey. They initiate their repair actions only upon receiving reports or complaints from customers.

The study team conducted leakage surveys in various parts of CMC. The survey covered different diameters and different age groups of existing distribution mains. In addition to visual inspection on the ground, mechanical equipment, such as leak detector, correlator and electromagnetic leak detector were tested to detect underground leakage. In reality, a large majority of the leaks detected by the study team were through visual inspection on the ground. Most of mechanical equipment available today is designed to pick up the sound and vibration generating from leaks. However in Colombo leaks do not generate the sound or vibration in sufficient intensity due to the low system pressure.

In the later part of the study, the study team experimented the Helium Gas Tracing Method in the NRW Reduction Pilot Project. This method was found effective although helium gas is somewhat expensive. As many leaks can be detected on the ground by visual inspection, it is recommended that NWSDB formulate special leak detection teams to conduct visual inspection along existing pipeline routes. The Helium Gas Tracing Method can be used only at those places where a leak is known to exist but its exact location cannot be determined.

5.4 PIPE ASSESSMENT

At various parts of the distribution system, the study team observed the internal conditions of existing cast iron mains using a rigidscope. The photographs below demonstrate typical internal conditions of existing cast iron pipes. Heavy encrustation has already developed inside the pipe leaving only a limited waterway space.

The use of the rigidscope allows the observation without disrupting service and minimizes the time required for the assessment.

The following is a summary of the observations.

- The state of encrustation is generally more serious in small diameter mains than in medium and large diameter mains. In small diameter mains (3" to 6"), encrustation is more serious in 3"and 4" mains than in 5" and 6" mains. In medium and large diameter mains (8" to 21"), encrustation is more serious in 10", 12" and 15" mains than in other larger diameter mains.
- Most of the water mains in the area to the north of the Ellie House reservoir have been severely encrusted.
- No significant difference in the state of encrustation is observed between the water mains scraped in the past and those never done before. This indicates that the implementation of only scraping without any cement mortar lining is entirely inadequate in respect of preventing the recurrence of encrustation.
- On the contrary, scraping accompanied by cement mortar lining is quite effective for deferring the regeneration of encrustation.

5.5 VALVE ASSESSMENT

Having analyzed the results of valve assessment, the following is a summary of the conditions of existing valves.

- Approximately 20% of existing valves are not provided with a surface valve box or have been completely covered by asphalt overlay thereby making it extremely difficult for valve operators to identify their locations.
- 56% of existing valves passed the on-off function test (Most however exhibited a leak from the stuffing box after this function test, suggesting that they have not been operated for a long time.)
- Approximately 11% failed the function test, mostly due to the un-rotatable valve spindles.

5.6 REHABILITATION OF EXISTING WATER MAINS

Medium and large diameter cast iron mains proposed for rehabilitation have been selected mainly based on the results of the foregoing pipe assessment, and partly by incorporating suggestions from the CMC staffs in charge of the distribution system.

A total of 27.87 km water mains listed below have been selected for rehabilitation by means of

scraping and cement mortar lining under the JBIC loan project. The locations of these existing mains are shown in Dwg. No. RML/DM/G-01.

Drawing No.	Road Name	Diameter(inch) & Length(m)				
		10"	12"	15"	18"	Total
RML/DM/RH/01	Mattakkuliya Centre Road	660				660
RML/DM/RH/02	Aluthmawatha Road		510			510
RML/DM/RH/03	Aluthmawatha Road		570			570
RML/DM/RH/04	Aluthmawatha Road		120			120
RML/DM/RH/05	St. Andrew's Road		457			457
RML/DM/RH/06	Muthuwella Mawatha		630			630
RML/DM/RH/07	Muthuwella Mawatha		60			60
RML/DM/RH/08	Ellie House Road	310				310
RML/DM/RH/09	Lawer St. Andrew's Place		330			330
RML/DM/RH/10	Collage Street	1,100				1,100
RML/DM/RH/11	Kotahena Street	480				480
RML/DM/RH/12	George R. De Silva Mawatha		640			640
RML/DM/RH/13	George R. De Silva Mawatha		496			496
RML/DM/RH/14	Sumanatissa Mawatha			385		385
RML/DM/RH/15	Sangaraja Mawatha		649			649
RML/DM/RH/16	Panchikawatta Road		675			675
RML/DM/RH/17	Grandpass Road	650				650
RML/DM/RH/18	Grandpass Road	280				280
RML/DM/RH/19	Galle Road	280	360			640
RML/DM/RH/20	Galle Road	660				660
RML/DM/RH/21	Galle Road	650				650
RML/DM/RH/22	Galle Road	650				650
RML/DM/RH/23	Galle Road	335	165			500
RML/DM/RH/24	Galle Road	650				650
RML/DM/RH/25	Galle Road	439				439
RML/DM/RH/26	Quarry Road		396			396
RML/DM/RH/27	Allan Mawatha		340			340
RML/DM/RH/28	Union Place		650			650
RML/DM/RH/29	Union Place	171	464			635
RML/DM/RH/30	Foster Lane		285			285
RML/DM/RH/31	Bridge Street	206	305			511
RML/DM/RH/32	Sir Macan Marker Street	280				280
RML/DM/RH/33	Dharmapala Mawatha	600		650		1,250
RML/DM/RH/34	Dharmapala Mawatha	650		650		1,300
RML/DM/RH/35	Dharmapala Mawatha	530	38	303		871
RML/DM/RH/36	Elvitigala Mawatha			650		650
RML/DM/RH/37	Elvitigala Mawatha			625		625
RML/DM/RH/38	Kirillapone Avenue			650		650
RML/DM/RH/39	Kirillapone Avenue			115		115
RML/DM/RH/40	High Level Road			503		503
RML/DM/RH/41	Dickman's Road	600				600
RML/DM/RH/42	Dickman's Road	133				133
RML/DM/RH/43	Kumarathunga Munidasa Mawatha	555				555
RML/DM/RH/44	Serpentine Road	190				190
RML/DM/RH/45	Havelock Road	650				650
RML/DM/RH/46	Havelock Road	485				485
RML/DM/RH/47	Havelock Road	600				600
RML/DM/RH/48	Havelock Road	600				600
RML/DM/RH/49	Havelock Road	249				249
RML/DM/RH/50	Sea Street				607	607
RML/DM/RH/51	St. Anthony's Mawatha				301	301
RML/DM/RH/52	Sri Ramanathan Mawatha				643	643
Total Length		**13,643**	**8,140**	**4,531**	**1,551**	**27,865**

5.7 REPLACEMENT OF VALVES

All the 199 valves that exist on the rehabilitation mains listed in the foregoing table are assumed to have been equally deteriorated. They also have to be replaced to ensure a smooth operation of scraping and cement mortar lining.

In addition, the study team, in collaboration with the CMC officials, identified 35 valves that have been seriously problematic in operation and maintenance of the distribution system. These valves are also included in the replacement program.

As a result, a total of 234 existing valves have been included in the replacement program as shown below.

Diameter		Valves on Rehabilitation Mains	Valves Being Problematic	Total
mm	Inch			
750	30	0	2	2
675	27	0	2	2
500	20	5	2	7
450	18	6	0	6
375	15	13	7	20
300	12	50	13	63
250	10	93	9	102
225	9	8	0	8
200	8	21	0	21
173	7	3	0	3
Total		199	35	234

5.8 REINFORCEMENT OF PIPE NETWORK

The SAPS study proposed that new mains with a total length of 8.8 km be installed in order to reinforce the existing water distribution system in CMC.

The study team conducted a review of the SAPS proposal to reassure that it is the most effective option for strengthening the water distribution capacity in CMC. The review included the assessment of the existing distribution system and evaluation of 3 reinforcement options. Hydraulic analyses were conducted for the following 4 cases and Case 2 (SAPS

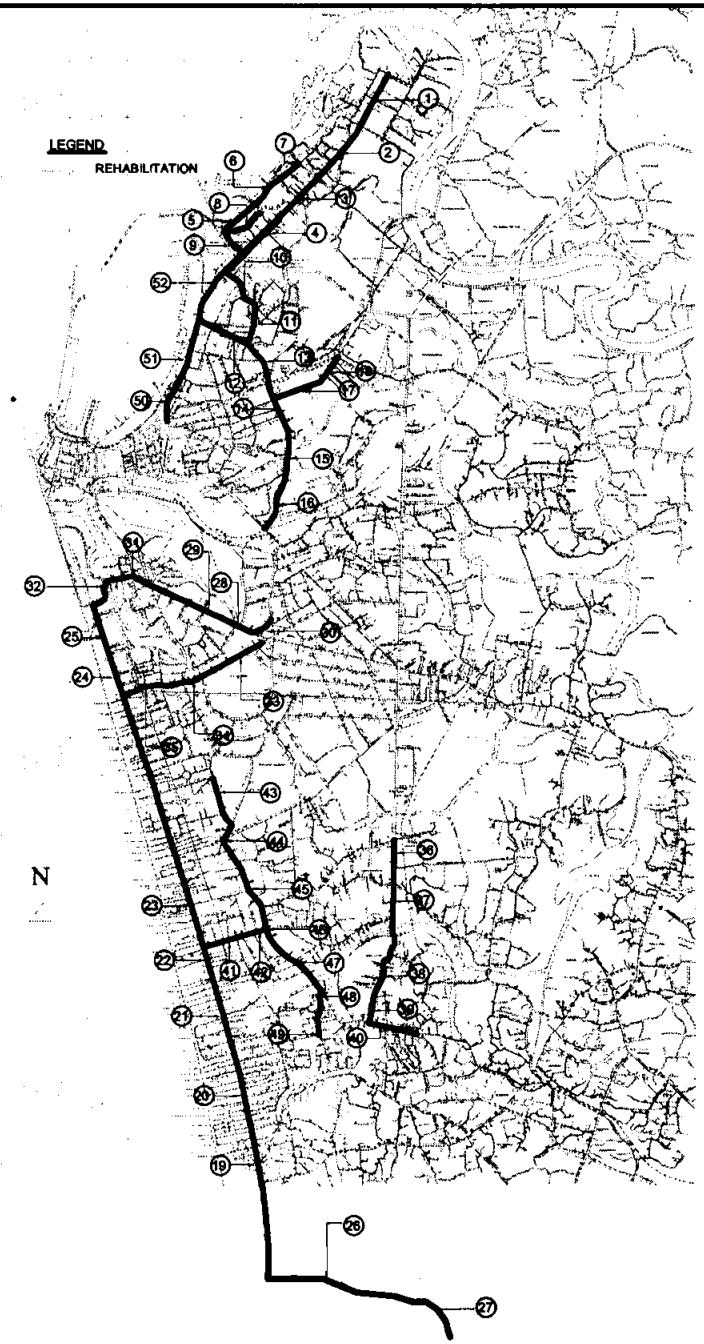
proposal) was confirmed to be the best reinforcement option.

Case 1: Existing Condition (without any reinforcement)
Case 2: Reinforcement Option No.1 (reinforcement according to SAPS proposal)
Case 3: Reinforcement Option No.2 (partial modifications to SAPS proposal)
Case 4: Reinforcement Option No.3 (partial modifications to SAPS proposal)

However it was later found that part of the reinforcing mains proposed in the SAPS study had already been taken up by NWSDB, and hence such mains were replaced with other mains. It was also found that the actual length of the reinforcing main in Stace Road was approximately twice longer than that included in the SAPS proposal (400 m).

Having included these modifications, a total of 9.27 km pipelines have been selected as the reinforcing mains. Their locations are shown in Dwg. No. RML/DM/G-02.

Drawing No.	Road Name	Diameter (mm) & Length (m)					
		300	350	400	450	500	Total
RML/DM/RF/01	Dematagoda Road	650					650
RML/DM/RF/02	Dematagoda Road/Reservoir road				336		336
RML/DM/RF/03	School Lane	207					207
RML/DM/RF/04	Prince Of Wales Avenue				650		650
RML/DM/RF/05	Prince Of Wales Avenue				550		550
RML/DM/RF/06	Sir Jeims Peiris Mawatha/Nawam Mawatha	632					632
RML/DM/RF/07	R.A. De Mell Mawatha/ Perahara Mawatha	510					510
RML/DM/RF/08	Aiwis Place	176					176
RML/DM/RF/09	Mart Road/Sri Nigrodharama Mawatha	248					248
RML/DM/RF/10	Saranapala Himi Mawatha	650					650
RML/DM/RF/11	Saranapala Himi Mawatha	253					253
RML/DM/RF/12	Stace Road		650				650
RML/DM/RF/13	Stace Road		160				160
RML/DM/RF/14	Ward Place			650			650
RML/DM/RF/15	Ward Place			650			650
RML/DM/RF/16	Ward Place			146			146
RML/DM/RF/17	Bloemandhal Road					237	237
RML/DM/RF/18	Port Access Road					600	600
RML/DM/RF/19	Port Access Road					401	401
RML/DM/RF/20	Thimbirigasyaya Road	290					290
RML/DM/RF/21	Mahakumarage Mawatha				627		627
Total Length		**3,616**	**810**	**1,446**	**2,163**	**1,238**	**9,273**



Rehabilitation of Medium & Large Dia. Pipe Network in CMC area Scraping and lining		
Contract No.	Drawing No	Name
NRWCW	RML/DM/RH/01	Mattakkuliya Centre Road
NRWCW	RML/DM/RH/02	Aluthmawatha Road
NRWCW	RML/DM/RH/03	Aluthmawatha Road
NRWCW	RML/DM/RH/04	Aluthmawatha Road
NRWCW	RML/DM/RH/05	St. Andrew's Road
NRWCW	RML/DM/RH/06	Muthuwella Mawatha
NRWCW	RML/DM/RH/07	Muthuwella Mawatha
NRWCW	RML/DM/RH/08	Ellie House Road
NRWCW	RML/DM/RH/09	Lawer St. Andrew's Place
NRWCW	RML/DM/RH/10	Collage Street
NRWCW	RML/DM/RH/11	Kotahena Street
NRWCW	RML/DM/RH/12	George R. De Silva Mawatha
NRWCW	RML/DM/RH/13	George R. De Silva Mawatha
NRWCW	RML/DM/RH/14	Sumanatissa Mawatha
NRWCW	RML/DM/RH/15	Sangaraja Mawatha
NRWCW	RML/DM/RH/16	Panchikawatta Road
NRWCW	RML/DM/RH/17	Grandpass Road
NRWCW	RML/DM/RH/18	Grandpass Road
NRWCW	RML/DM/RH/19	Galle Road
NRWCW	RML/DM/RH/20	Galle Road
NRWCW	RML/DM/RH/21	Galle Road
NRWCW	RML/DM/RH/22	Galle Road
NRWCW	RML/DM/RH/23	Galle Road
NRWCW	RML/DM/RH/24	Galle Road
NRWCW	RML/DM/RH/25	Galle Road
NRWCW	RML/DM/RH/26	Quarry Road
NRWCW	RML/DM/RH/27	Allan Mawatha
NRWCW	RML/DM/RH/28	Union Place
NRWCW	RML/DM/RH/29	Union Place
NRWCW	RML/DM/RH/30	Foster Lane
NRWCW	RML/DM/RH/31	Bridge Street
NRWCW	RML/DM/RH/32	Sir Macan Marker Street
NRWCW	RML/DM/RH/33	Dharmapala Mawatha
NRWCW	RML/DM/RH/34	Dharmapala Mawatha
NRWCW	RML/DM/RH/35	Dharmapala Mawatha
NRWCW	RML/DM/RH/36	Elvitigala Mawatha
NRWCW	RML/DM/RH/37	Elvitigala Mawatha
NRWCW	RML/DM/RH/38	Kirillapone Avenue
NRWCW	RML/DM/RH/39	Kirillapone Avenue
NRWCW	RML/DM/RH/40	High Level Road
NRWCW	RML/DM/RH/41	Dickman's Road
NRWCW	RML/DM/RH/42	Dickman's Road
NRWCW	RML/DM/RH/43	Kumarathunga Munidasa Mawatha
NRWCW	RML/DM/RH/44	Serpentine Road
NRWCW	RML/DM/RH/45	Havelock Road
NRWCW	RML/DM/RH/46	Havelock Road
NRWCW	RML/DM/RH/47	Havelock Road
NRWCW	RML/DM/RH/48	Havelock Road
NRWCW	RML/DM/RH/49	Havelock Road
NRWCW	RML/DM/RH/50	Sea Street
NRWCW	RML/DM/RH/51	St. Anthony's Mawatha
NRWCW	RML/DM/RH/52	Sri Ramanathan Mawatha

LEGEND

- SLUICE VALVE
- SUSPECTED SLUICE VALVE
- STAND POST
- FIRE HYDRANT
- AIR VALVE
- FIRE HYDRANT & SLUICE VALVE
- WASHOUT VALVE
- CHAMBER
- CENTER LINE
- BY PASS LINE
- NOT MAPPED ACCURATELY

Notes:

1. Plan of the existing distribution main and the junction details extract from the 1:1000 Drawings of the NWS&DB and the details at the junction should be verified at site.
2. Longitudinal section produced from the spot levels given in the 1:1000 Drgs and pipe diameters for existing pipes are inches and levels are in meters.
3. All the accessories on the mains and valves Immediately on Branch pipes proposed for scraping and lining should be replace with new accessories as per Standard Drawing No STD/C-10.
4. The shop drawings of the proposed main to be produced after a utility tracing. (Utilities like Telecom Cables, Electrical Cables, Sewer Lines, Storm Water Pipes /Drains etc. to avoid damage to them)
5. For standard details refer Standard Drgs STD/C/01-10
6. All existing pipes proposed for rehabilitation are cast iron pipes.
7. The each of ten random sample pipes investigated shows that existing Medium and Large Diameter pipes are at a depth range of 0.55-1.35m and the existing small diameter pipes are at a depth range of 0.5-1.3m
8. The minimum size of the by-pass should be of 200 mm in Dia. wherever possible.
9. Cross reference to be made for Drawing Nos. Starting from RML/DM/RF, RML/DM/RF, RS/DM/RP and RS/DM/RH
10. Scraping and Lining to be carried out for the sections given and Valve locations and tight bends and tees to be used as entry points of lining. The lining of the removed pieces to be carried out above ground and fix it backs with necessary coupling.

DO NOT SCALE

REV	DESCRIPTION

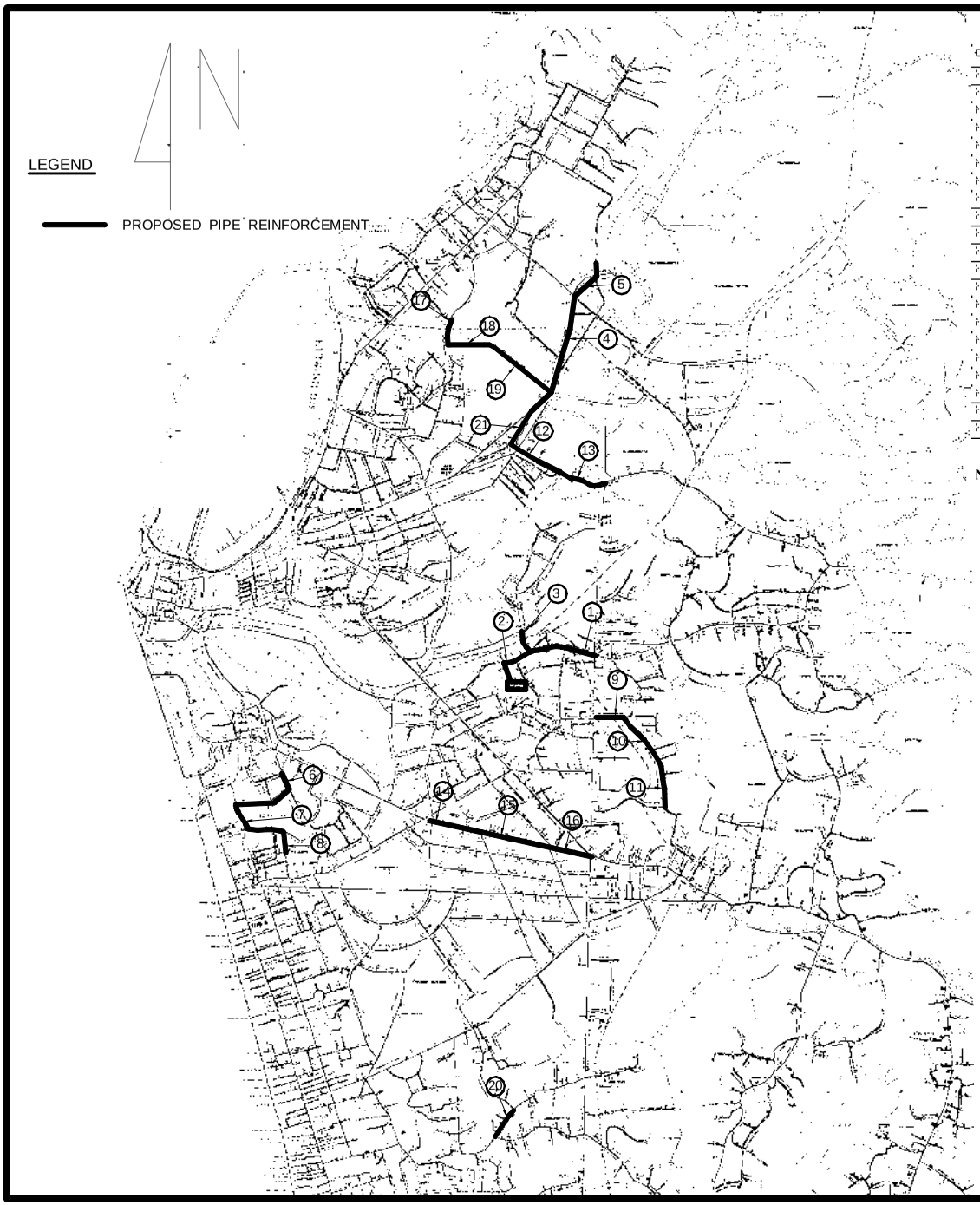
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD.,
TOKYO, JAPAN

SUB PROJECT: GENERAL

TITLE: KEY PLAN
REHABILITATION OF MEDIUM & LARGE DIAMETER PIPES

DESIGNED	DRAWN: THARANGA	DATE: JAN. 2001
CHECKED		CONTRACT No.: NRW / CW
DY. TEAM LEADER		DRG. No.: RML/DM/G-01
TEAM LEADER		



Reinforcement of Medium & Large Dia. Pipe Network in CMC area

Contract No.	Drawing No	Name
NRW/CW	RML/DM/RF/01	Dematagoda Road
NRW/CW	RML/DM/RF/02	Dematagoda Road/Reservoir road
NRW/CW	RML/DM/RF/03	School Lane
NRW/CW	RML/DM/RF/04	Prince Of Wales Avenue
NRW/CW	RML/DM/RF/05	Prince Of Wales Avenue
NRW/CW	RML/DM/RF/06	Sir Jeams Peiris Mawatha/Maccarthy Mawatha
NRW/CW	RML/DM/RF/07	R A De Mell Mawatha/ Peradeniya Mawatha
NRW/CW	RML/DM/RF/08	Aynis Place
NRW/CW	RML/DM/RF/09	Dart Road/Sri Rigrodharama Mawatha
NRW/CW	RML/DM/RF/10	Saranapala Dimi Mawatha
NRW/CW	RML/DM/RF/11	Saranapala Dimi Mawatha
NRW/CW	RML/DM/RF/12	Stace Road
NRW/CW	RML/DM/RF/13	Stace Road
NRW/CW	RML/DM/RF/14	Ward Place
NRW/CW	RML/DM/RF/15	Ward Place
NRW/CW	RML/DM/RF/16	Ward Place
NRW/CW	RML/DM/RF/17	Bloemendhal Road
NRW/CW	RML/DM/RF/18	Port Access Road
NRW/CW	RML/DM/RF/19	Port Access Road
NRW/CW	RML/DM/RF/20	Thimbirigasyaya Road
NRW/CW	RML/DM/RF/21	Kanakumarage Mawatha

LEGEND

- SLUICE VALVE
- SUSPECTED SLUICE VALVE
- STAND POST
- FIRE HYDRANT
- AIR VALVE
- FIRE HYDRANT & SLUICE VALVE
- WASHOUT VALVE
- CHAMBER
- CENTER LINE
- BY PASS LINE
- NOT MAPPED ACCURATELY

Notes:

1. Plan of existing distribution main and the junction details extract from the 1:1000 Drawings of the NWS&DB and the details at the junction should be verified at site.
2. Longitudinal section produced from the spot level given in the 1:1000 Drgs and pipe diameters for the proposed pipe lines are in mms and existing pipes are inches and levels are in meters.(The Port Access Road and Pipe Crossings at Stace Road & Navam Mawatha Bridge are based on topographic survey.)
3. All the interconnections and accessories on the proposed main should be as per the given drawing details and Standard Drawings.
4. When new pipe connecting to the existing main please refer the connection detail given in Drawing No. STD/C -10.
5. The shop drawings of the proposed main to be produced after a topographic survey and utility tracing.(Utilities like Telecom Cables, Electrical Cables, Sewer Lines, Storm Water Pipes /Drains etc. to avoid damage to them)
6. For Standard Drgs. Please refer STD/C-01 to 11.
7. All existing pipes connecting to the reinforcement pipes are cast iron pipes except mains laid under Base Line Project and Steel main at Walls Lane.
8. All the proposed mains to be DI Pipes and Fittings except pipe bridge crossings.
9. The each of ten random sample pipes investigated shows that existing Medium and Large Diameter pipes are at a depth range of 0.55-1.35m and the existing small diameter pipes are at a depth range of 0.5-1.3m
10. Cross reference to be made for Drawing Nos. Starting from RML/DM/RH, RML/DM/RF RS/DM/RP and RS/DM/RH.
11. Bends to be protected using thrust blocks as per Standard Drawing No. STD/C-08.
12. Commissioning of the Reinforcement Mains to be Carried out in steps by Closing the Tapping Off from Transmission Main to the Existing System This Process to be Carried out When the Rehabilitation of the Two Reservoirs (Maligakanda and Ellie House) Yard Piping are in Operation.

DO NOT SCALE

REV.	DESCRIPTION

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

SUB PROJECT: GENERAL

TITLE: KEY PLAN REINFORCEMENT OF MEDIUM & LARGE DIAMETER PIPES

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN

DESIGNED:	DRAWN: THARANGA	DATE: JAN. 2001
CHECKED:	PM (NRW/SAPE) NAME/DE:	CONTRACT No: NRW / CW
DY. TEAM LEADER:	A.G.M (P&D) NAME/DE:	DRG. No: RML/DM/G - 02
TEAM LEADER:	D.G.M (P&D) NAME/DE:	

CHAPTER 6

6 REHABILITATION & REPLACEMENT OF SMALL DIAMETER DISTRIBUTION MAINS IN CB1 AREA

6.1 BACKGROUND

The scope of JBIC loan includes the following improvement works to existing small diameter distribution mains in CB1 area.

- Rehabilitation of water mains (length: 33 km; diameter: 50 mm to 150 mm)
- Replacement of water mains (length: 5.55 km)
- Rehabilitation and replacement of valves and installation of valve covers
- Replacement of service connections

The scope of the JICA detailed design study is to conduct leakage survey and pipe assessment in CB1 area, formulate most effective rehabilitation and replacement plans, and prepare detail designs for the proposed improvement plans.

6.2 REHABILITATION OF EXISTING WATER MAINS

NWSDB records available in early 2000 indicated that more than 80% of the existing cast iron water mains in CB1 are older than 70 years and 64% being older than 100 years.

As mentioned earlier in Chapter 5, the study team conducted leakage surveys and pipe assessment on the existing distribution mains including small diameter mains in CB1. Leak repair records on the existing small diameter mains in CB1 were collected and analyzed. The study team also conducted the measurement of system pressure at 13 strategic locations to assess the current water supply conditions within CB1. In addition, discussions were held with CMC personnel in charge of the distribution system to reflect their views and opinions in the selection of water mains for rehabilitation.

The existing small diameter mains finally selected for rehabilitation program are listed below.

Road Name	Existing CI Mains to be Replaced Diameter (inch) & Length (m)				
	3"	4"	5"	6"	Total
1 st Cross Street			405		405
2 nd Cross street			440		440
3 rd Cross street	220				220
4 th Cross street			425		425
5 th Cross street		450			450
Keysor street	145				145
Main street	570	305			875
Recalamation/Sea Beach Rd			475		475
Malwatta Road		320			320
Olcott Mawatha	420				420
Maliban Street	400				400
Prince Street	98	190	128		416
St.China Lane, Butcher's St., China Lane	278	94			372
Gabos Lane	85				85
Kadiration Road			510		510
1 st Rohini Lane	90				90
2 nd Rohini Lane	95				95
Mayuri Lane	100				100
Cafferman's Lane	65	145			210
Lotus Road		490			490
Sri Wickrema Mawatha	665		190	340	1,195
Francewatta Road	400				400
Mattakkuliya Farm Road		400	400		800
Muthuwella Mawatha		690			690
Sea Street		295	300		595
Aluthmawatha Road		1,200			1,200
Modara Street		840			840
Vystwyke Road				650	650
Vivekananda Hill		544			544
Madampitiya Road		240			240
Bloemendhal Road	340	1,745		2,240	4,325
Messenger Street		1,120			1,120
Quarry Road		455			455
Hospital Road	220				220
College Street		510			510
Mattakkuliya Centre Road		265	400		665
Walls Lane				365	365
Upper St.Andrew's Place	330			165	495
Ferguson Road			170		170
Mayfield Lane	114	350			464
Paramananda Mawatha	105	386		130	621
Bloemendhal Lane			160	160	320
Arthur De Silva Mawatha		230			230
Mattakkuliya Church Road		650		650	1,300
Prince of Wales Avenue		1,117		1,588	2,705
Nagalagam Street		785			785
Rajamalwatta Road		230			230
St.Wilfred's Lane	270				270
St.James Lane	145				145
George R.de Silva Mawatha	450	1,270			1,720
Central Road		780			780
New Moor Street			549		549
Dam Street	215	641			856
Hultsdorf Street		300	285	460	1,045
Silversmith Street		560		30	590
Mirania Street		350	215		565
Sri Sangaraja Mawatha		855			855
Abdul Jabbar Mawatha	187				187
Kelaniganga Mill Road		300			300
Saunder's Place		250			250
Lower St. Andrew''s Place		320			320
Elie House Lane				185	185
St. Anthony Street		637			637
Mayfield Road		678		518	1,196
St. Josep's Street		570			570
Total	6,007	21,557	5,052	7,481	40,097

6.3 REHABILITATION METHOD

The scope of JBIC loan envisages that rehabilitation of small diameter mains would be attained both by scraping and lining (33 km) and by replacement (5.55 km).

However due to the following reasons, the study team recommended NWSDB that all of the water mains selected for rehabilitation program be replaced with new PVC mains.

- In terms of cost, scraping and cement mortar lining will be more expensive than replacement with PVC mains.

- As the final product, new PVC mains will be far more reliable than scraped and cement mortar lined old cast iron mains. About a half of the water mains selected have already developed frequent leaks and scraping and cement mortar lining cannot rectify this problem.

- The benefits of scraping without cement mortar lining will last only for several years, whereas providing cement mortar lining in small diameter mains will result in a significant decrease in the cross-sectional area, and the use of a thinner lining material such as “epoxy” will be much more costly.

- There appear to be many unknown valves completely buried underground and difficult to locate on the ground. Those unknown valves will certainly undermine the scraping and cement mortar lining operation.

The recommendation was discussed with NWSDB at many meetings, and it was finally decided that all of the 3”, 4” and 5” water mains listed in the foregoing table be replaced with new PVC mains whereas the 6” mains be reconditioned by scraping and cement mortar lining.

Accordingly, a plan for the replacement of existing 3”, 4” and 5” mains has been prepared. In general, both 3” and 4” mains will be replaced with 110 mm PVC mains whereas 5” mains with 160 mm PVC mains. However, in some extremely low pressure areas, 225 mm PVC mains will be used for replacement. Table below shows the replacement plan.

The locations of the existing 3”, 4” and 5” mains selected for replacement are shown in Drg. No. RS/DM/G-01. The locations of the 6” mains to be reconditioned by scraping and cement mortar lining are shown in Drg. No. RS/DM/G-02

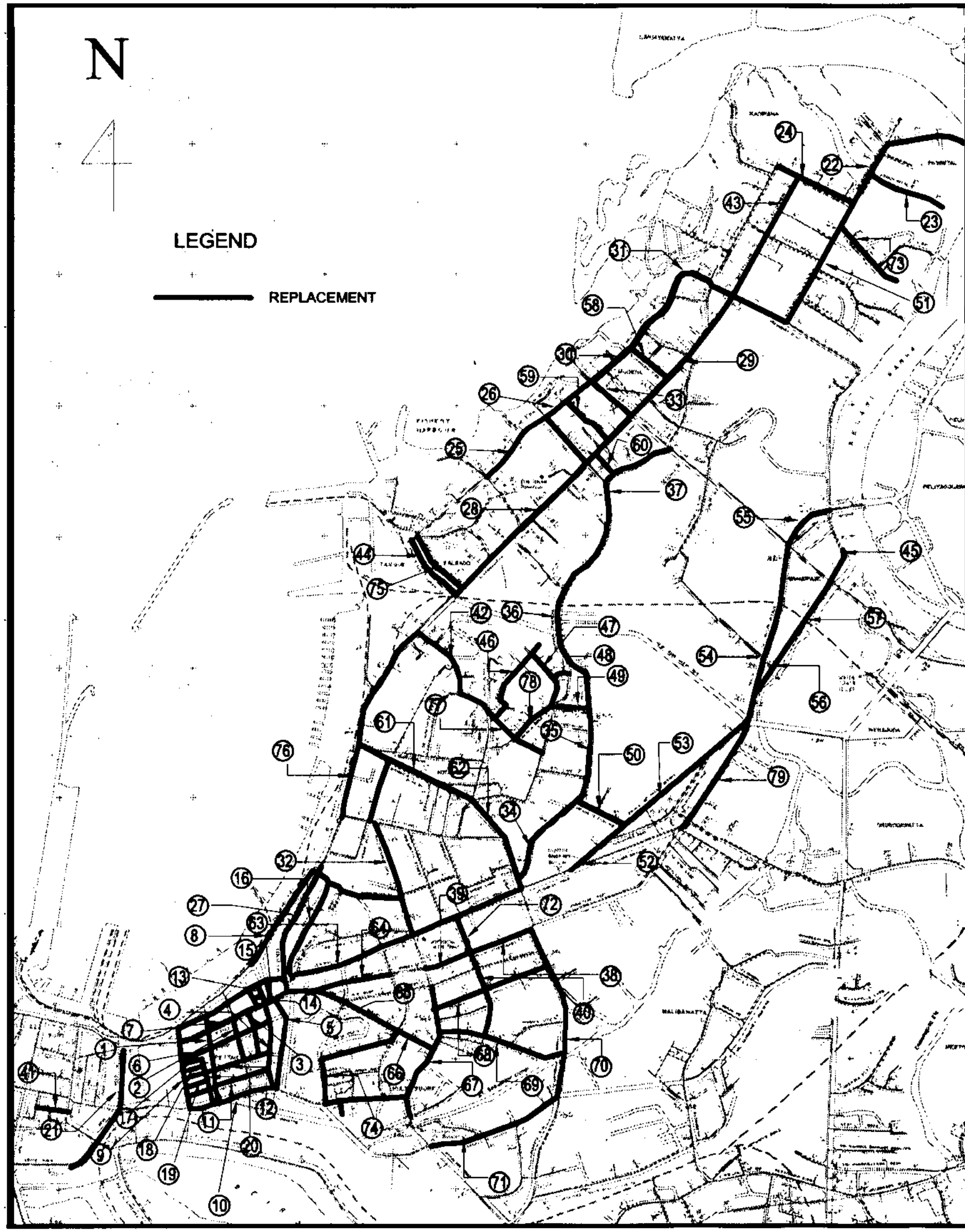
Road Name	Existing CI Mains to be Replaced				Proposed PVC Mains			
	Diameter (inch) & Length (m)				Diameter (mm) & Length (m)			
	3"	4"	5"	Total	110	160	225	Total
1 st Cross Street			405	405		405		405
2 nd Cross street			440	440		440		440
3 rd Cross street	220			220	220			220
4 th Cross street			425	425		425		425
5 th Cross street		450		450		450		450
Keysor street	145			145	145			145
Main street	570	305		875		875		875
Recalamation/Sea Beach Rd			475	475		475		475
Malwatta Road		320		320		320		320
Olcott Mawatha	420			420			420	420
Maliban Street	400			400		400		400
Prince Street	98	190	128	416	288	128		416
St.China Lane, Butcher's St., China Lane	278	94		372	372			372
Gabos Lane	85			85		85		85
Kadiration Road			510	510		510		510
1 st Rohini Lane	90			90	90			90
2 nd Rohini Lane	95			95	95			95
Mayuri Lane	100			100	100			100
Cafferman's Lane	65	145		210	210			210
Lotus Road		490		490		490		490
Sri Wickrema Mawatha	665		190	855	665	190		855
Francewatta Road	400			400	400			400
Mattakkuliya Farm Road		400	400	800	400	400		800
Muthuwella Mawatha		690		690	690			690
Sea Street		295	300	595	295	300		595
Aluthmawatha Road		1,200		1,200		1,200		1,200
Modara Street		840		840	840			840
Vivekananda Hill		544		544	544			544
Madampitiya Road		240		240	240			240
Bloemendhal Road	340	1,745		2,085	2,085			2,085
Messenger Street		1,120		1,120	1,120			1,120
Quarry Road		455		455	455			455
Hospital Road	220			220	220			220
College Street		510		510	510			510
Mattakkuliya Centre Road		265	400	665	265	400		665
Upper St.Andrew's Place	330			330	330			330
Ferguson Road			170	170		170		170
Mayfield Lane	114	350		464	464			464
Paramananda Mawatha	105	386		491	491			491
Bloemendhal Lane			160	160		160		160
Arthur De Silva Mawatha		230		230	230			230
Mattakkuliya Church Road		650		650		650		650
Prince of Wales Avenue		1,117		1,117	1,117			1,117
Nagalagam Street		785		785	785			785
Rajamalwatta Road		230		230	230			230
St.Wilfred's Lane	270			270	270			270
St.James Lane	145			145	145			145
George R.de Silva Mawatha	450	1,270		1,720	1,720			1,720
Central Road		780		780	780			780
New Moor Street			549	549		549		549
Dam Street	215	641		856	856			856
Hultsdorf Street		300	285	585	300	285		585
Silversmith Street		560		560		560		560
Mirania Street		350	215	565	350	215		565
Sri Sangaraja Mawatha		855		855	855			855
Abdul Jabbar Mawatha	187			187	187			187
Kelaniganga Mill Road		300		300	300			300
Saunder's Place		250		250	250			250
Lower St. Andrew"s Place		320		320	320			320
St. Anthony Street		637		637	637			637
Mayfield Road		534		534	534			534
Mayfield Road		144		144	144			144
St. Josep's Street		570		570	570			570
Total	6,007	21,557	5,052	32,616	22,114	10,082	420	32,616

6.4 REPLACEMENT OF SERVICE CONNECTIONS AND VALVES

NWSDB records indicate that there are a total of 8,923 service connections on the water mains selected for rehabilitation comprising 8,032 connections on the 3", 4" and 5" mains and 891 connections on the 6" mains. These service connections are assumed to have been similarly deteriorated. Replacement of these service connections is also necessary to minimize service interruption during replacement work and for a smooth operation of scraping and cement mortal lining.

NWSDB records also indicate that there are a total of 686 existing valves on the water mains selected for rehabilitation. For the same reasons as sited for service connection, these existing valves have been proposed for replacement.

Valve size (mm)	75	100	125	150	Total
Quantity	73	432	20	161	686



Rehabilitation of Small Dia. Pipe Network in CMC area			
1	NRW/CW	RS/DM/RP/01	1 st Cross Street
2	NRW/CW	RS/DM/RP/02	2 nd Cross street
3	NRW/CW	RS/DM/RP/03	3 rd Cross street
4	NRW/CW	RS/DM/RP/04	4 th Cross street
5	NRW/CW	RS/DM/RP/05	5 th Cross street
6	NRW/CW	RS/DM/RP/06	Keysor street
7	NRW/CW	RS/DM/RP/07	Main street
8	NRW/CW	RS/DM/RP/08	Reclamation/Sea Beach Rd
9	NRW/CW	RS/DM/RP/09	Malwatte Road
10	NRW/CW	RS/DM/RP/10	Olcott Mawatha
11	NRW/CW	RS/DM/RP/11	Maliban Street
12	NRW/CW	RS/DM/RP/12	Prince Street
13	NRW/CW	RS/DM/RP/13	Sameera's lane,Market
14	NRW/CW	RS/DM/RP/14	Butcher's St., China Lane
15	NRW/CW	RS/DM/RP/15	Gaboe Lane
16	NRW/CW	RS/DM/RP/16	Kadirailon Road
17	NRW/CW	RS/DM/RP/17	1 st Rohini Lane
18	NRW/CW	RS/DM/RP/18	2 nd Rohini Lane
19	NRW/CW	RS/DM/RP/19	Mayuri Lane
20	NRW/CW	RS/DM/RP/20	Caffarman's Lane
21	NRW/CW	RS/DM/RP/21	Lotus Road
22	NRW/CW	RS/DM/RP/22	Sri Wickrama Mawatha
23	NRW/CW	RS/DM/RP/23	Francewatta Road
24	NRW/CW	RS/DM/RP/24	Mattakkuliya Farm Road
25	NRW/CW	RS/DM/RP/25	Muthuwella Mawatha
26	NRW/CW	RS/DM/RP/26	Muthuwella Mawatha
27	NRW/CW	RS/DM/RP/27	Sea Street
28	NRW/CW	RS/DM/RP/28	Aluthmawatha Road
29	NRW/CW	RS/DM/RP/29	Aluthmawatha Road
30	NRW/CW	RS/DM/RP/30	Modera Street
31	NRW/CW	RS/DM/RP/31	Modera Street
32	NRW/CW	RS/DM/RP/32	Vivekananda Hill
33	NRW/CW	RS/DM/RP/33	Madampitiya Road
34	NRW/CW	RS/DM/RP/34	Bloemendhal Road
35	NRW/CW	RS/DM/RP/35	Bloemendhal Road
36	NRW/CW	RS/DM/RP/36	Bloemendhal Road
37	NRW/CW	RS/DM/RP/37	Bloemendhal Road
38	NRW/CW	RS/DM/RP/38	Messenger Street
39	NRW/CW	RS/DM/RP/39	Messenger Street
40	NRW/CW	RS/DM/RP/40	Quarry Road
41	NRW/CW	RS/DM/RP/41	Hospital Road
42	NRW/CW	RS/DM/RP/42	College Street
43	NRW/CW	RS/DM/RP/43	Mattakkuliya Centre Road
44	NRW/CW	RS/DM/RP/44	Upper St.Andrew's Place
45	NRW/CW	RS/DM/RP/45	Ferguson Road
46	NRW/CW	RS/DM/RP/46	Mayfield Lane
47	NRW/CW	RS/DM/RP/47	Paramananda Mawatha
48	NRW/CW	RS/DM/RP/48	Paramananda Mawatha
49	NRW/CW	RS/DM/RP/49	Bloemendhal Lane
50	NRW/CW	RS/DM/RP/50	Arthur De Silva Mawatha
51	NRW/CW	RS/DM/RP/51	Mattakkuliya Church Road
52	NRW/CW	RS/DM/RP/52	Prince of Wales Avenue
53	NRW/CW	RS/DM/RP/53	Prince of Wales Avenue
54	NRW/CW	RS/DM/RP/54	Prince of Wales Avenue
55	NRW/CW	RS/DM/RP/55	Prince of Wales Avenue
56	NRW/CW	RS/DM/RP/56	Nagalagam Street
57	NRW/CW	RS/DM/RP/57	Nagalagam Street
58	NRW/CW	RS/DM/RP/58	Rajamalwatta Road
59	NRW/CW	RS/DM/RP/59	St.Wilfred's Lane
60	NRW/CW	RS/DM/RP/60	St.James Lane
61	NRW/CW	RS/DM/RP/61	George R.de Silva Mawatha
62	NRW/CW	RS/DM/RP/62	George R.de Silva Mawatha
63	NRW/CW	RS/DM/RP/63	Central Road
64	NRW/CW	RS/DM/RP/64	New Moor Street
65	NRW/CW	RS/DM/RP/65	Dam Street
66	NRW/CW	RS/DM/RP/66	Dam Street
67	NRW/CW	RS/DM/RP/67	Hultsdorf Street
68	NRW/CW	RS/DM/RP/68	Silversmith Street
69	NRW/CW	RS/DM/RP/69	Mirania Street
70	NRW/CW	RS/DM/RP/70	Sri Sangaraja Mawatha
71	NRW/CW	RS/DM/RP/71	Sri Sangaraja Mawatha
72	NRW/CW	RS/DM/RP/72	Abdul Jabbar Mawatha
73	NRW/CW	RS/DM/RP/73	Kelaniganga Mill Road
74	NRW/CW	RS/DM/RP/74	Saunder's Place
75	NRW/CW	RS/DM/RP/75	Lower St. Andrew's Place
76	NRW/CW	RS/DM/RP/76	St. Anthony Street
77	NRW/CW	RS/DM/RP/77	Mayfield Road
78	NRW/CW	RS/DM/RP/78	Wasala Road
79	NRW/CW	RS/DM/RP/79	St. Josep's Street

LEGEND

- SLUICE VALVE
- SUSPECTED SLUICE VALVE
- STAND POST
- FIRE HYDRANT
- AIR VALVE
- FIRE HYDRANT & SLUICE VALVE
- WASHOUT VALVE
- CHAMBER
- CENTER LINE
- BY PASS LINE
- NOT MAPPED ACCURATELY

Notes:

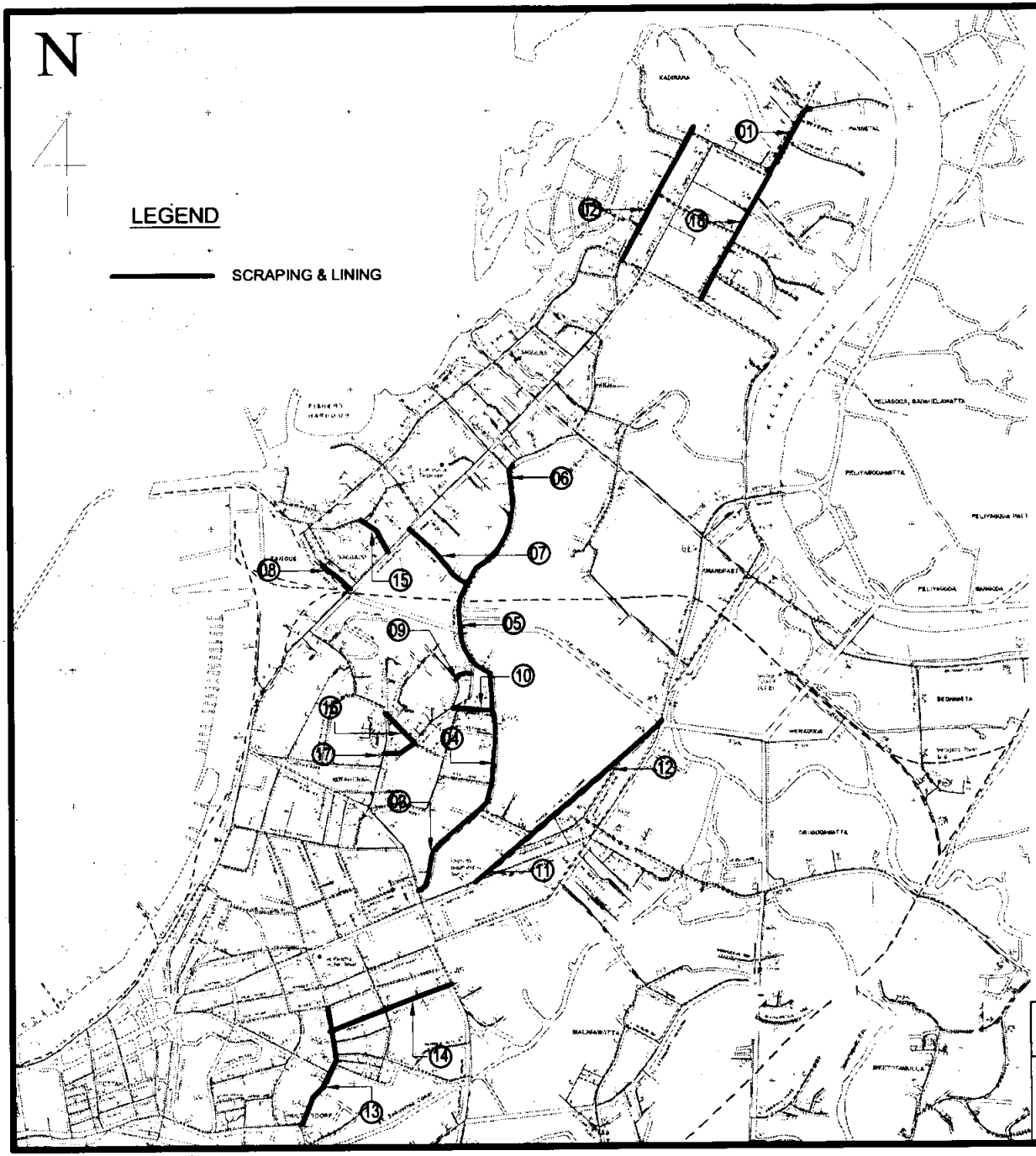
1. Plan of the existing distribution main and the junction details extract from the 1:1000 Drawings of the NWS&DB and the details at the junction should be verified at site.
2. Longitudinal section produced from the spot level given in the 1:1000 Drgs and pipe diameters for the proposed pipe lines are in mms and existing pipes are inches and levels are in meters.
3. All the interconnections and accessories on the proposed main should similar in location to the accessories on the existing pipe line proposed for replacement and as per Standard Drawings.
4. When new pipe connecting to the existing main please refer the Standard connection detail given in drawing No. STD/C-10.
5. The route of the proposed main to be in close proximity to the existing pipe wherever possible.
6. The shop drawings of the proposed main to be produced after a topographic survey and utility tracing. (Utilities like Telecom Cables, Electrical Cables, Sewer Lines, Storm Water Pipes /Drains etc. to avoid damage to them)
7. For Standard Drgs. Please refer STD/C/01-10
8. All existing pipes proposed for replacement are cast iron pipes.
9. All the proposed pipes to be Type 600 uPVC socket and spigot pipes with rubber ring joints and Fittings to be as specified.
10. All existing service connections to be transferred to the new pipe after the pressure test of new pipe with new service connections as per Standard Drawing No STD/C-09.
11. The each of ten sample pipes investigated shows that existing Medium and Large Diameter pipes are at a depth range of 0.55-1.35m and the existing small diameter pipes are at a depth range of 0.5-1.3m
12. The minimum size of the by-pass should be 100mm Dia.
13. Cross reference to be made for Drawing Nos. Starting from RML/DM/RF, RML/DM/RH, RS/DM/RP and RS/DM/RH.
14. Bend to be protected using Thrust Blocks as per Standard Drawing No STD/C-08.

DO NOT SCALE

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD., TOKYO, JAPAN

SUB PROJECT: GENERAL
TITLE: KEY PLAN REHABILITATION OF SMALL DIAMETER PIPES
DRAWN: THARANGA
DATE: JAN. 2001
CONTRACT No: NRW / CW
DRG. No: RS/DM/G-01



LEGEND

- SLUICE VALVE
- SUSPECTED SLUICE VALVE
- STAND POST
- FIRE HYDRANT
- AIR VALVE
- FIRE HYDRANT & SLUICE VALVE
- WASHOUT VALVE
- CHAMBER
- CENTER LINE
- BY PASS LINE
- NOT MAPPED ACCURATELY

Rehabilitation of Small Dia. Pipe Network in CMC area Scraping & lining			
1	NRW/CW	RS/DM/RH/01	Sri Wickrama Mawatha
2	NRW/CW	RS/DM/RH/02	Vyshya Road
3	NRW/CW	RS/DM/RH/03	Bloemendhal Road
4	NRW/CW	RS/DM/RH/04	Bloemendhal Road
5	NRW/CW	RS/DM/RH/05	Bloemendhal Road
6	NRW/CW	RS/DM/RH/06	Bloemendhal Road
7	NRW/CW	RS/DM/RH/07	Wells Lane
8	NRW/CW	RS/DM/RH/08	Upper St Andrew's Place
9	NRW/CW	RS/DM/RH/09	Peramunanda Mawatha
10	NRW/CW	RS/DM/RH/10	Bloemendhal Lane
11	NRW/CW	RS/DM/RH/11	Prince of Wales Avenue
12	NRW/CW	RS/DM/RH/12	Prince of Wales Avenue
13	NRW/CW	RS/DM/RH/13	Hultsdorf Street
14	NRW/CW	RS/DM/RH/14	Silversmith Street
15	NRW/CW	RS/DM/RH/15	Elie House Lane
16	NRW/CW	RS/DM/RH/16	Mayfield Road
17	NRW/CW	RS/DM/RH/17	Wasala Road
18	NRW/CW	RS/DM/RH/18	Mattakkuliya Church Road

Notes:

1. Plan of the existing distribution main and the junction details extract from the 1:1000 Drawings of the NWS&DB and the details at the junction should be verified at site.
2. Longitudinal section produced from the spot levels given in the 1:1000 Drgs and pipe diameters for existing pipes are inches and levels are in meters.
3. All the accessories on the mains and valves Immediately on Branch pipes proposed for scraping and lining should be replace with new accessories.
4. The shop drawings of the proposed main to be produced after a utility tracing. (Utilities like Telecom Cables, Electrical Cables, Sewer Lines, Storm Water Pipes /Drains etc. to avoid damage to them)
5. For standard details refer Standard Drgs STD/C/01-10
6. All existing pipes proposed for rehabilitation are cast iron pipes.
7. The each of ten random sample pipes investigated shows that existing Medium and Large Diameter pipes are at a depth range of 0.55-1.35m and the existing small diameter pipes are at a depth range of 0.5-1.3m
8. The minimum size of the by-pass should be of 100 mm in Dia. wherever possible.
9. Cross reference to be made for Drawing Nos. Starting from RML/DM/RF, RS/DM/RP, RS/DM/RH and RML/DM/RH.
10. Scraping and Lining to be carried out for the sections given and Valve locations and tight bends and toes to be used as entry points of lining. The lining of the removed pieces to be carried out above ground and fix it back with necessary coupling.
11. Bend to be protected using Thrust Blocks as per Standard Drawing No. STD/C - 08
12. Service connections to be replaced with new service connections as per Standard Drawing No. STD/C – 10.
13. Continuity of the water supply to all houses affected to be ensured.

DO NOT SCALE

REV	DESCRIPTION

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
THE PROJECT FOR THE REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STUDY TEAM
NIHON SUIDO CONSULTANTS CO. LTD.,
TOKYO, JAPAN

SUB PROJECT: GENERAL

TITLE: KEY PLAN
REHABILITATION OF SMALL DIAMETER PIPES (SCRAPING & LINING)

DESIGNED | DRAWN: THARANGA | DATE: JAN 2009
CHECKED | PM (WATER SUPPLY) | CONTRACT No. NRW / CW
DY TEAM LEADER | A & M (PIPELINES) | DRG. No.
TEAM LEADER | D & M (PIPELINES) | RS/DM/G-02

CHAPTER 7

7 CONSTRUCTION PLAN AND SCHEDULE

7.1 BASIC ASSUMPTIONS

In preparing construction plans and schedules, typical unit outputs for civil works are assumed as follows:

Description	**Item**	**Unit**	**Output**
Excavation/earthmoving	Backhoe 1.5 m^3	m^3/hour	20
	Front end loader 2 m^3	m^3/hour	20
Concrete forms in place	Slab on grade, mat foundations	m^2/day	15
	Beams	m^2/day	5
	Elevated slabs	m^2/day	10
	Columns, square	Contact area m^2/day	2
	Walls	m^2/day	30
Concrete forms, slip form	Columns, round	Contact area m^2/day	80
Concrete reinforcement	Slabs on grade	Tons/day	2
	Elevated slabs	Tons/day	3
	Columns	Tons/day	2
	Walls	Tons/day	3
Placing concrete (pumped to forms in place)	Slab on grade	m^3/day	100
	Walls	m^3/day	75
	Columns	m^3/day	50
	Elevated slabs	m^3/day	100
	beams	m^3/day	50
Slip forming	Walls and columns	Mm/hour vertical lift	300 mm/hr

Similarly, typical unit outputs for pipe installation of water mains are assumed as follows:

Description	Item	Unit	Output
New ductile iron pipe [1]	400 to 500 mm ND	m/day	16.5
	250 to 300 mm ND	m/day	22.0
New PVC pipe [1]	225 mm ND	m/day	30.0
	160 mm ND	m/day	36.0
	110 mm ND	m/day	48.0
Pipe scrapping and lining [2] medium and large diameters	Day work	m/day	35.0
	Night work	m/day	30.0
Pipe scrapping and lining small diameters[2]	Day work	m/day	50.0
Laying replacement mains [1] [3]	Day work (225 to 400 mm ND)	m/day	18
	Day work (160 mm ND)	m/day	20
	Day work (110 mm ND)	m/day	22.0
	Night work (225 & 500 mm ND)	m/day	14.5
	Night work (160 mm ND)	m/day	16
	Night work (110 mm ND)	m/day	18

Notes:
(1) Rate includes excavation, testing, disinfection and backfill.
(2) Rate does not include by-pass & temporary service connections, excavation, testing and disinfection
(3) Rate does not include by-pass & temporary service connections

Experience with recent water supply projects such as Towns North of Colombo, Towns South of Colombo and Towns East of Colombo indicates that 6 working days per week is achievable on average despite the many holidays that occur in Sri Lanka. Construction schedules are based on 1 working day equal to 8 hours, and 6 days per week.

Ready mix concrete of the required grade is available from several suppliers within the city limits and can be transported in truck mixers in sufficient quantity for continuous concreting operations. The following suppliers will be available for this project.

Supplier		Location	Max. Production capacity (m^3)
1	Keangnam	Malambe	250
2	Maga	Rajagiriya	250
3	Tudawe	Narahenpita	250
4	ICC	Piliyandala	410
5	Sanken Lanka	Peliyagoda	400
6	Sunbee	Orugodawatta	250
7	Devcoshow	Peliyagoda	250

7.2 CONSTRUCTION PERIOD

For each of the proposed facilities, schedule, priority of works and dependencies, and the factors affecting construction activities were evaluated and construction schedules have been prepared. The following is a summary of estimated number of working days required for construction and the expected dates of completion.

	Working Days	Finish
• Maligakanda Office Building	:528	Aug, 2004
• Maligakanda Reservoir	:469	Dec, 2004
• Maligakanda Roof Rehabilitation	:461	Nov, 2006
• Ellie House Reservoir	:1,258	Oct, 2006
• Kolonnawa-Gothatuwa pump house	: 370	July, 2004
• Gothatuwa reservoir, pump house and water tower	: 633	Oct, 2005
• Gothatuwa Transmission main	: 559	Aug, 2004
• Gothatuwa distribution mains	: 712	Feb, 2005
• Large and medium mains scrapping and re-lining	: 831	Jan, 2006
• Large and medium mains reinforcement	: 575	Jan, 2005
• Small mains scrapping and re-lining	: 656	Apr, 2005
• Small mains replacement	: 946	Jun, 2006

The overall implementation schedule for the whole project is presented in Chapter 9.

CHAPTER 8

8 PROJECT COST

8.1 PROJECT COST

The project cost has been estimated as shown in Table 8-1.

Table 8-1 Project Cost

No.	Item	Cost (Yen)
A	Civil Works Contract	3,573,164,788
A1	Preliminary and General Works	539,584,706
A2	Rehabilitation of Maligakanda Reservoir and Ellie House Reservoir	1,318,680,956
A3	Water Supply Enhancement in Kotikawatte and Mulleriyawa Area	846,292,757
A4	Rehabilitation and Reinforcement of Medium and Large Diameter Pipe Network in CMC Area	470,188,753
A5	Rehabilitation of Small Diameter Distribution Mains in CB1 Area	274,924,852
A6	Supply of Materials and Equipment for Reduction of NRW	123,492,764
B	Leak Repair Works Contract	154,849,512
C	Low Income Settlement Environmental Improvement Contract	20,257,613
	Sub-Total for Three Contracts (A+B+C)	3,748,271,912
D	Consulting Service	389,177,139
E	Interest During Construction and Service Charge	177,049,549
	Sub-Total for JBIC Loan Part	**4,314,498,601**
F	Project Administration Cost	64,717,555
G	Land Acquisition Cost	27,400,358
H	Custom Duties	244,736,783
I	GST (Goods and Services Tax)	446,646,072
	Sub-Total for NWSDB Part	**783,500,767**
	Total Project Cost	**5,097,999,368**

CHAPTER 9

9. PROJECT IMPLEMENTATION

9.1 CONTRACT PACKAGES

The project has been divided into three separate contracts as agreed between JBIC and the Sri Lankan Government

(1) Tender Package No.1 - Contract for Civil Works
The contract for civil works will be open to International Competitive Bidding (ICB) and contractors will be screened through a pre-qualification process.

(2) Tender package No.2 - Contract for Leak Repair Works
This contract is open to Local Competitive Bidding (LCB) and contractors will be screened through a pre-qualification process. The contract is for the installation only of materials supplied by NWSDB to repair leaks in distribution mains and service connections in CMC area.

(3) Tender package No. 3 - Contract for Low Income Settlement Environmental Improvement
This contract is open to Local Competitive Bidding (LCB) and contractors will be screened through a pre-qualification process. The contract is for the installation only of materials supplied by NWSDB to provide individual service connections and disconnect common outlets in low-income settlements in CB1 area.

9.2 PROJECT IMPLEMENTATION SCHEDULE

The implementation schedule for the whole project is presented in Figure 9-1

The pre-qualification of international contractors for Civil Works should be finished by end of December 2001. The tender process is expected to take 301 working days from December 2001 to October 2002. The earliest possible construction start date for all components of the Civil Works contract is last week of October 2002. Construction will proceed on several job sites simultaneously and finish in November 2006.

Contracts for leak repair works are subject to local competitive bidding and will take less time to pre-qualify and tender than the civil works contract. The LCB contract will be re-tendered after one year. Pre-qualification is only required once at the beginning and is not necessary for subsequent tender calls. The contract for low-income settlements is arranged in the same

way and has the same schedule as the leak repair contract. The earliest start date for both contracts is January 2002.

9.3 PROJECT IMPLEMENTATION UNIT

9.3.1 Roles and Responsibilities for Project Implementation

The project is one of several large development projects being simultaneously implemented by the NWSDB. The need for consulting services has therefore been identified by the NWSDB to assist with tendering, project management and construction supervision. The project implementation team will consist of three key members:

(1) NWSDB
(2) CMC Water Works
(3) Consultant

9.3.2 Organization of the Project Implementation Unit (PIU)

The NWSDB Project Implementation Unit assembled for the Detailed Designed Study will be re-structured for the construction stage. The PIU will be responsible for project management and coordination within NWSDB and with other authorities. Figure 9-2 shows the location of the PIU within the NWSDB Organization as well as internal and external relationships. The PIU will remain under the principal direction of the Additional GM for Colombo Metropolitan Region. Figure 9-3 indicates the organizational structure and staffing needs of the PIU. The PIU will be divided into 4 major sub teams: 3 for the major construction components of the project and 1 for NRW reduction activities. Each sub-team will be staffed by NWSDB and supported by consultant services.

9.4 ENGINEERING SERVICES FOR IMPLEMENTATION

9.4.1 TOR of Consulting Services

The terms of reference for the consulting services will include:

(1) Assistance with Tendering
(2) Services required during construction (rehabilitation works)
(3) Resident Staff Services (civil works)
(4) Training for operation and maintenance (civil works)
(5) Counterpart Training (in-house and overseas)

(6) Services required during implementation of NRW program

In addition, the consultant will provide advisory/ management services on the NRW reduction activities.

9.4.2 Allocation of Resources and Inputs

Allocation of resources and inputs for consultant services during construction is presented in Figure 9-4. Duration of inputs is based on the estimated construction schedule. Services during construction are required for a period of approximately 69 months (5.75 years). Consultant services should start September 2001 to coincide with the evaluation of pre-qualification submissions.

9.5 RECOMMENDATIONS ON THE WAY FORWARD

9.5.1 Land acquisition and easements

Land and temporary easements must be acquired before the project is tendered and sufficient time must be allowed for any adjustments to the design drawings if required.

(1) Maligakanda office building
(2) Temporary easement for reservoir at Maligakanda
(3) Land acquisition for Gothatuwa reservoir and tower

9.5.2 Temporary relocation of CMC offices at Maligakanda

In the initial planning concept the staff from CMC offices are to be relocated to the new office building before starting the construction of the reservoir. This sequence must be revised because construction scheduling indicates that the rehabilitation of old reservoir could not be finished until mid-2007 thereby exceeding the JBIC loan period. Construction of the new reservoir must start before the new office building is finished. Therefore the staff from CMC offices will need temporary accommodations from approximately March 2003 to June 2004 until the new office building is ready for occupancy.

9.5.3 Assessment of Old Maligakanda Reservoir

A structural appraisal of the old reservoir is required before starting construction of the new roof to determine if the reservoir can in fact provide another 40 to 50 years of trouble free,

watertight service. If the reservoir is deemed unsound or near the end of its service life then there will be no financial benefit for replacing the roof and the reservoir should be replaced entirely or abandoned. A thorough inspection and appraisal of the structure will require a 4 to 5 month study period.

9.5.4 Confirmation of Geotechnical conditions at Gothatuwa

A complete geotechnical investigation was not possible during the detailed design because permission to access the property was not granted by the owners. NWSDB must carry out a Geotechnical investigation and assessment of the reservoir site to confirm the foundation design parameters.

9.5.5 Timing for Construction of a 600 mm Transmission Main to Kolonnawa New Reservoir

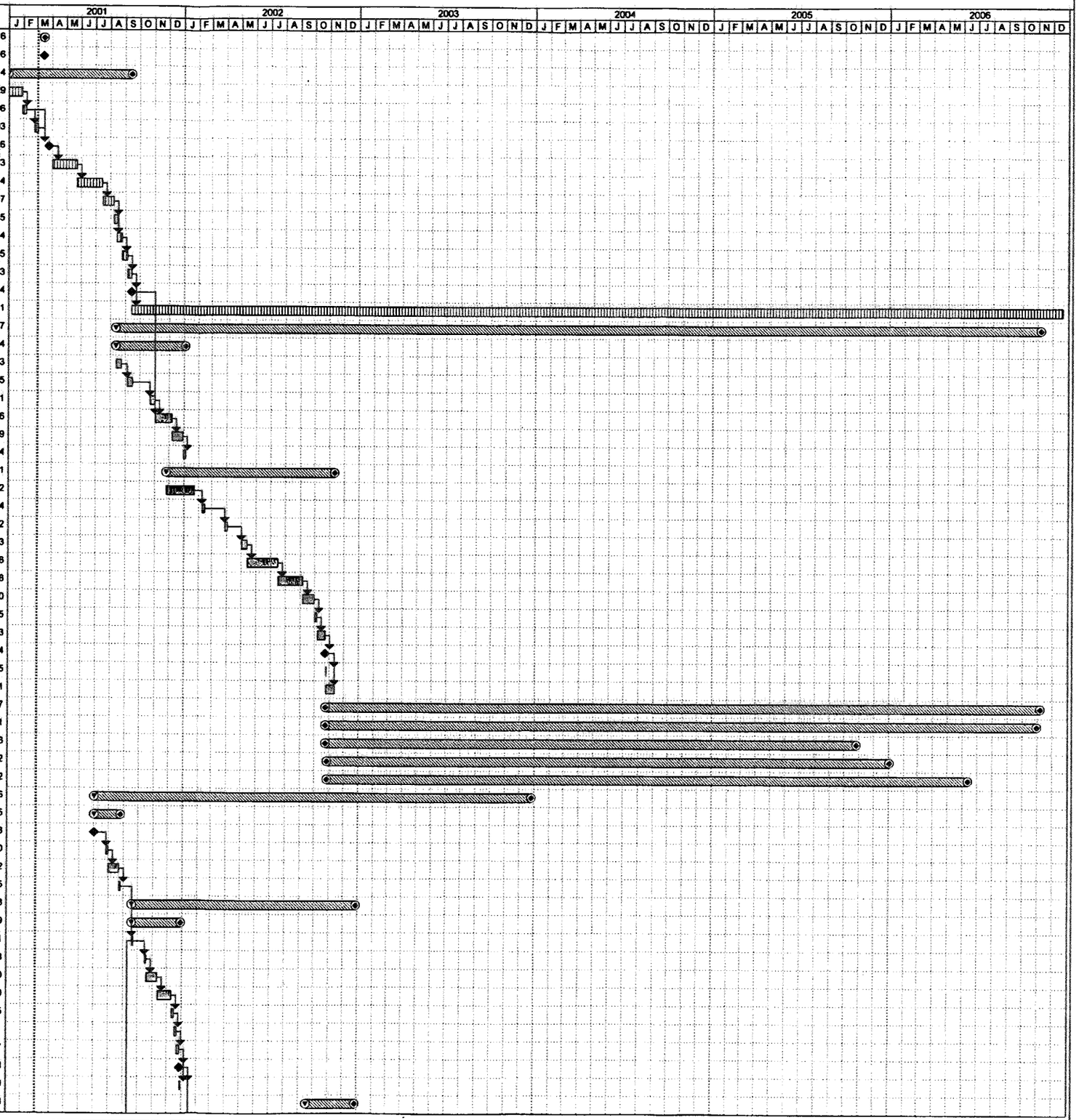
Route of the above main which is to be constructed by NWSDB under another contract passes through Angoda Road and Delgahawatta Road along which laying of distribution mains under this project will be carried out. NWSDB should coordinate the detailed design of 600 mm main in these roads and the timing of its construction to reduce inconvenience to the public.

9.5.6 As-built drawings and construction records

The present construction records keeping system is completely inadequate. Effective operations and maintenance of the water supply system requires accurate records and drawings of the distribution network and other important water supply facilities, and these documents must be available to the operators and kept up to date for future reference. A workable record keeping and management system needs to be implemented on an priority basis to ensure the sustainability of investments.

Figure 9-1 Project Implementation Schedule (Sheet 1 of 2)

ID	Task Name	Duration	Start	Finish
1	**JICA DETAILED DESIGN**	1 day	Fri 01/03/16	Fri 01/03/16
2	Submission of Final Report	1 day	Fri 01/03/16	Fri 01/03/16
3	**I-1. SELECTION OF CONSULTANT FOR CONSTRUCTION SUPERVISION**	221 days	Mon 01/01/01	Fri 01/09/14
4	Approval of TOR, Short List & Inv. Ltr by JBIC	25 days	Mon 01/01/01	Mon 01/01/29
5	Issuance of Invitation Letter	7 days	Tue 01/01/30	Tue 01/02/06
6	Briefing	7 days	Sat 01/02/24	Sat 01/03/03
7	Receipt of Proposals	1 day	Mon 01/03/26	Mon 01/03/26
8	Evaluation of Proposals	45 days	Mon 01/04/02	Wed 01/05/23
9	Internal Approval of Evaluation Results	45 days	Thu 01/05/24	Sat 01/07/14
10	Approval of Evaluation Results by JBIC	20 days	Mon 01/07/16	Tue 01/08/07
11	Issuance of NOITAC	7 days	Wed 01/08/08	Wed 01/08/15
12	Preparation of Contract	10 days	Tue 01/08/14	Fri 01/08/24
13	Signing of Contract	10 days	Sat 01/08/25	Wed 01/09/05
14	Issuance of NTP	7 days	Thu 01/09/06	Thu 01/09/13
15	Mobilization by Consultant	1 day	Fri 01/09/14	Fri 01/09/14
16	**I-2. SERVICES DURING CONSTRUCTION**	1650 days	Fri 01/09/14	Thu 06/12/21
17	**II. CIVIL WORKS**	1640 days	Mon 01/08/13	Tue 06/11/07
18	**II-1. PREQUALIFICATION**	125 days	Mon 01/08/13	Fri 02/01/04
19	Approval of PQ Documents by JBIC	10 days	Mon 01/08/13	Thu 01/08/23
20	PQ Announcement	10 days	Wed 01/09/05	Sat 01/09/15
21	Receipt of Applications	10 days	Mon 01/10/22	Thu 01/11/01
22	Evaluation of Applications	30 days	Fri 01/11/02	Thu 01/12/06
23	Approval of Evaluation Results by JBIC	20 days	Fri 01/12/07	Sat 01/12/29
24	Notice of Evaluation Results to Applicants	5 days	Mon 01/12/31	Fri 02/01/04
25	**II-2. TENDERING (ICB)**	301 days	Mon 01/11/26	Mon 02/11/11
26	Approval of Tender Documents by JBIC	50 days	Mon 01/11/26	Tue 02/01/22
27	Tender Announcement	5 days	Sat 02/02/09	Thu 02/02/14
28	Pre-Bid Meeting	5 days	Thu 02/03/28	Tue 02/04/02
29	Reciept & Opening of Tenders	10 days	Thu 02/05/02	Mon 02/05/13
30	Evaluation of Tenders	55 days	Tue 02/05/14	Tue 02/07/16
31	Internal Approval of Evaluation Results	45 days	Wed 02/07/17	Fri 02/09/06
32	Approval of Evaluation Results by JBIC	20 days	Sat 02/09/07	Mon 02/09/30
33	Issuance of NOITAC	5 days	Tue 02/10/01	Sat 02/10/05
34	Preparation of Contract	15 days	Mon 02/10/07	Wed 02/10/23
35	Signing of Contract	1 day	Thu 02/10/24	Thu 02/10/24
36	Issuance of NTP	1 day	Fri 02/10/25	Fri 02/10/25
37	Approval of Contract by JBIC	15 days	Fri 02/10/25	Mon 02/11/11
38	**II-3. MALIGAKANDA RESERVOIR SITE**	1264 days	Fri 02/10/25	Tue 06/11/07
39	**II-4. ELLIE HOUSE RESERVOIR**	1258 days	Fri 02/10/25	Tue 06/10/31
40	**II-5. KOTIKAWATTE-MULLERIYAWA**	941 days	Fri 02/10/25	Wed 05/10/26
41	**II-6. MEDIUM/LARGE MAINS REHABILITATION**	831 days	Mon 02/10/28	Mon 06/01/02
42	**II-7. SMALL MAINS REHABILITATION**	946 days	Mon 02/10/28	Mon 06/06/12
43	**III. LEAK REPAIR WORKS**	779 days	Mon 01/07/02	Fri 03/12/26
44	**III-1. PREQUALIFICATION**	48 days	Mon 01/07/02	Sat 01/08/25
45	PQ Announcement	2 days	Mon 01/07/02	Tue 01/07/03
46	Receipt of Applications	3 days	Fri 01/07/27	Mon 01/07/30
47	Evaluation of Applications	20 days	Tue 01/07/31	Wed 01/08/22
48	Notice of Evaluation Results to Applicants	3 days	Thu 01/08/23	Sat 01/08/25
49	**III-2. TENDERING (LCB)**	400 days	Wed 01/09/19	Sat 02/12/28
50	***Tender service contract for year 1***	88 days	Wed 01/09/19	Sat 01/12/29
51	Tender Announcement	3 days	Wed 01/09/19	Fri 01/09/21
52	Reciept & Opening of Tenders	3 days	Tue 01/10/16	Thu 01/10/18
53	Evaluation of Tenders	20 days	Fri 01/10/19	Sat 01/11/10
54	Internal Approval of Evaluation Results	25 days	Mon 01/11/12	Mon 01/12/10
55	Issuance of NOITAC	5 days	Tue 01/12/11	Sat 01/12/15
56	Preparation of Contract	5 days	Mon 01/12/17	Fri 01/12/21
57	Signing of Contract	5 days	Sat 01/12/22	Thu 01/12/27
58	Issuance of NTP	1 day	Fri 01/12/28	Fri 01/12/28
59	Notification of Contract to JBIC	1 day	Sat 01/12/29	Sat 01/12/29
60	***Tender service contract for year 2***	88 days	Wed 02/09/18	Sat 02/12/28

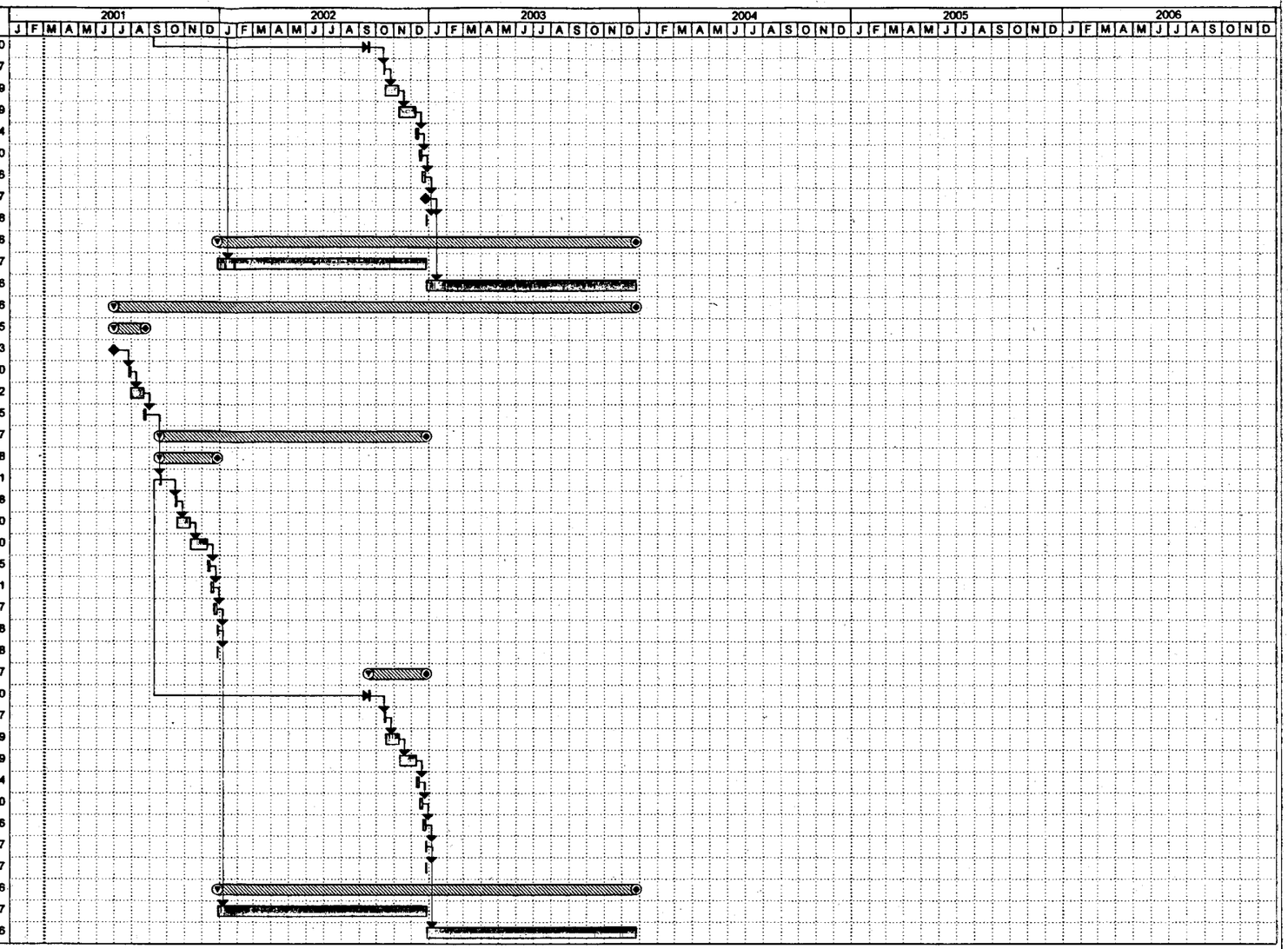


Project: Pre-construction
Date: Fri 01/03/02

Task | Task Progress | Critical Task | Critical Task Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary

Figure 9-1 Project Implementation Schedule (Sheet 2 of 2)

ID	Task Name	Duration	Start	Finish
61	Tender Announcement	3 days	Wed 02/09/18	Fri 02/09/20
62	Reciept & Opening of Tenders	3 days	Tue 02/10/15	Thu 02/10/17
63	Evaluation of Tenders	20 days	Fri 02/10/18	Sat 02/11/09
64	Internal Approval of Evaluation Results	25 days	Mon 02/11/11	Mon 02/12/09
65	Issuance of NOITAC	5 days	Tue 02/12/10	Sat 02/12/14
66	Preparation of Contract	5 days	Mon 02/12/16	Fri 02/12/20
67	Signing of Contract	5 days	Sat 02/12/21	Thu 02/12/26
68	Issuance of NTP	1 day	Fri 02/12/27	Fri 02/12/27
69	Notification of Contract to JBIC	1 day	Sat 02/12/28	Sat 02/12/28
70	**III-3. SERVICE CONTRACTS**	624 days	Sat 01/12/29	Fri 03/12/26
71	***contract for year 1***	312 days	Sat 01/12/29	Fri 02/12/27
72	***contract for year 2***	312 days	Sat 02/12/28	Fri 03/12/26
73	**IV. LOW-INCOME SETTLEMENT ENVIRONMENTAL IMPROVEMENT**	779 days	Mon 01/07/02	Fri 03/12/26
74	**IV-1. PREQUALIFICATION**	48 days	Mon 01/07/02	Sat 01/08/25
75	PQ Announcement	2 days	Mon 01/07/02	Tue 01/07/03
76	Receipt of Applications	3 days	Fri 01/07/27	Mon 01/07/30
77	Evaluation of Applications	20 days	Tue 01/07/31	Wed 01/08/22
78	Notice of Evaluation Results to Applicants	3 days	Thu 01/08/23	Sat 01/08/25
79	**IV-2. TENDERING (LCB)***	399 days	Wed 01/09/19	Fri 02/12/27
80	***Tender service contract for year 1***	87 days	Wed 01/09/19	Fri 01/12/28
81	Tender Announcement	3 days	Wed 01/09/19	Fri 01/09/21
82	Reciept & Opening of Tenders	3 days	Tue 01/10/16	Thu 01/10/18
83	Evaluation of Tenders	20 days	Fri 01/10/19	Sat 01/11/10
84	Internal Approval of Evaluation Results	25 days	Mon 01/11/12	Mon 01/12/10
85	Issuance of NOITAC	5 days	Tue 01/12/11	Sat 01/12/15
86	Preparation of Contract	5 days	Mon 01/12/17	Fri 01/12/21
87	Signing of Contract	5 days	Sat 01/12/22	Thu 01/12/27
88	Issuance of NTP	1 day	Fri 01/12/28	Fri 01/12/28
89	Notification of Contract to JBIC	1 day	Fri 01/12/28	Fri 01/12/28
90	***Tender service contract for year 2***	87 days	Wed 02/09/18	Fri 02/12/27
91	Tender Announcement	3 days	Wed 02/09/18	Fri 02/09/20
92	Reciept & Opening of Tenders	3 days	Tue 02/10/15	Thu 02/10/17
93	Evaluation of Tenders	20 days	Fri 02/10/18	Sat 02/11/09
94	Internal Approval of Evaluation Results	25 days	Mon 02/11/11	Mon 02/12/09
95	Issuance of NOITAC	5 days	Tue 02/12/10	Sat 02/12/14
96	Preparation of Contract	5 days	Mon 02/12/16	Fri 02/12/20
97	Signing of Contract	5 days	Sat 02/12/21	Thu 02/12/26
98	Issuance of NTP	1 day	Fri 02/12/27	Fri 02/12/27
99	Notification of Contract to JBIC	1 day	Fri 02/12/27	Fri 02/12/27
100	**IV-3. SERVICE CONTRACTS**	624 days	Sat 01/12/29	Fri 03/12/26
101	***contract for year 1***	312 days	Sat 01/12/29	Fri 02/12/27
102	***contract for year 2***	312 days	Sat 02/12/28	Fri 03/12/26



Project: Pre-construction
Date: Fri 01/03/02

Task | Critical Task | Milestone | Rolled Up Task | Rolled Up Milestone | Split | Project Summary
Task Progress | Critical Task Progress | Summary | Rolled Up Critical Task | Rolled Up Progress | External Tasks

Page 2

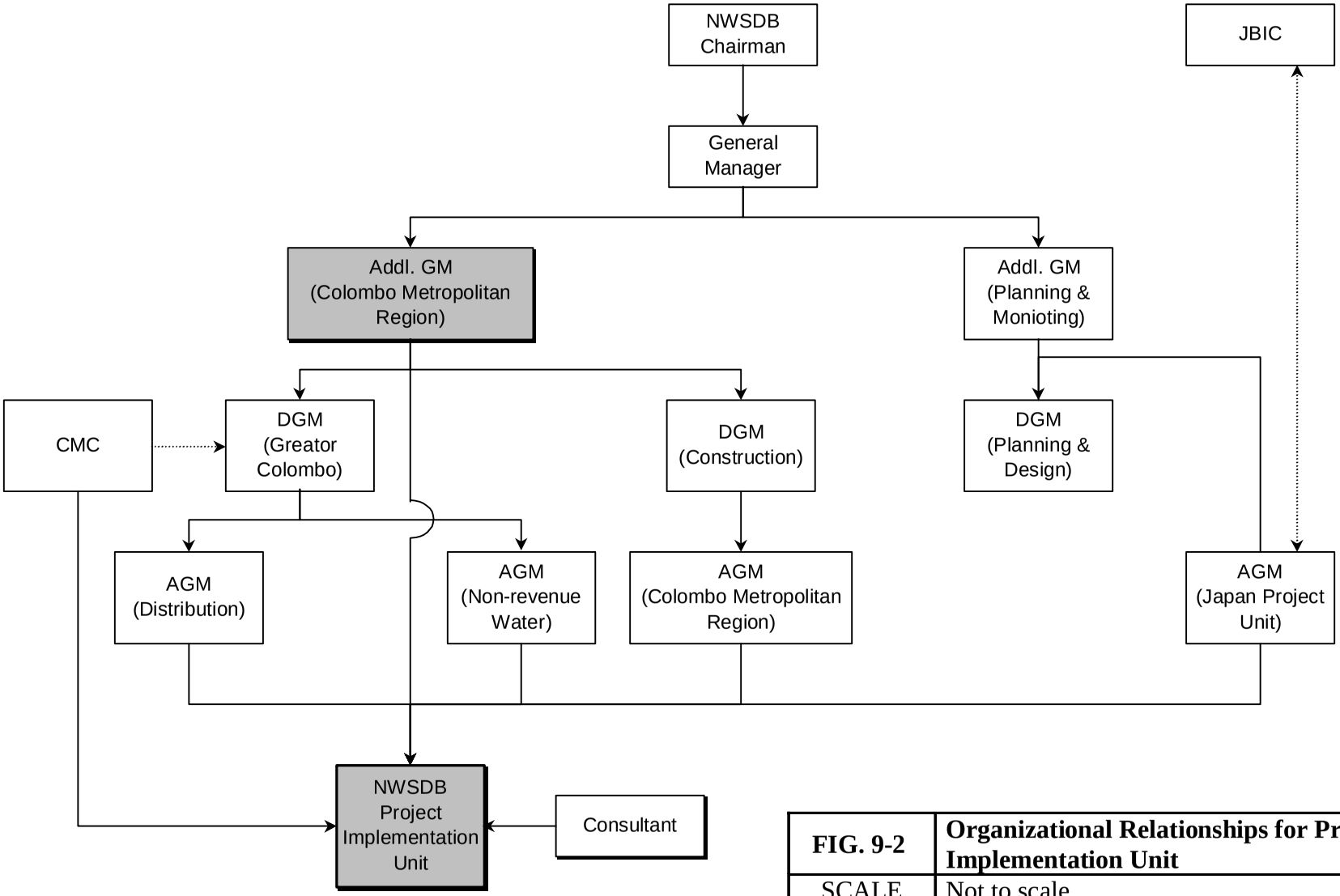


FIG. 9-2	**Organizational Relationships for Project Implementation Unit**
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

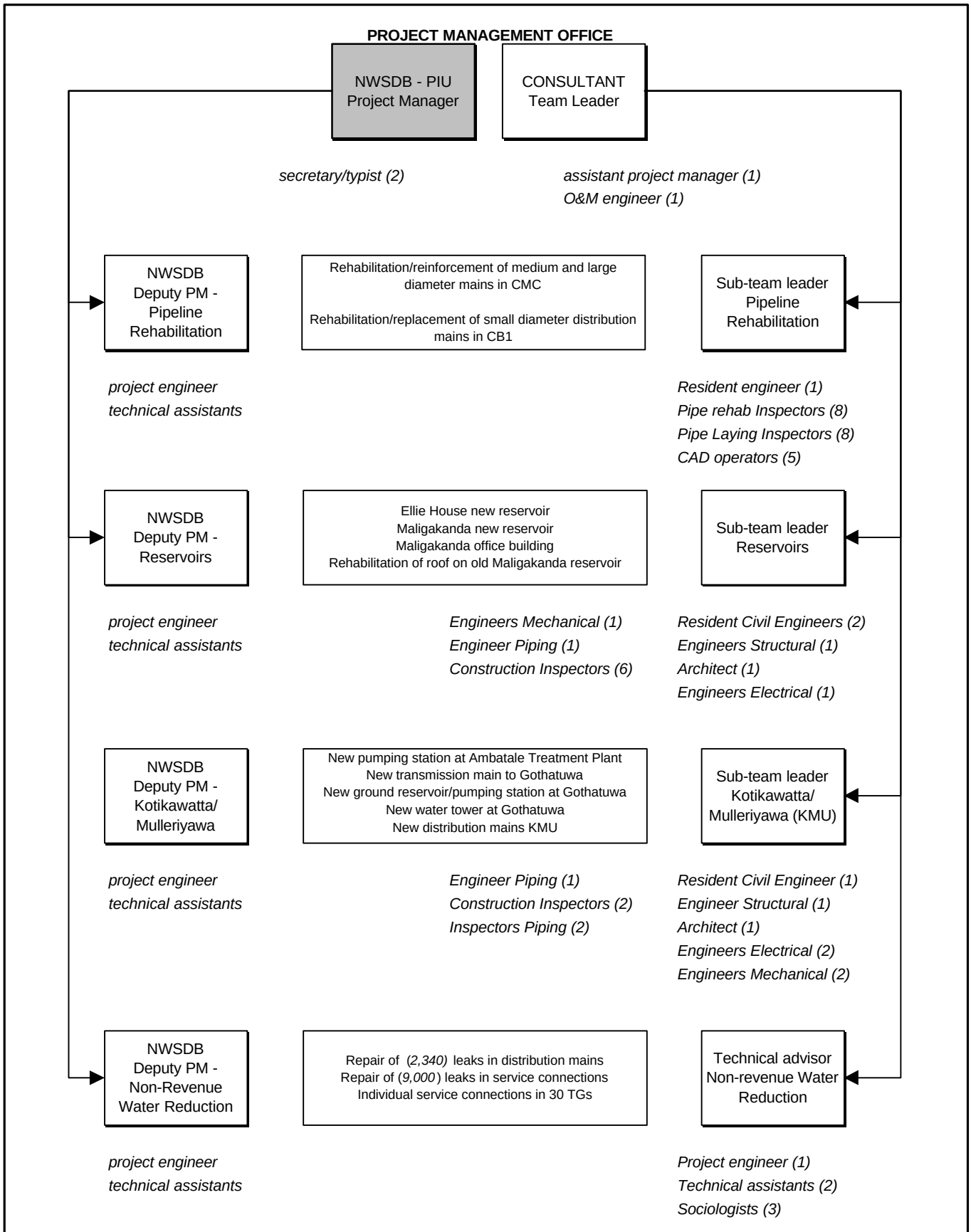


FIG. 9-3	**Functional Organization Chart for Project Implementation Unit**
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Figure 9-4 Engineering and Personnel Input Breakdowns for Implementation

Positions / Resources	Service provider	Required man months																										Total Man-Months	
		2001			2002				2003				2004				2005				2006				2007				Foreign	Local
1) PROJECT MANAGEMENT OFFICE																													
1-1 Tendering Civil Works (ICB)																													
1-2 Tendering (LCB)																													
Consultant Services - Team Leader	Foreign Consultant				1	3			2	2		2	2		2	2		2	2		2	2		1	3				28	
Assistant Team Leader - scheduling, documentation, cost control	local consultant				1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5					31.5
O&M Engineer - manuals, and training	Foreign Consultant														3	2												5	
Secretary/typist (2)	local consultant				2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6					122
office boy	local consultant				1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3					61
per diems F/C																												33	
car rentals (1)																													
2) MALIGAKANDA and ELLIE HOUSE RESERVOIRS																													
Sub-team leader - civil/structural engineer	Foreign Consultant								2	2		3		2	2		2	2		2	2			2	2				23	
per diems																													
car rentals (1)																													
2-1 Maligakanda Office Building																													
2-2 Maligakanda New Reservoir																													
2-3a Maligakanda roof rehabilitation																													
Resident - civil/structural engineer	Local Consultant								2	2	2	2	2	2	2	2	2		1	2	2	2	2	2	2					31
structural engineer	Local Consultant								1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5		1	1	1	1.5	1.5	1.5	1.5					22.5
architect	Local Consultant								1	1	1	1	2	2	2	2														12
electrical engineer	Local Consultant													2	2	2														6
mechanical engineer	Local Consultant													2	2	2														6
piping engineer	Local Consultant															1	1	1	2	2	2									9
construction inspectors - structural (1)	Local Consultant								2	3	3	3	3	3	3	3	3		1	3	3	3	3	3	2					44
construction inspector - electrical	Local Consultant											1	1	2	2	2	1													9
construction inspector - mechanical	Local Consultant													2	2	2	1													7
construction inspector - building trades	Local Consultant										1.5	1.5	1.5	1.5	1.5	1.5														9
construction inspector - piping	Local Consultant														3	3	3													9
2-3b Structural appraisal old Maligakanda reservoir																													
structural engineer - appraisal and rehabilitation specialist	Foreign Consultant																	3	1									4	
structural engineer	Local Consultant																	3	2										5
geotechnical engineer	Local Consultant																	2											2
car rentals (1)																													
per diems																												4	
2-4 Ellie House Reservoir																													
Resident - civil/structural engineer	Local Consultant								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2					34
pipe engineer	Local Consultant												1.5	1.5	1.5	1.5	1.5				1	1	1	1						11.5
structural engineer	Local Consultant										1.5	1.5	1.5					1.5	1.5	1.5	1.5									10.5
architect	Local Consultant												1.5	1.5											1.5					4.5
electrical engineer	Local Consultant													1	1															2
mechanical engineer	Local Consultant													1	1															2
construction inspector - structural (1)	Local Consultant								2	3	3	3	3			3	3	3	3	3	3									32
construction inspector - electrical/mechanical	Local Consultant													1	1															2
construction inspector - piping	Local Consultant												3	3	3						2	2	2	2						17
3) WATER SUPPLY ENHANCEMENT in KOTIKAWATTE and MULLERIYAWA AREA																													
3-1 GothatuwaTransmission main																													
3-2 Gothatuwa-Kolonnawa Pump House																													
3-3 Gothatuwa Reservoir, Pump House and New Water Tower																													
3-4 Gothatuwa Distribution mains																													
Sub-team leader - civil/structural engineer	Foreign Consultant											3	1		2	2		2	3									13	
Resident - civil/structural engineer	Local Consultant								1	1	2	2	2	2	2	2	2	2	2										20
mechanical engineer	Foreign Consultant													2	1													3	
mechanical engineer	Local Consultant											1	2	2	2														7
electrical engineer	Foreign Consultant													2	1													3	
electrical engineer	Local Consultant											1	2	2	2														7
pipeline engineer	Local Consultant								1	1	1	1	3	3	3	3	1												20
architect	Local Consultant										1	1	1	1	1														5
construction inspector - structural (1)	Local Consultant										2	3	3	3	3	3	2	2											24
construction inspector - electrical/mechanical	Local Consultant											2	2	2	2														8
construction inspectors - piping (2)	Local Consultant											2	6	6	6	6	6	2											34
per diems F/C																												19	
car rentals (2)																													
4) REHABILITATION AND REINFORCEMENT OF MEDIUM AND LARGE DIAMETER PIPE NETWORK																													
rehabilitation																													
reinforcement																													
Sub-team leader - water supply/pipeline engineer	Local Consultant											1	3	3	3	3	3	3	3	3									28	
Assistant Resident Engineer	Local Consultant											1	3	3	3	3	3	3	3	3									28	
pipe scrapping and relining inspectors (4)	Local Consultant											4	12	12	12	12	12	12	12	12									112	
pipe laying inspectors (4)	Local Consultant											4	12	12	12	12	12	12	4										80	
CAD Operators (2)	Local Consultant												6	6	6	6	6	6	6	6									54	
per diems F/C																												0	
car rentals																													
5) REHABILITATION/REPLACEMENT OF SMALL DIAMETER DISTRIBUTION MAINS																													
rehabilitation																													
reinforcement																													
pipe scrapping and relining inspectors (4)	Local Consultant											4	12	12	12	12	12	12	4										80	
pipe laying inspectors (4)	Local Consultant											4	12	12	12	12	12	12	12	12	12	12	12	12					160	
CAD Operators (3)	Local Consultant											3	9	9	9	9	9	9	3	3	3	3	3	3					84	
per diems F/C																												0	
car rentals																													
6) IMPLEMENTATION of NRW REDUCTION																													
6-1 Leak Repair Works																													
6-2 Low Income Settlement Environmental Improvements																													
6-3 Supply of materials and equipment																													
6-4 Advisory and management services on NRW Program																													
Technical advisor - NRW/Water supply engineer	Foreign				1	3			2	2																		8	
Project Engineer	local consultant				1	3	3	3	3	3	3	3	3																25
Technical assistants (2)	local consultants				2	6	6	6	6	6	6	6	6																50
Sociologists (3)	Local Consultant/NGO					9				9																			18
per diems F/C																												8	
car rentals (1)																													
TOTAL																												151	1,346

CHAPTER 10

10 PROJECT EVALUATION

10.1 TECHNICAL EVALUATION

The facilities have been designed to simplify operations and to minimize the amount of preventive maintenance required. Nevertheless operations staff will require training and a preventive maintenance program will need to be implemented to ensure reliable delivery of water.

10.1.1 Work Program for Operation and Maintenance

Planned operation and maintenance activities for the new facilities are described below.

Facility	Operations	Maintenance
Pump Houses	• Reading and recording instruments • Operation of electrical and mechanical systems • Responding to alarm conditions • Manual override of automatic systems (periodic) • Adjusting start and stop schedule and sequence	• Visual inspection of M&E equipment • Weekly test of diesel generator • Preventive maintenance to M&E equipment
Transmission Main	• Adjust flow control to match reservoir operations	• visual inspection of valves, and pipe bridges (monthly) • air valve maintenance (monthly)
Ground Reservoirs	• Check residual chlorine at outlet (daily) • Adjust chlorine dosage (weekly) • Water quality examination in reservoir (weekly) • Adjust position of inlet valves • Adjust position of distribution valves	• Operate inlet valves (weekly) • Operate sluice gates (weekly) • Visual inspection (annual) • Cleaning (annual) • Grass cutting etc…
Elevated Tank	• Check residual chlorine at outlet (daily)	• Visual inspection (annual) • Cleaning (annual) • Operate by-pass valve (monthly)
Distribution Mains	• Water quality examination at end points (monthly) • Flush mains (annually) • Operate valves (semi-annually)	• Leakage detection and correction • Repair and replacement of pipe and meters • Repair covers and clean out valve chambers (annual)

10.1.2 Organization for Operation and Maintenance

Although the water board is ultimately responsible for all aspects of water supply in Metropolitan Colombo, some aspects of service delivery and maintenance within CMC are contracted out to CMC Water Works Department. Responsibility for operation and maintenance of the new facilities will be as follows:

Facility	Organization Responsible	Organizational Unit
Kolonnawa-Gothatuwa Pump House	• NWSDB	• AGM Production
Gothatuwa Pump House & Ground Reservoir	• NWSDB	• AGM Distribution Section 1 • Manager Towns East
Gothatuwa Elevated Water Tower	• NWDSB	• AGM Distribution Section 1 • Manager Towns East
Kolonnawa-Gothatuwa Transmission Main	• NWSDB	• AGM Distribution Section 1 • Manager Towns East
Distribution mains in Kotikawatte-Muleriyawa	• NWSDB	• Manager Towns East
Maligakanda Ground Reservoir	• CMC	• Water works office
Ellie House Ground Reservoir	• CMC	• Water works office
Distribution Mains (CB1, CB2, CB3)	• NWSDB • CMC	• AGM Distribution Section 2 • Manager Colombo City

Maintenance and operation of the water supply system in Colombo lacks clear definition of roles and responsibilities. Maintenance of the distribution mains is predominantly carried out by CMC Water Works Department under a service contract to the NWSDB. Maintenance and repair of service connections is carried out by both CMC and NWSDB (Area offices/NRW unit).

Problems noted during the study indicate that duplication of roles and responsibility will be a significant impediment to the successful implementation of leakage detection and correction.

As long as NRW remains high, NWSDB should be the sole agency responsible for operation and maintenance of the water supply system including leakage detection and correction.

10.2 FINANCIAL EVALUATION

The financial viability of each component will be evaluated by three indicators, which are the Net Present Value (NPV), the Benefit Cost Ratio (B/C) and the Internal Rate of Return (IRR). The results of computation of NPV, B/C, and IRR and NPV are summarized below.

Component	NPV	B/C	IRR
① Rehabilitation of reservoirs	Rs. 1,091 M	Incomputable	Incomputable
② Rehabilitation and strengthening of distribution facilities	- Rs. 180 M	0.5	6.4 %
③ NRW Action Plan ④ Rehabilitation of distribution pipe network	Incomputable	Incomputable	Incomputable
Total Project	Over Rs. 911 M	Incomputable	Incomputable

"①Rehabilitation of reservoirs component" is regarded financially viable because of its positive NPV. "②Rehabilitation and strengthening of distribution facilities component" is not financially viable if it is implemented alone. However if "①Rehabilitation of reservoirs component" and "②Rehabilitation and strengthening of distribution facilities component" are implemented together, or all of the four components are combined, the overall NPV would exceed Rs. 911 million. Therefore the financial viability is justifiable.

10.3 SOCIOECONOMIC EVALUATION

10.3.1 Affordability and Willingness of Low Income Settlements

The report on Pilot Projects in Low Income Settlements adequately demonstrates the affordability of the householders to pay for an individual water connection and to pay the monthly water bill at a reasonable level of consumption. The minimum charge for 10 m^3 per month is Rs 35. The average monthly income of families in the pilot sites at Rs 7,858 is well above the perceived poverty line of Rs 1,500 and indeed above the government minimum monthly salary of Rs 6,000 quoted at mid 2000.

Over the last few years NWSDB has reduced the concessionary connection fee to Rs 4,160 (including application form costs and stamp duties), and it allows payment of Rs 3,000 of this amount to be made over 30 months at the rate of Rs 100 per month. To some extent this has been achieved by the requirement that the communities provide all labour for excavation and backfilling free of charge for the reticulation system and the household connections.

The householders are willing to pay this amount for individual connections, particularly when NGO intervention is able to strengthen existing CDCs and gain the confidence of the community in general.

Householders are also willing to pay for the monthly charges, but this will only be successful over time when NWSDB are able to organise the regular and accurate reading of water meters and the timely distribution of monthly bills. Of particular importance is the timely receipt of the first monthly bill for two reasons. Firstly, there is a tendency for new customers to over use the facility resulting in too high a payment. Secondly, if the first bill is received late and is for several months of supply, it is likely that the family will not have the cash to cover such a large bill.

In the Community Attitude Survey over 85% of the households stated that they could assist the project by giving cash contributions for both construction activities and for maintenance of completed infrastructure facilities.

10.3.2 Increase in Public Awareness

Public awareness of most aspects of water supply was found to be lacking by the questionnaire survey carried out on a representative sample of 1,000 customers. However, the survey also found that the public was eager to learn more about the subject hence there is a large audience which is both ready and willing to be educated on the subject of water supply.

Implementation of the Water Awareness Mass Media Campaign should go a long way to increasing the public awareness regarding the water supply to Colombo. It is specifically designed to raise the profile of NWSDB and to develop co-operation between NWSDB and the public. Conservation of water resources is to be introduced early in the campaign to set the scene for the need to avoid misuse of water and the need to pay for the provision of water.

The mass media campaign will be able to reach all sections of the public, as it comprises of television and radio broadcasts, information booklets and a variety of posters and stickers. Also, the campaign is designed to be an ongoing procedure, since this is the only way to

maintain a high level of awareness and hence sustain the interest, involvement and co-operation of the public.

10.3.3 Necessity for Eliminating External Interventions

Perhaps the most pressing problem faced by NWSDB today is the high level of NRW. This Study seeks to assist NWSDB in its endeavours to reduce considerably the NRW, particularly in the CB1 area of CMC.

Many of the NRW components are linked to consumers; illegal connections and non-payment of monthly water bills are clear examples of this. In its 1999 annual Report, NWSDB recognised that the problem of illegal connections was much more serious than previously thought. This Study has confirmed the seriousness of the situation in both the general housing areas and in the Tenement Gardens (settlements). The pilot projects in the settlements showed a high number of illegal connections, but also a willingness of these households to have their connections legalised.

There are a great number of domestic customers, who have not paid their water bills, and are still connected. The NWSDB senior management holds an extensive list of such defaulters. There appears to be a reluctance to resolve the matter of defaulters, particularly in low- income groups due to external interventions.

The National Water Supply and Drainage Board (Amendment) Act, No 13 of 1992, details the composition of the Board and lays down the requirement that board members shall have wide experience and capability in engineering, finance, public health, and administration and law, and these members will be supported by officers from several related ministries. The Board's powers and duties are clearly defined and intervention by the Minister is, quite rightly, allowed for matters that affect the national interest.

Clearly such a Board, supported by competent senior staff within NWSDB should have no problem in handling all matters related the functions of the organisation. NWSDB need a powerful legal right to combat malpractice's such as non-payment of water bills, and this is provided for under the Act.

In reality, the staff of NWSDB has shown that in the majority of cases of non-payment, illegal connections etc. such matters can be resolved quickly and quietly without recourse to legal action, which is exactly as it should be.

This Study recommends a Mass Media Campaign on water awareness and seeks to improve the relationship between NWSDB and the public it serves. The acceptance by the Board and the staff of NWSDB of this policy will enable the co-operation of the customers to become a reality, and an atmosphere created to attend to many outstanding issues. The campaign also needs the support of government at all levels, and if this is obtained then the acceptance of the need to pay for water will be confirmed.

Accordingly, it will no longer be necessary for external interventions in matters such as payment of water bills and disconnection of illegal connections, since the general public, including politicians and government officials at all levels, will have been sensitised to the need to pay for water to ensure the future of NWSDB.

There must be a political consensus on the policy of payment for the provision of water by individual connections, and no intervention in the due process of disconnection of defaulters. The very existence of NWSDB as a viable agency depends on this.

It is very much in the hands of the Board and its senior staff to ensure that, by creating awareness in the general public, including government officials and politicians, particularly on the need to pay for water, there would be no reason for intervention by ministers and others in the political arena.

10.4 ENVIRONMENTAL EVALUATION

10.4.1 General

The project is exempt from a formal Environmental Impact Assessment by agreement between GOJ and GOSL. The project will have no major environmental impacts since there is no new water abstraction or treatment process.

The construction and operation of works planned under this project will involve some minor impacts that can be mitigated:

- High noise and vibration levels during construction caused by engine operation, power generators and pumps
- Dust generated by demolition and construction activities
- Transport and Disposal of demolition and construction waste
- Impacts on air quality caused by emissions from construction equipment
- Impact on surface drainage during construction, and discharge of chlorinated water during

disinfections of water mains

- Disruption to pedestrian and vehicular traffic during construction
- Health and safety of the public during construction
- Potential health and safety risk from chlorination facilities during operations

10.4.2 Operation of Chlorination Facilities

NWSDB adds chlorine to the water in service reservoirs at Maligakanda and Ellie House to maintain water quality within the reservoir and boost free residual in the distribution system. Existing chlorine installations lack any safety standards and pose a significant threat to neighbouring communities in close proximity to the reservoirs. The 900 kg cylinders are stored outdoors, unprotected from damage and impossible to contain in case of a leak. Furthermore there are no established procedures for dealing with an emergency or evacuating the public.

In order to reduce the risk to the public, the study team has designed chlorination facilities for improved safety by:

- using smaller 68 kg chlorine gas cylinders to reduce the amount of gas released if a cylinder leaks
- storing a smaller quantity of chlorine at the reservoir site, 680 kg instead of 900 kg
- providing gas detection and alarm system
- providing safety equipment and means to neutralize a chlorine leak