ASMARA WATER SUPPLY

ASMARA WATER SUPPLY DEPARTMENT

TECHNICAL AND INSTITUTIONAL REHABILITATION STUDY OF ASMARA WATER SUPPLY SYSTEM

Executive summary report

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EXECUTIVE SUMMARY

TABLES

1. INTRODUCTION

This document is presenting the executive summary analysis of the rehabilitation programme (technical and institutional components) as defined in the Terms of References, task n°6.

The development programme for the drinking water supply infrastructures in ASMARA comes under the category of one where the administration controlling the installations is a financially dependent municipal service, and which for the moment, is ill-prepared to become independent. Under the tutelage of the City's administration, like all the other municipal services, the AWSD has very few means at its disposal (both human and technical) of establishing its budgets and managing the results of its activities.

The present financial equilibrium of the AWSD is the result of a favourable context characterised by an absence of financial overheads and a relatively high rate of invoice collection. However the potential equilibrium remains in doubt because the balance sheets have shown a deficit since 1994.

The last three years have been marked by high expenditure on power , still contested, and which for the moment permits neither the balance of the operating costs nor to clearly identify the exact amount of expenses to be borne.

The lack of clarity in large areas of the operating expenses, along with chronic delays in verification and approval of balance sheets, only highlight the incapacity of the present system to manage and to absorb the increase in management activities the project will create.

Without a significant improvement in the management of the installations as well as the accounting system to control the balance of payments, both incoming and outgoing, nothing allows to suppose that the financial results will remain positive. Already it appears clear that these results will stay at an insufficient level to finance any improvement in the quality of service for several years to come.

2. INSTITUTIONAL AND ORGANISATIONAL COMPONENT

2.1 APPRAISAL

Asmara Water Supply Department is a part of the technical services of the City of Asmara. This Department is managed by the Head of Department under the authority of the Head of Planning and Technical Departments of the town. The city of Asmara administration is under the responsibility of the Governor of the Central Area of Eritrea, called Zoba Maakel. The Governor is a high ranked civil servant of the Ministry of local Government. (And not of the Ministry of Environment, Land and Water — which includes the Water Department — in charge of the protection, the development and the water resources overall management.)

The Government policy is to decentralise, as far is possible and to hand over the local administration to elect municipalities, as soon as the local abilities and organisations are ready to assume these new responsibilities.

Asmara Water Supply Department is installed in technical buildings, three kilometres away from the City Hall building.

There is no representation in this location of functions other than Technical and Customer management. The usual administrative functions of any organisation are mainly located in Town Hall offices. (Finance and Accounting - Human Resources - Purchasing - General Administration and Legal unit).

The Sewerage Department is also operating under the responsibility of AWSD.

As AWSD is only a Department of the Technical Services, the official level of empowerment of the Head of Department is very low and as far as Documents are concerned the management style is extremely bureaucratic and not flexible. As it was necessary to adapt to a new situation to cope with new problems, new recruitment took place on contract basis, but as this was not supposed to be permanent, the organisation chart could not be modified. This induces lack of clear responsibility and complex levels of command.

Nevertheless, the personal contacts of the staff, are good and key things going.

The Customer management unit, although scarcely computerised, is efficient in its methods and results — taking apart the necessity to insert in the renewal of the Meters and to carry out a site customer survey. The usual delay to connect a Customer is 3 months and the Department realise around 1000 connections per year (Number of Customers in June 1997: 19 500).

The Technical Management is hampered by a lack of qualification of the agents in general, and the lack of organised transfer of the skill of the older workers. Procedures, qualifications, methods are missing at all levels of operation and maintenance (plants and networks).

Many executive positions are vacant, which is not only an AWSD problem but a national issue.

The accounting system is very weak, as the last available yearly Balance is the 1995 Balance.

Despite all these negative points in the organisation and the reporting, there is no misuse of the AWSD funds. AWSD shows a strong will to improve its position and had already posed its ability to organise pipe laying works.

2.2 PROGRAMME OF ACTIONS

Complying with the Terms of References the main proposal is to give AWSD autonomy by conversion in an Authority.

It is recommended that the State of Eritrea, represented by the Governor of Zoba Maakel (provisory holder of the Drinking Water Supply and Sewerage works of Asmara since the hand over by the Ethiopian Water and Sewage authority) will transfer the property, and the rights and obligation to develop operate and maintain these works to a newly created Authority. The only share holder will be the State of Eritrea through Zoba Maakel Administration. Any evolution of in the local power structure will be followed by a total or partial transfer of shares.

This new status encompasses financial, accounting and human resources autonomy.

In consequence, the relevant functions will be organised in this new Authority (Finance and Accounting, Human Resource, Purchase, General Administration and Legal).

The Customer Department will be up-graded by a progressive computerisation and the review of 80% of the meters.

The Technical part will be up-graded by a refurbishment of the works accompanied by an improvement of the qualification by the implementation of a Training Centre. The enterprise will be re-equipped in tools and operation equipment including 4 light vans. A workshop and a Central Laboratory will also be provided. Technical assistance should be provided to improve operation and maintenance of the networks (division into sectors, leakage control), of the resources management and of the plants.

The training Centre will be open to the others Water Supply organisations of Eritrea in the same way as AWSD is presently giving help to Keren and Massawa for the hilling system. All these actions are detailed in 18 Programs of Action (see Institutional and Organisational volume).

The Monitoring of the Management improvement of the Authority will be organise in 9 Performance / Management Indicators tables. As soon as the Accounting system will be operating, the usual analytical accounting monthly report will be set up, allowing a modern management style including an empowerment at the right level of the cost centres.

3. TECHNICAL COMPONENT

3.1 APPRAISAL

The city of Asmara counts 320 000 inhabitants out of the 4 million people of the country (Asmara Municipality Census Office).

Asmara water supply relies mostly on surface water resources and the rainfall regime is very irregular, as the rainy season extends from the end of June to late September, while the annual mean is between 300 and 700 mm.

Today the average production is not sufficient to meet the estimated present demand. The current daily yield is around 20 000 m^3, coming from Mai Nefhi (3/4 of the total production) and Stretta Vaudetto (1/4 of the total production) Treatment Plants. The Toker dam now in construction will help to face this insufficiency by yielding more than 14 000 m^3 per day.

The overall Unaccounted For Water (UFW) ratio is estimated to be 40%. It is then a priority for AWSD to ensure the best management of available resources while undertaking longer term works.

AWSD serves more than 19 000 consumers (domestic and industrials) through an old, under-designed network and a system of governmental and private trucks.

The low number of connections, 1 connection for 3 families on average, hides the fact that in most cases more than two families rely on the same meter and that some areas of the city are not connected at all. Nevertheless today, AWSD is not able to face the rapid growth in the demand for new connections, amounting to about 1 000 per year installed.

The appraisal of the hydraulic structures concerns three levels of the drinking water system :

- *The production system* which includes raw water pumping stations and the treatment plants.

  The mains problems concerns the high level of turbidity of the raw water due to the silting up of the dams.

  Mai Nefhi treatment plant is in good condition, since the renewal of the facilities realised by DEGREMONT in 1996.

  On the other hand Stretta Vaudetto is an old treatment plant (1941) which suffers civil works dilapidated state and low efficiency of the processes.

- *The conveyer system* which includes all the infrastructure conveying potable water from the treatment plant to distribution level

  The northern conveyor system is now very old and made of a fragile structure of asbestos cement. This main is not protected against water-hammers and do not bear high pressures.

- *The distribution system* which delivers water to the consumer and mainly comprises reservoirs, pumping stations, booster stations, networks and connections.
  - Pumping stations and storage - The absence of remote control leads to a irrational operating of the network. The total capacity of the 5 distribution reservoirs is not sufficient to meet peak demand and to securitize the water supply of the whole town.
  - Network - The network is often under-sized. This leads to bottlenecks and water shortages in the elevated areas as Acria. Some old pipes are to be replaced since they are subject to high levels of leakage. The tightness of the valves and fittings is to be checked because of the leaks that appears on these special components, especially during the night.

AWSD technical staff manage to cope with these problems, in spite of the lack of means, by changing broken pipes and repairing leaks as quick as possible.

Now ASWD has to face the rapid development of the greater Asmara area, and hence has to resolve several issues to satisfy the water demand in a short and medium term :

- the renewal or replacement of the old production facilities,
- the network restructuration,
- the rationalisation of the hydraulic operations and maintenance.

3.2 WATER BALANCE

Projects scenarios are based on the analysis of the water demand in Asmara and the potential resources to be mobilised to satisfy this demand.

Water demand forecasts are summarised in the table below:

Table 1 : Water demand - Summary.

	year	1 997	2 000	2 005	*Progress rates*
Population	inh	319 723	354 885	448 921	*+ 40%*
Connections	cx	20 174	24 200	34 358	*+ 70%*
connection rate	%	*60%*	*65%*	*75%*	*+ 26%*
Consumption data					
Domestic consumption	Cum/d	8 085	10 641	18 630	*+ 130%*
cons./dom. connection	l/d	325	375	500	*+ 54%*
cons./inh (connected)	l/d	34	39	50	*+ 45%*
cons./inh (tanker trucks users)	l/d	12	13	15	*+ 25%*
cons./inh (all)	l/d	25	30	41	*+ 64%*
Non domestic consumption	Cum/d	4 217	4 948	8 287	*+ 97%*
Commercial consumption	Cum/d	866	1 137	2 026	*+ 134%*
Large consumers	Cum/d	3 351	3 812	6 260	*+ 87%*
Total consumption	Cum/d	12 302	15 589	26 917	*+ 119%*
Annual consumption	Cum/Y	4 490 163	5 690 011	9 824 596	*+ 119%*
Average cons./inh	l/d	38	44	60	*+ 56%*
Production data					
Losses	%	*40%*	*35%*	*25%*	*-38%*
Annual production	Cum/Y	7 483 605	8 753 864	13 099 462	*+ 75%*
Average day	Cum/d	20 503	23 983	35 889	*+ 75%*
Peak day	Cum/d	24 604	28 780	43 067	
Peak hour	Cum/H	2 239	2 619	3 919	
Average prod./inh	l/d	64	68	80	*+ 25%*

This table shows the results in terms of production requirements in the parameters set for the consumption following population growth forecasts.

In brief, the population supplied by AWSD will increase by 40%, connections by 70% (2 000 new connections per year from 1999 to 2005) and the water production have to increase by 75% from 7.5 million Cum in 1997 to 13 million in 2005 corresponding to a production capacity of 36 000 Cum/day in average to fit the 2005 demand. This shows the need not only for the enhancement of existing facilities but also for new water supply infrastructure.

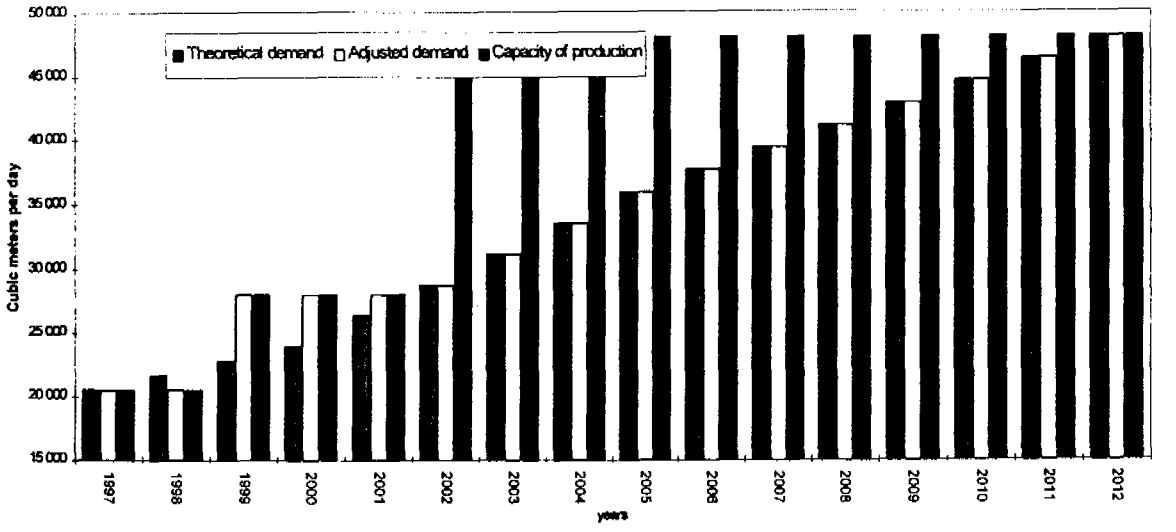
Considering the different potential resources, the potential production by 2005 would be :

Table 2 : Potential production by year 2005

Systems (mean daily in Cum/d)	1997	2000	2005
Mai Nefhi	15 000	18 000	18 000
Stretta Vaudetto	5 500	10 000	10 000
Toker	0	0	20 000
Average daily production	20 500	28 000	48 000

The Figure below shows how production capacity balances water demand growth for the next 15 years.

Water balance for the next 15 years



(A reduction of leakage from 40% in 1997 to 25% in 2005 and 20% in 2012 is included in the demand.)

To balance the calculated water demand, production capacity should step in 1998 - 1999 (**Priority phase works**) and then in 2001 - 2002 (**Second phase works**).

Hence, have define two different phases of investments:

- A priority phase (1998 - 2000) with all necessary works to satisfy the water demand in 2000 i.e. a production capacity of 28 000 Cum/d. This phase consists mainly in the rehabilitation and reinforcement of the existing systems to adapt it to a production of 18 000 Cum/d in the south (Mai Nefhi) and 10 000 Cum/d in the north (Stretta Vaudetto).

- A second phase (2001 - 2005) with all necessary works to satisfy the water demand in 2005 i.e. a production capacity of 48 000 Cum/d. This phase consists mainly in the extension of the system to serve the greater Asmara area and its adaptation to a new production capacity of 20 000 Cum/d from the Toker system.

3.3 PROGRAMME OF ACTIONS

3.3.1 Hydraulic works

TREATMENT PLANTS

A) MAI NEFHI

Required capacity : 18 000 m^3/d

- *Inlet :*
  - installation of a flow meter
  - installation of a DN600 mm electric-controlled valve
- *Aluminium sulphate apparatus :* installation of an electric trolley-lift
- *Chlorination :*
  - installation of 2 chlorine-measuring meters
  - installation of a chlorine leak detector
  - separation of the premises for storing from the chlorination system
  - construction of a room for chlorine containers storage and leak detector installation
- *Filtration :* installation of a more effective flow-splitting system
- *Laboratory :* setting up of a laboratory

B) STRETTA VAUDETTO

Required capacity : 10 000 m^3/d

- *Inlets :*
  - installation of 5 electric gates and flow meters (one on each inlet)
  - construction of water mixing facilities to share the incoming water between the four cascade aerators
- *Reagents :* re-design of the aluminium sulphate apparatus
- *Aeration* : no change
- *Baffle flocculators :* installation of a pipe connection between the outlets of the two flocculators

- *Clarifiers :*
  - installation of 6 automatic blow-downs with pinch valves and isolating valves (one for each clarifier)
  - changing of the pipe outlet into a pipe leading to the inlet of the filter building for each clarifier
  - installation of 6 flow meters at the end of these pipes
  - installation of a flow meter control device that enables functioning of all clarifiers
  - installation of a tank with a flow-splitting system to receive and dispatch the clarified water to the filters.
- *Filters :*
  - repairing of the existing filters
  - transformation of the existing sedimentation basins into two 2500mm diameter filters
- *Sterilisation :* installation of a 2kg/h chlorine injector in premises building
- *Setting up of a laboratory*

C) GODAIF, ACRIA

These treatment plants are abandoned.

PUMPING STATIONS

Raw water pumping stations

A) ADI SCIACA LAKE

Required capacity : 350 m^3/d, head 50m.

- *Pumps :*
  - replacement of the old pumps by two 350 m^3/h under 50m head pumps (1 operating, 1 on standby)
  - installation of upstream and downstream valves and fittings
  - installation of a flow meter
  - installation of an electric control cabinet
  - installation of a circuit-changer
  - installation of a low voltage meter board
- *Pipe :*
  - installation of an air-valve
  - improvement of the narrowing
- *Civil works :* no investment
- *Reservoir :*
  - draining of the reservoir
  - installation of a self-stabilising metal structure supporting a vertical pipe equipped with multi-level inlet gates

B) MAI SERWA LAKE

Required capacity : 200 m^3/d, head 50m

- *Pumps :*
  - replacement of the old pumps by two 200 m^3/h under 50m head pumps (1 operating, 1 on standby)
  - installation of upstream and downstream valves and fittings
  - installation of a flow meter
  - installation of a system for protection against transient phenomena
  - installation of an electric control cabinet with a Y/Δ starter
  - installation of a radio receiver for remote control of the pumps
  - installation of a low voltage meter board
- *Civil works :* provision of a self-supporting travelling crane (the same as the one of Adi Sciaca pumping station)

C) STRETTA VAUDETTO LAKE

Required capacity : 150 m^3/d, head 35m

- *Inlet :* installation of three vertical pipes of different lengths down the face of the dam with discharge connection for a submersible pump on each pipe
- *Pumps :*
  - replacement of the old pumps by two 150 m^3/h under 35m head submerged pumps (1 operating, 1 on standby)
  - installation of downstream valves and fittings
  - installation of an electric control cabinet with a Y/Δ starter

Clear water pumping stations

A) MAI NEFHI

Required capacity : 900 m^3/d, head 200m.

- *Pumping station :*
  - replacement of the old pumps by three 450 m^3/h under 200m head pumps (2 in parallel operating, 1 on standby)
  - installation of upstream and downstream valves and fittings
  - installation of a flow meter at the outlet
  - replacement of the medium voltage transformer by a 1 000 kVA cell unit
  - changing of the electric cabinet by a new one with autotransformer
  - installation of a radio receiver for remote control of the pumps
  - rehabilitation of the water hammer tank

B) NEW SEMBEL

Required capacity : 600 m^3/d, head 85m towards Balcia reservoir, 300 m^3/d, head 85m towards Ras Alula reservoir, 250 m^3/d to supply a truck filling area next to Sembel reservoir.

- *Pumping station :*
  - extension of the pump room
  - replacement of the old pumps by one line with two 300 m^3/h under 85m head pumps, a second line with one 300 m^3/h under 85m head pumps (in total :3 operating, 1 on standby)
  - equipment of 10 x 25 m^3/d pumps to supply truck water tankers
  - recalibrating of upstream and downstream manifolds
  - changing of upstream and downstream manifolds valves and fittings
  - installation of a flow meter
  - installation of a system for protection against transient phenomena
  - replacement of the 5.5/0.380kV transformer by a 400kVA cell unit
  - installation of an electric control cabinet with an autotransformer system
  - installation of a radio receiver for remote control of the pumps

C) STRETTA VAUDETTO

Required capacity : 2 x 300 m^3/h, head 42m to Abba Metchal reservoir and 1 x 300 m^3/h head 87m to Arbate Asmara new reservoir.

- *Pumping station :*
  - replacement of the old pumps by two pumps of 300 m^3/h under 42m head pumps for the 1st network, and one pump of 300 m^3/h under 87m head pumps for the 2nd network (1 operating, 1 on stand-by for each network)
  - changing of the electric cabinet by a new one with autotransformers
  - replacement of valves and fittings
  - installation of a flow meters at each 2 pipes feeding the respective networks
- *Electric power :* installation of a medium voltage cell-type board in an extension to the pump room

D) MAI CIOWET

Required capacity : 40 m^3/h, 52m head to New Mai Ciowet reservoir and 55 m^3/h, 40m head to Addis Alem reservoir.

- *Inlet* : installation of an hydraulic controlled tank-cock upstream of the reservoir
- *Pumping station* :
  - installation of two 40 m^3/h under 52m head pumps to New Mai Ciowet reservoir (1 operating, 1 on standby)
  - installation of two 55 m^3/h under 40m head pumps to Addis Alem reservoir (1 operating, 1 on standby)
  - changing of the electric cabinet by a new one with autotransformers
  - installation of valves and fittings
  - installation of a flow meters at each network feeder pipe
  - installation of an electric cabinet with a Y/Δ starter
  - installation of a low-voltage meter board
  - installation of a radio receiver for remote control of the pumps

F) ARBATE ASMARA, GODAIF, ACRIA

These pumping stations are abandoned.

RESERVOIRS

Pumping station storage

A) MAI NEFHI

- Installation of a water tank level recorder
- Cleaning, coating
- Equipment of reservoir shut off valve

B) NEW SEMBEL

- Installation of a series of baffles inside the reservoirs to direct the water and prevent stagnation
- Installation of a level recording system with a radio transmitter connected to Mai Nefhi pumping station
- Installation of an additional rod-fed chlorination at the entrance pipe
- Cleaning, coating
- Equipment of reservoir shut off valve

C) STRETTA VAUDETTO, MAI CIOWET

- Cleaning, coating
- Equipment of reservoir shut off valve

D) GODAIF, ACRIA

These reservoirs are abandoned.

Distribution reservoirs

A) ABBA MECHAL, ADDIS ALEM, DEJ BALCIA, RAS ALULA

- *Equipment :*
  - top-water level closing system
  - shut-off valve
  - level recording system
  - discharge metering system
  - radio transmitter
- *Civil works :* cleaning, coating

B) ARBATE ASMARA, HAZ HAZ

These reservoirs are abandoned.

B) NEW RESERVOIRS

The future reservoirs are :

- New Arbate Asmara (2000 m^3)
- New Mai Ciowet (25 m^3)
- New Balcia (4000 m^3)

EQUIPMENT :

- top-water level closing system
- shut-off valve
- level recording system
- discharge metering system
- radio transmitter

3.3.2 Network restructuring

Network restructuring programme consists in four items :

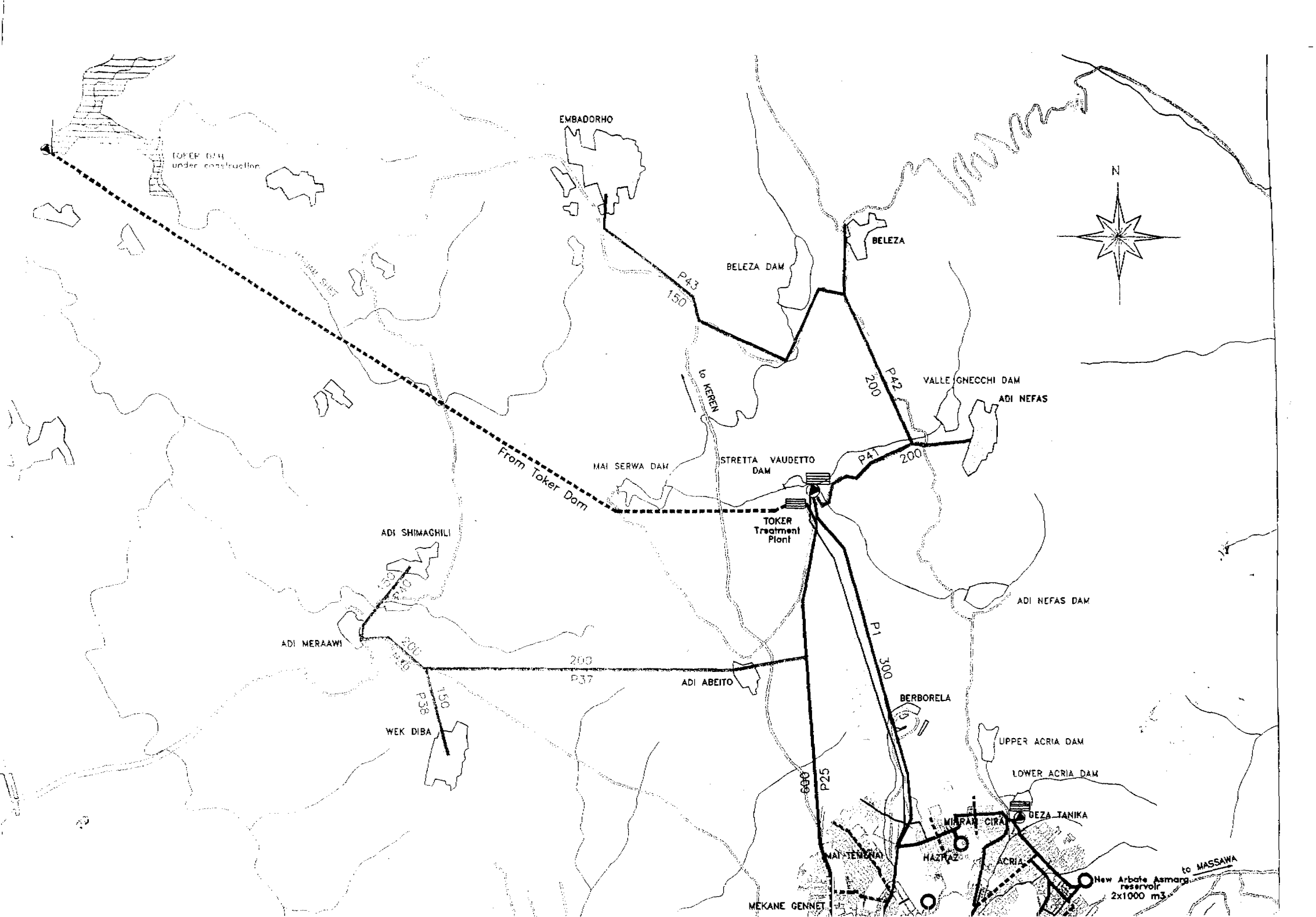
- So called Crash programme : corresponding to network replacement projects already engaged by AWSD and that have been redesigned to be consistent with the short and medium term rehabilitation programme. This item concerns about 20 km of PVC pipes from 150 to 300 mm.

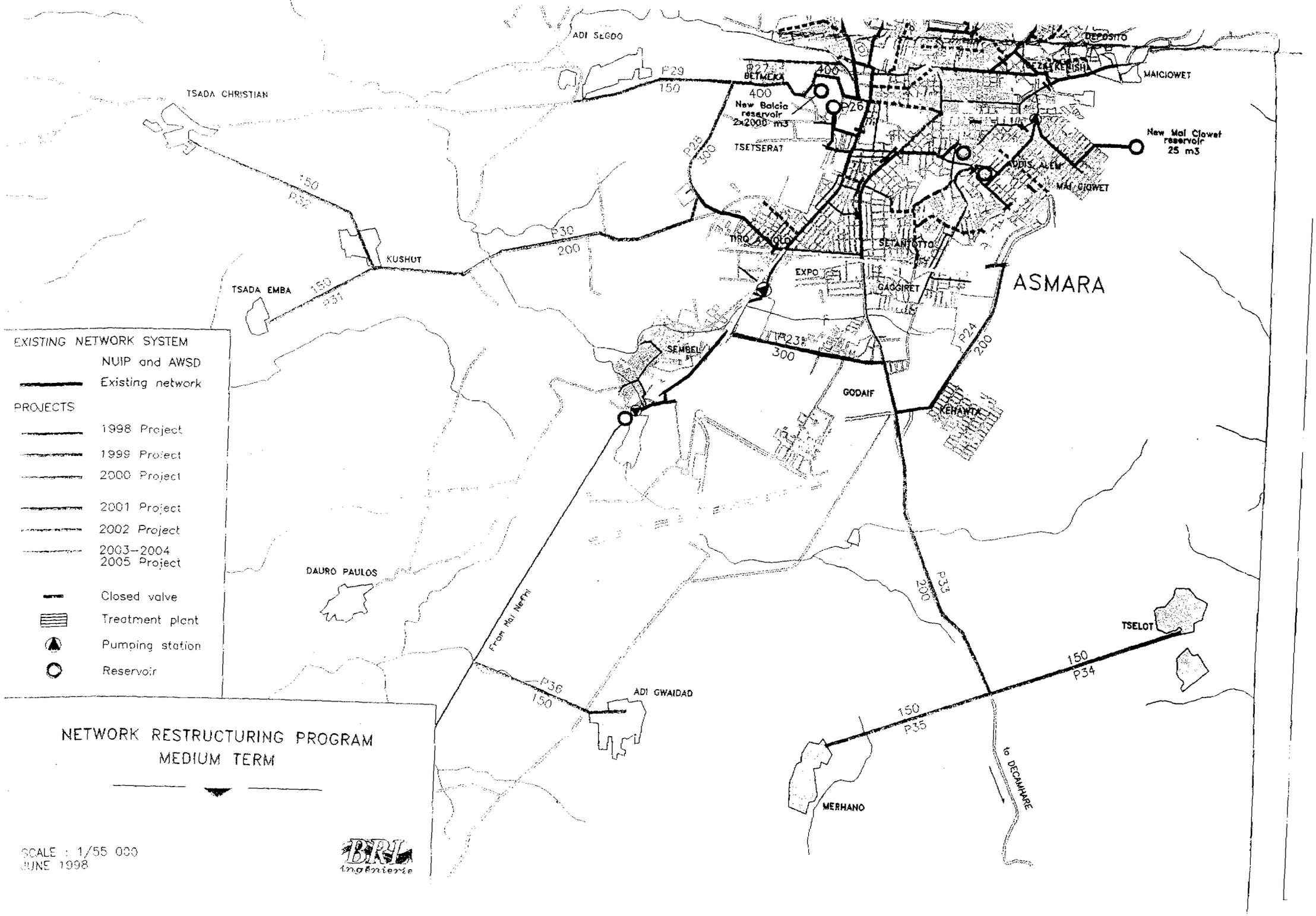
  Older pipe replacement : a network data base analysis has been used for the selection of the more fragile and exposed pipes (30 km of pipes to be replaced).

Primary and secondary network programme : reinforcement of the network have been designed according to the general design of the project presented in the technical report (paragraph 4.1) using mathematical modelling : for the characteristics of the new pipes to meet the peak day demand (pressure and flow) in the serviced area in 2000 and 2005. (primary network : 65 km, secondary 18 km)

Extension works : new serviced areas and new connections from 1998 to 2005 have been determined from the urban and demographic analysis and production design capacities (programme includes the service of 675 ha, i.e. network 155 km, and 14 000 new connections).

Network restructuring programme for the medium term is summarised in the following map.


EMBADORHO
TOKER DAM
under construction
BELEZA
BELEZA DAM
P43
150
to KEREN
P42
200
VALLE GNECCHI DAM
ADI NEFAS
From Toker Dam
MAI SERWA DAM
STRETTA VAUDETTO DAM
P41
200
TOKER
Treatment
Plant
ADI SHIMAGHILI
ADI NEFAS DAM
ADI MERAAWI
200
P40
150
200
P39
203
P37
ADI ABEITO
P1
300
BERBORELA
150
P38
WEK DIBA
UPPER ACRIA DAM
LOWER ACRIA DAM
600
P25
GEZA TANIKA
MIARAM CIRA
MAI TEMENAI
HAZHAZ
ACRIA
to MASSAWA
New Arbate Asmara
reservoir
2x1000 m3
MEKANE GENNET
N


ADI SEGDO
TSADA CHRISTIAN
P29
150
P27
BETWEXA
400
400
New Balcia reservoir 2x2000 m3
P26
DEPOSITO
MAICIOWET
New Mai Ciawet reservoir 25 m3
TSETSERAT
P28
300
ADDIS ALEM
MAI CIAWET
150
P32
KUSHUT
P30
200
TIRO AFEWORQI
SEMAYOTTA
EXPO
GAGGIRET
ASMARA
TSADA EMBA
150
P31
SEMBEL
P23
300
P24
200
GODAIF
KEHAWTA
DAURO PAULOS
From Mai Nefhi
P33
200
TSELOT
150
P34
P36
150
ADI GWAIDAD
150
P35
MERHANO
to DEGAMHARE
EXISTING NETWORK SYSTEM
NUIP and AWSD
Existing network
PROJECTS
1998 Project
1999 Project
2000 Project
2001 Project
2002 Project
2003–2004 2005 Project
Closed valve
Treatment plant
Pumping station
Reservoir
NETWORK RESTRUCTURING PROGRAM
MEDIUM TERM
SCALE : 1/55 000
JUNE 1998
BRL ingénierie

4. INVESTMENT SCHEDULE

The Investment Plan concerns :

1. Institutional and organisational component :
   - Institutional strengthening
   - Improvement of operation and maintenance

2. Technical component :
   - hydraulic works (Water treatment plants, pumping stations and reservoirs)
   - Pipes works (rehabilitation and new works)

Investment plans are described in Chapter 5, Institutional report and, Chapter 4 Technical report, with detailed costs estimates ; summary investment costs are listed below.

The unit prices used for comparative purposes in this investment plan for the technical component are presented in Appendix 6 (Appendices report).

For equipment procurement, assembly costs are estimated to 15% of the procurement costs ; engineering costs for the detailed studies of the works are estimated to 6% and supervision costs are estimated to 5% of the investment costs.

Technical assistance costs have been estimated to carry out the implementation of the Institutional and Organisational plan of actions.

Priority phase programme includes works phased from 1998 to year 2000.

Table 3 : Investment program (1998-2005).

Items	Components	Foreign costs (FRF HT)	Local works (FRF HT)	Total (FRF HT)	Subtotal Priority phase (1998-2000)
Item 1	Institutional strengthening				
	Management information system upgrading:				
	Supply and installation of computer hardware inc. air freight (accounting system, human resources, warehousing)	1 000 000		1 000 000	0
	Supply and installation of computer software (accounting system, human resources, warehousing)	250 000		250 000	0
	Interface existing and new billing systems	80 000		80 000	0
	Customer management	80 000		80 000	
	Operations improvement :				0
	Supply of equipment & tools	400 000		400 000	0
	Supply of workshop equipment (mechanical, electrical, garage)	500 000		500 000	0
	Supply of central laboratory including microbiology	600 000		600 000	0
	Supply of laboratory equipment 2 WTP	200 000		200 000	0
	Customer survey whole town		50 000	50 000	0
	Replacement of 17 000 meters	3 500 000	425 000	3 925 000	0
	Human resources development :				
	Installation of training center equipment (full scale models hydraulics, electrical, mechanical and automation)	1 000 000		1 000 000	0
	TA for training (2,5 man-months and 4 trainers-months in Europe)	665 000		665 000	0
	Computer training	100 000	200 000	300 000	0
	Logistics upgrading:				0
	Head office refurbishment		400 000	400 000	0
	Supply of office equipment		100 000	100 000	0
	Vehicles (4 light vans)		360 000	360 000	0
	Overall management TA & project supervision (11 man-months in short missions)	1 050 000		1 050 000	0
	Sub total	9 425 000	1 535 000	10 960 000	0
Item 2	Improvement of operation & maintenance				
	Network management and leakage survey:				
	Supply of valves & other operations equipment	300 000		300 000	0
	supply of bulk meters	250 000		250 000	0
	Supply of additional leakage equipment	250 000		250 000	0
	Leakage detection & repair campaign		150 000	150 000	0
	TA for supervision of improvement of O & M	600 000		600 000	0
	Sub total	1 400 000	150 000	1 550 000	0
	Total Institutional Component	10 825 000	1 685 000	12 510 000	0
Item 3	Plants & hydraulic works				
	Mai Nefhi WTP & pumping station	2 972 000	100 000	3 072 000	3 072 000
	New Sembel pumping station	2 022 000	250 000	2 272 000	2 272 000
	Adi Sciaca raw water PS	387 000	10 000	397 000	397 000
	Mai Serwa raw water PS	356 000	10 000	366 000	366 000
	Stretta lake PS	359 000	50 000	409 000	409 000
	Stretta Vaudetto WTP & PS	5 112 000	270 000	5 382 000	5 382 000
	Mai Ciowet PS	330 000	10 000	340 000	340 000
	Existing reservoirs	429 000	20 000	449 000	449 000
	New reservoirs	410 000	5 622 000	6 032 000	1 446 000
	Total works	12 377 000	6 342 000	18 719 000	14 133 000
	Assembly costs	1 857 000		1 857 000	1 819 000
	Engineering costs	1 123 000		1 123 000	848 000
	Supervision costs	936 000		936 000	707 000
	Sub total	16 293 000	6 342 000	22 635 000	17 507 000
Item 4	Network restructuring				
	AWSD crash program	9 878 000	9 372 000	19 250 000	19 250 000
	Older pipes replacement	1 135 000	1 406 000	2 541 000	1 044 000
	Primary network	23 132 000	14 294 000	37 426 000	7 019 000
	Secondary network	4 389 000	5 878 000	10 267 000	609 000
	New serviced areas	12 786 000	24 325 000	37 111 000	13 793 000
	New connections	7 826 000	3 708 000	11 534 000	4 143 000
	Total works	59 146 000	58 983 000	118 129 000	45 858 000
	Engineering costs	7 088 000		7 088 000	2 751 000
	Supervision costs	5 906 000		5 906 000	2 293 000
	Sub total	72 140 000	58 983 000	131 123 000	50 902 000
	Total Technical Component	88 433 000	65 325 000	153 758 000	68 409 000
Total Institutional and Technical Components		**99 258 000**	**67 010 000**	**166 268 000**	**68 409 000**

5. FINANCIAL ANALYSIS

The objective of this analysis is to calculate the profitability of the project or, in other words, to compare the profits obtained from the project with the investments carried out.

5.1 RESULTS AND INTERNAL RATE OF RETURN

The micro-economic framework under which the cost/benefit analysis was carried out reflects the collective well-being sought by the project. The analysis assesses decision in terms of the sum of all effects monetized, here investments and income from water sales.

Their translation into monetary terms enables the calculation of an Internal Rate of Return. The analysis is completed by a calculation of the Net Present Value or NPV with an updating rate of 8%. This rate is equally used to compare the Costs and Profits of the project.

	NPV (updating rate: 8%)	P / C (updating rate: 8%)	IRR
Total investment program	- 47 704	0.63	2.84%
Priority phase	- 21 700	0.70	3.76%

The NPV is expressed in thousand Francs. The comparison, Up-dated Profits over Up-dated Costs is a ratio. The Internal Rate of Return is expressed in %.

The project balance is positive, with an internal rate of return on investment ranging from 3.8% and 2.8%. The simulation concerning the Priority phase shows one point higher.

It should be underlined that these results have been obtained without increasing the average price of water sales.

5.2 FRAMEWORK OF THE ANALYSIS

To obtain this results the analysis has been calculated:

- over a 25 year period, which corresponds to the working life of the main engineering installations,
- based on a micro-economic approach in a Cost-Advantages analysis which compares the expense flow against the earnings corresponding to the Rehabilitation Project,

- without the financial expenses linked to the investments,
- on market prices at the constant Franc value. For those elements initially expressed in Birr, the value are based on the average exchange rate of the USD over the last four years (Bank of France).

Three phases were analysed:

1. The description of a situation without investments, called **Phase without Project**.
2. **Situation of the Total investment program:** this considers the investments from 1998 over a prolonged period until the year 2005. This stage includes the commissioning of the Toker Dam and its associated installations.
3. **Situation of the Priority Phase:** this corresponds to the investments to be realised between 1998 and 2000 - which are the rehabilitation and extension stages.

For each of the phases it has been useful to distinguish:

- the provisional operating account,
- an analysis of the investments and their profitability.

The operating accounts have been calculated over 15 years. Their values are stabilised from the year 2012 when full production capacity of the installations is achieved.

The result of an operating account establishes the difference between the annual operating expenditure and the income from the sale of water.

The analysis of the Project's profitability includes the differential of results between the two operating accounts:

- that of the situation without the project,
- that of the situation with the project consisting of two case studies: the total investment program, and the priority phase.

The investment and rehabilitation stages are associated to the results of the operating account by the evolution in the volumes produced and sold. In other words the rehabilitation stages are linked to the results by the evolution in efficiency won on the installations and by the increase in the number of connections to the water mains.

It should be noted that only the investments are compared differentially to the results of the different situations. At this level of the analysis, it is only the profitability of the project that is sought independently of the financial package.

The financial analysis is based on the yearly projection of the volumes sold by AWSD for the next 15 years assuming the realisation of Total Investment Program (called second phase in the table below), with only the realisation of the Priority Phase, or in the case where no project is undergone.

Detailed figures are recalled in the following table (see also Technical report, Chapter 3) :

Table 4 : Production capacity and volumes sold 1997 -2012

	WITHOUT PROJECT			PRIORITY PHASE				SECOND PHASE			
year	Capacity	efficiency	Consumption	Capacity	eff.	Consumption	Increment	Capacity	eff.	Consumption	Increment
1997	20 500	60%	12 300	20500	60%	12 300	0	20500	60%	12 300	0
1998	19 500	58%	11 375	20500	62%	12 642	1 267	20500	62%	12 642	0
1999	18 500	57%	10 483	**28000**	**63%**	**17 733**	**7 250**	28000	63%	17 733	0
2000	**17 500**	**55%**	**9 625**	28000	65%	18 200	8 575	28000	65%	18 200	0
2001	17 500	55%	9 625	28000	67%	18 760	9 135	28000	67%	18 760	0
2002	17 500	55%	9 625	28000	69%	19 320	9 695	**48000**	**69%**	**20 120**	**800**
2003	17 500	55%	9 625	28000	71%	19 880	10 255	48000	71%	22 386	2 506
2004	17 500	55%	9 625	28000	73%	20 440	10 815	48000	73%	24 651	4 211
2005	17 500	55%	9 625	28000	75%	21 000	11 375	48000	75%	26 917	5 917
2006	17 500	55%	9 625	28000	76%	21 200	11 575	48000	76%	28 557	7 357
2007	17 500	55%	9 625	28000	76%	21 400	11 775	48000	76%	30 198	8 798
2008	17 500	55%	9 625	28000	77%	21 600	11 975	48000	77%	31 838	10 238
2009	17 500	55%	9 625	28000	78%	21 800	12 175	48000	78%	33 479	11 679
2010	17 500	55%	9 625	28000	79%	22 000	12 375	48000	79%	35 119	13 119
2011	17 500	55%	9 625	28000	79%	22 200	12 575	48000	79%	36 760	14 560
2012	17 500	55%	9 625	28000	80%	22 400	12 775	48000	80%	38 400	16 000

In the No Project case, production capacity is decreasing to its 1995 level and network efficiency is decreasing from 60 to 55% in 2000.

With the Priority Phase case, production capacity is enhanced to 28 000 Cum/d, water consumption is immediately adjusted to the production capacity ; network efficiency is improved from 60 to 65% in 2000, 75% in 2005 and 80% in 2012.

With the Second Phase case (total investment program), production capacity is enhanced to 48 000 Cum/d, network efficiency improvements are the same than for the Priority Phase case.

All detailed data of operating account are given in **Appendix 10 (Technical Appendices volume)**, including running costs, water sales and revenues with and without the project.

6. CONCLUSION

The financial analysis of the drinking water network rehabilitation project for Asmara highlighted a profitable and sustainable project, particularly when a financial subsidy for a part of the Project 's Priority phase is taken into account.

The analysis shows the urgency of implementing such a large-scale rehabilitation and extension project. Indeed, the scenario without the project indicates how rapidly the situation would deteriorate.

Lastly, it is necessary to underline the fact that the present structure of the AWSD is insufficient to cope with the implementation and management of such a project, which must imperatively be accompanied by institutional strengthening, support services for management and administrative aspects and an important set of training courses for the present personnel.