4.2 Socioeconomic, Water Supply and Sanitation Conditions

4.2.1 Socio-economy and Gender Issue

(1) History and population

Located in the south-western part of Debub Region, Segeneity is the main town of one of the 12 sub-zones in Debub region. It is in between two mountains covered with eucalyptus trees and has a pleasant temperate climate. The town was established by the Italians some one hundred years ago in original village also known by the same name. Presently, it is divided into two sub-administrative zones the first encompassing the original village and the second made up of the rather modern part with old and dilapidated buildings.

Currently, Segeneity has a population of 6,146 comprising of 45.1% males and 55.9% females. Data on age structure reveal that 42.2% of the population are below 14 years of age and those over 65 years only 8.4%, the remaining 49.4% are of working age group. In terms of ethnic composition, 90.4% are of Tigrigna ethnic group while that of Saho and Tigre are 1.3% and 8.2% respectively. Almost 90% of the inhabitants profess Christianity while 10.0% are followers of Islam.

(2) Economic conditions

According to the information provided from the town administration, the town dwellers could be classified into farmers (55.7%), laborers (8.9%), self employed traders (13.9%) and other workers (21.2%). The farming community are the original inhabitants of Segeneity, while other workers are those who do not have permanent employment and do all sorts of daily and contractual jobs. The traders and shop-owners include those who reside in the town and not those ones that live in the surrounding villages and other towns but who have shops in the town. Segeneity has 180 licensed micro and small-scale enterprises classified as manufacturing (27); trade and distribution (120); hotels, restaurants, tea rooms, etc. (21); service establishments (6); local breweries (20); and others (6). Most of these are one man establishments. Market day is every Saturday and about 20-25 villages (about 7000-10,000 people) come to the market. More are reportedly coming during harvest period and holidays to sell their livestock. Besides, there are 14 line ministry offices and one non-government office.

An estimated 49.7% of the inhabitants of the town are illiterate, and the rest are primary school completors and above. This could suggest that there is good deal of educated unemployment in the town. There are 6 educational institutions (1 kindergarten, 3 primary, 1 junior and one senior secondary school).

(3) Social and gender issues: Analysis of the result of the survey

a) Household characteristics

The average household size for the town of Segeneity is 4.64. Female head households comprise about 45%. The Tigrigna ethnic group and adherents of the Christian faith comprise the large majority (Appendix A, Table 4.1).

b) Occupation

According to the survey, an equal number of sampled households (18%) derive their livelihood from agriculture and employment in Government. There are more male head households engaged in both

agriculture and Government offices. Those sampled households that are engaged in commerce and trade are 13% in which more women (20%) are occupied. Women are also engaged in more labor intensive jobs like daily labor. The unemployed residents constitute 27% of the population, out of which females comprise 43% (Appendix A, Table 4.2).

c) Agriculture and land

The area surrounding Segeneity is not a rich agricultural area, nor is agriculture a major source of employment. Nevertheless, whatever is produced is consumed save for a small portion of maize production (Appendix A, Table 4.3).

With regards to livestock, 30% of the respondents own some livestock most of which comprise of sheep and goats (8 per household). On the average, one sampled household owns 3 cows/ox, 1.7 donkeys and camels and 3.5 chicken. As far as agricultural land is concerned, 21% of the respondents own farm land the average size of which is 0.8 hectares (Appendix A, Table 4.4).

d) Household income and expenditure

The average income of those responding households in Segeneity is Nfa 518 per month. Female headed households reportedly earn less (Nfa 405) than that of male headed households. Those households that are engaged in commerce earn an average income of Nfa 1112 per month, followed by those who are engaged in others and Government. The category of other occupation is not dis-aggregated but still is the second major earner next to commerce. The possible occupations that could include others are private quarrying (other than construction) and non-formal sector activities. The reported earning of unemployed (Nfa 558) is also quite high as compared to say one of the major employers like agriculture which is Nfa 492 (Appendix A, Table 4.5).

The composition of the town's households by income group and the percentage share of expenditure on some basic items of household expenditures is presented in table 4.6. About 25% percent of the sampled households are reportedly earning less than Nfa 299 per month. Almost one third each are in the Nfa 300-599 and 600-999 income group respectively; and another (8%) on the 1000-1499. Looking at the expenditure column of the table reveals that a little less than one half of respondents' income is spent on food and beverages, followed by savings and repayment (an impressive 23%), and electricity and energy (12%). The amount spent for electricity and energy is similar as that of the other towns we saw previously. However, in Segeneity, responding households seem to spend less on travel/culture and more in clothes and footwear when compared to the pattern in other towns. Expenses for water is a mere Nfa 1.3 which is very low when we compare with other towns. The reason could be that most households get their water from the town well for free (Appendix A, Table 4.6).

e) Household level of education

Like in the other towns, all of the school-age children in the sampled households attend schooling. Looking at the education status of the respondents, 63% are literate, 43% primary school complete, 12% have completed junior secondary and 29% completed senior secondary school. Those who reported to have attended non-formal education amount to 14% (Appendix A, Table 4.7).

f) Women status and participation in communal activities

On the average, almost all women in sample households reportedly participate in women's

organizations or groups. When seen against the daily activities of women however, all of the women in the households are engaged in housekeeping, about 23% in Government jobs, 11% in trade and 5% in daily labor. Those engaged in Government jobs make up a larger share when compared to the other towns. In the sample households, 57% of the young girls attend school and 36% of them also assist their mothers in housekeeping. Only 1.5% of the girls responded that they are engaged in trade - a figure which is much lower than that of other towns (Appendix A, Table 4.8).

About 30% of the adult women in the interviewed households of Segeneity participate in educational session of social services of one kind or the other. More specifically, almost one third participate in water use, childcare and family planning sessions. The highest participation (37%) is in sanitation sessions. There is no literacy session through which medium many socially useful messages could be transmitted (Appendix A, Table 4.9).

Even though 68% and 54% of the respondents said they favor management of community water points and community toilets respectively, none of them participate in the meetings. The majority of them (90%) are members of voluntary traditional organizations like (Ekub - traditional savings association, Maheber, etc.). Another 63% participate in national organizations like the Peoples' Front for Democracy and Justice (PFDJ) and National Union of Eritrean Women (NUEW). About 2% of the respondents participate in meeting on activities related to credit and micro-finance institutions (Appendix A, Table 4.10).

If we examine the participation of adult women in communal activities, such as, those enumerated in Table 4.11, Appendix A, a little less than one in four of the women household heads do not participate in any of the listed ones. About 58% reported that they participate in traditional voluntary communal activities that are mostly dominated by the men folks. Participation in soil and water conservation is about 39% and in road building 7% - activities that could be difficult to categorize as communal activities. Again Table 4.11 confirm the earlier assertion that there is no participation in voluntary communal water point or communal toilet management. Despite the fact that it is reported that more than one third of women participate in sanitation education sessions, actual participation in sanitation related activities is reportedly nil.

g) Problems of Segeneity residents

About 55% of the sampled households responded by saying lack of income is their major problem, where women feel the shortage of income more than men. Shortage of water (22%) is reported to be the next big problems facing households in Segeneity, again affecting more of the women than the men. Lack of sanitation is also prominently reported as a problem. There seems to be no apparent problem with regards to transport, family relations and social services (Appendix A, Table 4.12).

When the first three household's responses to the problem or conditions related with the existing water supply facility are ranked, high water tariff comes first, followed by distance to water source, and third long queuing. They also reported stoppage of water, deteriorating facilities and shortage of water to be significant problems. Labor to fetch water is reported to be a problem among the interviewed households (Appendix A, Table 4.13).

h) Affordability for water and sanitation facilities

A total of 19.5% from all income groups responded that they can afford to pay less than Nfa 5 per month. When table 15 is analyzed a total of 34% from all income group could afford to pay between Nfa 5-9 and another 25% between Nfa 10-14. A significant 20% of the respondents said

they could only afford Nfa less than 5 (Appendix A, Table 4.15).

With regards to payment for community toilet, 10% the lower income group responded that they can afford to pay up to Nfa 4-6 monthly, but a higher percentage of 20% said they can afford Nfa 10-14 per month for community toilet. Of the income group of Nfa 300-599, only 10% responded that they can afford to pay from Nfa 4-6. Overall, all income groups would be willing to pay more than Nfa 4-6 monthly for community toilets (Appendix A, Table 4.16).

About 12% of the sampled households of the town travel less than 90 meters to the nearest communal water point. However, a little less than half responded that they travel more than 400 meters to the nearest communal water point. Even though the burden of fetching water lies predominantly on women (18 times a week), the share of girls and boys seems to be rather equal fetching 15 and 17 times a week each. When asked whether they prefer house connection, communal water point or yard connection, 53% of the unsatisfied household respondents said that they prefer house connection (Appendix A, Table 4.17).

4.2.2 Water Supply Conditions

The town has piped water supply from a well. At present there are 105 household connections. From the socio-economic survey the house connection, yard connection and communal water point users are 3%, 5% and 91% of the residents and the average consumption rate of 12l/c/d, 6l/c/d and 9l/c/d (Appendix E, Table 4.2). The very high discrepancy on consumption rate data collected from WSS and the socio economic survey might be (1) the private tap owner may resell water to the water vendors (2) there must be a technical error in the water meters installed. However, the data collected from socio survey is found reliable and hence will be considered for the bases of this study.

3% (186 households) of the residents fetch water from an unprotected river/spring sources. And 50% of them said they even use the water for drinking. In addition it is observed that people also fetch water from the Italian developed unprotected well. Since the water is believed to be contaminated by the community they use the water for cleaning and livestock watering purposes only.

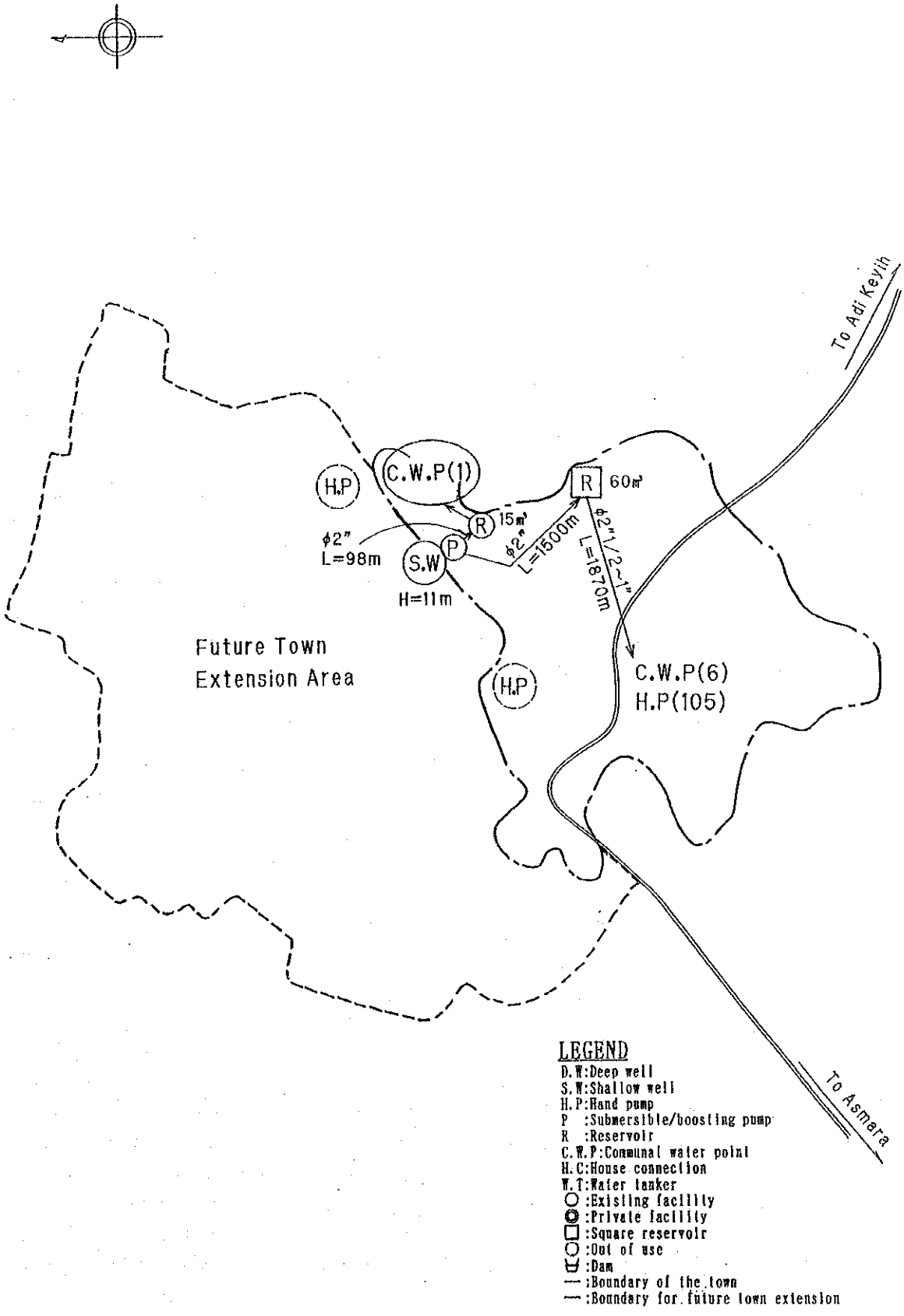
With regard to the communal water point management, so far community based management is not introduced. Currently, WSS takes the responsibility to manage the water system. However, in the survey it is reported that about 72% of the households are favoring the community based management for the communal water points.

44% of the communities fetching water from the communal water points travel more than 400 meters and those who fetch from the river travel 200 to 500 meters (Appendix E, Table 4.3).

Main water source of the town is one dug well located in the southern part of the Study Area and 800 meters far from the municipality. Depth of the well is 11 meters, and water is distributed to two reservoirs by one submersible pump. The pump is operated 8 hours per day. The smaller reservoir of 15 m^3 in capacity is at about 100 meters far from the well and the larger one of 60 m^3 in capacity is at 500-meter distance. The two reservoirs distribute to six communal water points and 105 house connections.

There are other two water sources of wells equipped with hand pump but they cannot be used because of their hardness of water quality. All of those situations are summarized as Figure 4.2.1.

Figure 4.2.1 Outline of Water Supply Facility



Major problems of the existing water supply facilities are limited yield of well, small capacity of reservoirs, obsolete motors, leakage from distribution pipes, damaged communal water point, etc.

4.2.3 Sanitary and Health Condition

(1) Public sanitation

Segeneity does not have sewerage system. There are two public latrines in the market place where the influx on Saturdays is 5,000 to 10,000 people from 20 to 25 villages, and another one is located in the transport station. These latrines where built in 1989-90 without any attention to the management aspect. Hence, they have been left without any attendant or cleaner consequently the latrines are blocked with stones and now are out of use. In Segeneity though 87% of the population use paper for anal cleansing 36% of the population still use stone (Appendix E, Table 4.4).

The town has one dump truck for refuse collection purposes. The truck collects garbage four days a week and covers only 50% of the town. The remaining part of the town are not getting services, due to inaccessibility. The final disposal of the garbage for many years had been to three environmentally unsafe areas, in close proximity in the neighboring villages.

Bars, hotels, restaurants, sewa houses, etc. neither do not have a latrine nor the latrines they have are nuisance and unhygienic to use.

There is no slaughter house for the town but there are two butcheries, where the shops have not been constructed for this special purpose. The walls are not made with tiles for easy washing. Moreover, there is no provision for refrigerators, livestock do not undergo a medical check, and sellers' personal hygiene and health is not taken into consideration.

The town administration of Segeneity does not have a sanitation section. According to the sub regional administrator, the main constraints to improve sanitation conditions are:

- lack of budget for the initial investment on facilities provision and, for operation and maintenance,
- lack of educational program on sanitation awareness creation.
- unchanged traditional old habits of the society with respect to sanitation.

According to the town administration, if the initial capital investment is somehow secured, regulations along with an awareness creation campaign, would not be a difficult task for the town administration to handle.

(2) Household sanitation

In general Segeneity residents are not accustomed to household latrine. About 75% of the society relieve them selves on open field. The type of latrines exist in town are septic tank/cesspool, dry pit and community toilets at the rate of 16%, 8% and 2% respectively. Among those who have latrine, about 70% of them said they are not satisfied by the type and condition of latrine they have and the type of latrine they prefer and said they can afford is flush (septic tank) at higher level (75%) and the second preference is community latrine (17%). From the socio survey it is realized that the residents are aware to the need for toilet. About 64% of the population even support the credit system, if introduced for

private latrine construction. The average affordable repayment rate for those who support the credit system is 23Nfa per month (Appendix E, Table 4.4).

The town administration also realizing the inevitable consequences of lack of private latrines on environment pollution hence, introduced a new regulation which prohibit construction of private houses with out latrine provision. This regulation however shall be implemented only to proper town of Segeneity which have a new master plan. Unfortunately the new master plan does not include Hadamo.

With regard to waste disposal practices of the residents, solid waste is disposed by 57% in their surrounding and only 43% use the town administrations refuse truck. Wastewater is disposed to open field by 96% of the population. Only 3% of the population use wastewater for gardening purpose. Animal wastes are used as fuel or for fertilizer by 67% of those who have domestic animals, but 33% of them do not collect the waste. Infant excreta in most cases is thrown on the field (81%) (Appendix E, Table 4.5).

(3) School sanitation

There are four schools, whose sanitation conditions are shown in Appendix E, Table 4.6. In the non-governmental school, sanitation and personal hygiene education is part and parcel of the curriculum. The school has a sanitation committee, which not only conduct the hygiene education program but also gives due attention to the necessary hygienic behavioral changes. As a result, good outcomes are observed in the sanitation condition of this school.

The government schools also have sanitation committees whose duty is to make students clean their class rooms, clean the compound and conduct hygiene education programs. However the practical education with respect to latrines usage is never addressed. For this reason students improper usage of latrines resulted blockage of latrine. In some cases the school administration due to lack of budget did not provide latrines. ice

(4) Health condition

The town for many years had a health center with 25 beds, a clinic, 4 pharmacies and an ambulance, 6 nurses, 8 dressers and 3 pharmacists. Now the town administration upgraded the health facility to mini hospital level. The hospital was built by the contributions of the natives of the town and the Catholic Mission. The hospital has 60 beds, OPD, First aid, laboratory, OR, X-ray, isolation rooms, laundry, bakery, store, offices, staff residence, flushed latrine for in patients and 12 pit latrines for out-patients. From the socio-economic survey it is observed that 94% of the population visit physician for medication (Appendix E, Table 4.8).

According to the hospital statistics, water and poor sanitation related diseases are common in the town. Annually in a range of 20-30% of the population are affected by water and poor sanitation related diseases (Appendix E, Table 4.7). These data however said includes cases referred from the surrounding rural towns. Moreover, patients who did not actually visit the hospital are assumed to be quite a number.

In the socio economic survey conducted house to house the existence of water and poor sanitation related diseases at its high degree are indicated. An average of 13 and 3 persons per household are reported

were being sick of diarrhea and dysentery respectively in six months period from the time of survey and the average infant death in ten year was an average of one infant per household in 10 years (Appendix E, Table 4.8).

Peoples participation on health/hygiene education program is low (39%). On the other hand peoples perception on child immunization program is 98% and ORS preparation knowledge is significantly high (94%). The residents by 93% participated in community sanitation work. The areas of participation are cash, material and labor (Appendix E, Table 4.8 and 4.11)

The hygienic behaviors as part of the sanitation were examined from the socio-economic survey and it is realized from the study that the hand washing practice is very low. Hand washing with soap after defecation, before cooking, before eating, after disposal of children stool and after handling animal dung is only 60%, 16%, 13%, 55% and 10% only. Relatively food handling practice is better, all of them wash raw vegetable before eating and cover leftover food (Appendix E, Table 4.9 and 4.10).

4.2.4 Financial Condition of WSS

Water Supply Service (WSS) of Segeneity earned 70,485 Nfa from Jan. to Jun. in 1997, while the expenditures incurred amounted to 34,122 Nfa, or a profit ratio of 51.6%. This ratio is considered an excellent financial performance.

Water sales accounted for 56.2% incomes. Salaries, materials and fuel occupied 31.5%, 19.6% and 19.6% of expenditures, respectively, totaling 70.7%.

Numbers of water supply facilities are 105 for house connections, 6 for communal water points, 1 for the public well and 1 for the private well. Provision of these facilities in Segeneity is considered low compared to the other 6 towns, represented by a few number of house connections.

Water tariffs per cubic meter are 2-2.5 Nfa for house connection users and 5 Nfa for communal water point users. These tariffs are considered an average level.

WSS has 6 workers. Each worker earns an income of 18,070 Nfa, which is high among the 7 towns. The average monthly salary per worker is calculated at 514 Nfa.

The per capita per day consumption of water is 15.3 liters according to the results of the socio-economic survey. This per capita consumption is at the average level.

(1) Population in 1997: 6,146

(2) Financial Performance from Jan. to Jun., 1997

Unit: Nfa

Revenues		Expenditures	
Item	Amount	Item	Amount
Water sales by meter	39,645	Salaries	10,745
Water sales by cash	-*	Per diem	316
Rental charge of meter	-*	Electricity	0
Service charge	30,840	Fuel	6,676
Others	0	Supply materials	6,688
Total	70,485	Repairs	0
		Office supply	133
		Others	9,564
		Total	34,122

Note: *=included in "Water sales by meter".

(3) Water tariffs

Unit: Nfa/m^3

House connection	Communal water point	Water tanker	Water vendor	Public well
2-2.5*	5	-	-	-

Note: *2.5 Nfa/m^3 is for establishments/institutions.

(4) Number of water supply facilities

House connection	Communal water point	Water tanker	Public well	Private well
105	6	0	1	1

(5) Number of personnel

Division	Functions	Male	Female	Total	Perm.*	C./T.**	Total
Head		1		1	1		1
Financial	Water seller		3	3		3	3
Technical	Motor operator	1		1	1		1
	Plumber	1		1	1		1
	Total	3	3	6	3	3	6

Note: *=Permanent, **=Contract/Temporary

(6) Production and consumption of water in 1996 (m^3): 15,939 and 12,751.

(7) Average monthly salary: 514 Nfa.

(8) Per capita per day water consumption: 10.9 liters

CHAPTER 5 STRATEGY ON PLANNING

5.1 Basic Strategy on the Planning

(1) Target year

The project for water resource development, water supply and sanitation improvement is to be formulated as a phased plan to the year 2015. A preliminary assumption would be that the project would comprise 3 phases, with phase horizons of 2005, 2010, and 2015, respectively. Although the 2010~2015 period would comprise mid~long term planning, the subject project formulation would include preliminary facility design and funding plan for this stage as well. With regard to the first phase (priority project with a target date of around 2005) of the project, facility design and costing would be to the feasibility study level.

(2) Water resources development plan

The water resources development plan would focus primarily on groundwater and underflow. This would include study of the feasibility of tapping shallow groundwater in the Quaternary formation and weathered rock zone in and around the target towns, and deep groundwater in rock formations.
Although the water source development plan will focus primarily on groundwater, discharge measurement will be carried out for Mereb river as a candidate, long term water source for Mendefera.

(3) Water use

Water supply would give priority to domestic water, however, industrial water use would also be considered with special attention to future demand trend in this regard in the case of towns such as Debarwa and Dekemhare which are pursuing programs to attract industrial enterprises.

(4) Water supply and sanitation plan

Water supply and sanitation plan would comprise a) facility plan with appropriate attention to natural and socio-economic condition, b) project cost estimation, c) O&M plan for sustainability of facilities, d) institutional strengthening plan, e) examination of the financial feasibility of the project and f) project implementation schedule.

(5) Sustainability of the project

Water supply project for rural towns lies with the municipal government of the concerned town with the aim to achieve budgetary independence. Specific recommendations on an operating structure for water supply systems which is sustainable under independent budget will be done. This would include an examination of factors such as O&M costs, replacement of main equipment after depreciation, etc. Also, in cases where the capacity of beneficiaries to pay water fees is too low to achieve independent budget viability, specific recommendations are to be made with regard to ways to compensate for this gap.

5.2 Population Projection

5.2.1 Population as of 1997

According to figures made available from the Ministry of Local Government, the total population of the seven towns as of 1997 amounts to 89,660 of which 53% are females and 47% males (see Table 5.2.1 below). The figures include the population of the surrounding villages which were incorporated within the town administrations by the MoLG. The population of the surrounding villages amounts to about 11%.

Table 5.2.1 Present Population and Household Size of the Seven Towns

Town	Population
Debarwa	4,831
Mendefera	20,371
Adiquala	9,488
Dekemhare	21,675
Segeneiti	6,146
Adi Keyih	14,215
Senafe	12,934
Total	89,660

Source: Ministry of Local Government,
Town Administration Department, 1997

5.2.2 Basic Assumptions Adopted for Population Projection

Base population data (1997) for all towns is taken from the data provided by the Town Planning Department of the Ministry of Local Government.

It is assumed that during the development plan period, the population of these seven towns will grow very rapidly due to the following reasons:

- the fact that the climate in all these areas is conducive for human settlement,
- that present demand for urban land is quite high as attested by the number of applications received by the town administrations,
- due to the high influx of rural people in search of better employment opportunities, and in search of better public amenities like schooling, health, water, etc.
- the fact that these towns are market centers which attract potential investors in trade and other service and manufacturing activities
- the various infrastructure (road, electricity, telephone, market places, et.) planned to be implemented by the government in the very near future.

5.2.3 Projected Population

Despite the fact that there will be rapid population growth rates in the coming years, it cannot be assumed that all the seven towns will experience uniform growth rate. Therefore, for the present planning

purpose, the seven towns have been categorized into two: those that will likely experience very rapid population growth and those that are likely to have lower growth rates. Following is elaboration on this:

(1) Category One: Mendefera, Dekemhare and Debarwa

These towns are envisaged to undergo a rather fast population growth rate due to the planned economic development program envisaged to be under-taken by the government and the expected private sector investment to follow in, in and around these towns.

Thus, the growth rate for these towns will be:

- at 5% per annum from the years 1998 – 2005, and
- from the year 2006 until the year 2015 they will experience a slower growth rate of 4.5% due to the general expectation of declining population growth.

The number of returnees assumed to settle in these towns is assumed to increase up to the year 2010 and slightly decrease from the year 2011 onwards.

Therefore, the number of returnees assumed to inflow to these towns are:

- from 1997 to 2000 a total inflow of 900,
- from 2001 to 2005 a total inflow of 1200,
- from 2006 to 2010 a total inflow of 1200, and
- from 2011 to 2015 a total inflow of 1000.

(2) Category Two: Adiquala, Segeneity, Adi Keyih and Senafe

The growth rate adopted for these towns is 4.5% up to the year 2005 and a slightly lower one of 3.5% until the year 2015.

The number of returnees assumed to settle in these towns is assumed to increase up to the year 2010 and slightly decrease from the year 2011 onwards.

Therefore, the number of returnees assumed to inflow to these towns are:

- from 1997 to 2000 a total inflow of 750,
- from 2001 to 2005 a total inflow of 1000,
- from 2006 to 2010 a total inflow of 1000, and
- from 2011 to 2015 a total inflow of 750.

5.3 Water Demand Projection

5.3.1 Present Domestic Water Consumption

According to the social economic survey report, present water consumption is expected as follows;

There are many water supply modes in the towns. Main modes are individual connection like house

connection and yard connection, communal water point, water wagon and water vender by donkey. Present supply mode and its water consumption is shown in Table 5.3.1.

This table shows that the house connection is the highest consumption and it is more than 20 l/s/d in five towns. Water wagon supply is the second and its consumption is about 15 – 16 l/s/d. Communal water point is lowest consumption. It means that water wagon supply is very important in seven towns at present.

The average consumption of each mode of service for seven towns is estimated 20.8 l/s/d in house connection, 11.3 l/s/d in yard connection, 11.0 l/s/d in communal water point and 14.1 l/s/d in water wagon.

5.3.2 Approach on Domestic Water Demand

The average domestic water demand and percentage of consumers for each mode of service for the seven towns is estimated based on the following consideration:

(1) Hygiene

The hygienic behaviors are influenced by the availability of adequate water. Hence the estimated water demand need to be adequate enough to keep personal and household hygiene.

(2) Available infrastructure

The infrastructures taken into account are availability of sewerage systems, cistern flush and pour flush latrines, shower and kitchen sink which have great effect on domestic water demand. At present Mendefera, Dekemhare and Adiquala have sewerage system. The town administrations of these towns realized the need and developed plans to rehabilitate and expand the system. In each town the only constraint to its implementation is budget. Moreover, with the implementation of the prospective water supply development project, lack of proper sewerage system will be aggravated.

With regard to present household latrine availability, Dekemhare, Mendefera and Adi Keyih are categorized #1, with 60%, 54% and 47.5% coverage respectively. Senafe and Adiquala are categorized #2, with coverage of 40% and 36.7% respectively, and Segeneiti and Debarwa are categorized # 3 with only 25.4% and 11.1% respectively.

(3) Economic potential

The present economic potential of the people has a direct implication with the available infrastructures. The future economic development growth is difficult to tell but with the development of water supply system it is envisaged that other economic activities will also accelerate accordingly. Hence the present situation is taken into consideration in this approach.

(4) Water resources potential

The water resources potential in these towns are limited in general. Therefore, demand on water supply may also be conditioned in accordance with the water resources potential, if there is no other choice.

Table 5.3.1 Present Supply Mode and Water Consumption

Name of Town	Mode of Supply	Consumers Percentage	Consumption (l/s/d)	Remarks
Debarwa	H.C.	1.25	25.0	
	Y.C.	-	-	
	C.W.	41.7	8.56	
	W.W.	27.8	15.61	
Mendefera	H.C.	10.94	24.11	
	Y.C.	6.56	14.95	
	C.W.	29.2	10.13	
	W.W.	53.3	16.39	
Adiquala	H.C.	13.86	20.45	
	Y.C.	6.14	12.07	
	C.W.	63.6	14.31	
	W.W.	-	-	
Dekemhare	H.C.	5.67	25.59	
	Y.C.	8.67	15.67	
	C.W.	-	-	
	W.W.	78.1	16.51	
Segeneity	H.C.	3.0	11.66	
	Y.C.	5.0	5.94	
	C.W.	90.5	8.79	
	W.W.	-	5.59	
Adi Keyih	H.C.	4.95	28.73	
	Y.C.	10.64	12.64	
	C.W.	13.94	16.45	
	W.W.	78.86	-	
Senafe	H.C.	7.78	10.3	
	Y.C.	6.62	6.8	
	C.W.	83.8	8.04	
	W.W.	1.82	16.49	
Total / Average	H.C.	7.5	20.8	
	Y.C.	7.2	11.3	
	C.W.	36.1	11.0	
	W.W.	45.3	14.1	

- "H.C." means house connection.
- "Y.C." means yard connection.
- "C.W." means communal water point.
- "W.W." means water wagon including water vender by donkey.
- The sums of consumers are not 100% because of multiple answers and neglected other sources.

(5) The government policy

The government policy do not favor subsidy for the services. While determining the water tariff, all expenses including the cost of investment on the system, production cost, and expansion cost are believed to be covered by the consumers. Hence, it is inevitable that people's affordability will limit them from consuming more water.

(6) Population

Population has great impact on water supply and sanitation. With the increase in the population the environment caused by sanitation loses its absorbing capacity and the economic development of the town accordingly increases. Hence development of infrastructures is a pressing demand of the town. At present Adi Keyih, Mendefera and Dekemhare having high populations are categorized #1, Senafe in second level and Segeneiti, Adiquala and Debarwa are placed third level.

(7) Current water demand trend

In all towns the water demand trend for water supplied home is high and for human transported water is vise versa.

Therefore, the towns based on the above listed factor are categorized, and basic factors for water demand are estimated based on the present water supply condition, as follows (refer to Table 5.3.2).

- Category 1 - Mendefera, Dekemhare and Adi Keyih
  - Consumers % of population (in 2000) => HC:YC:CW= 25:30:45
  - Demand rate in 2000 => 30, 20, 15 lcd for HC, YC, and CW
  - Annual growth rate of supply modes => 3% (HC), 2% (YC, only 2005)
  - Annual growth rate of demand by mode => 3% (HC), 2% (YC)
- Category 2 - Senafe and Adiquala
  - Consumers % of population (in 2000) => HC:YC:CW= 20:30:50
  - Demand in 2000 => 25, 20, 15 lcd for HC, YC, and CW
  - Annual growth rate of supply modes => 3% (HC), 2% (YC, to 2010)
  - Annual growth rate of demand by mode => 3% (HC), 2% (YC)
- Category 3 - Debarwa and Segeneiti
  - Consumers % of population => HC:YC:CW= 15:20:65
  - Demand in 2000 => 25, 20, 15 lcd for HC, YC, and CW
  - Annual growth rate of consumers => 3% (HC), 2% (YC, to 2010)
  - Annual growth rate of demand by mode => 2% (HC), 2% (YC)

Note) HC: House Connection, YC: Yard Connection, CW: Communal Water point.

Average domestic water demand based on Table 5.3.2 is shown in Table 5.3.3.

Table 5.3.2 Water Consumption

Name of town	Present water consumption pattern			Expected water demand											
	Mode of supply	Consumption l/c/d	Consumers % of household 1)	Year 2000-2005				Year 2005-2010				Year 2010-2015			
				Consumers (% of hld)		Ave. Consumption (l/c/d)		Consumers (% of hld)		Ave. Consumption (l/c/d)		Consumers (% of hld)		Ave. Consumption (l/c/d)	
				2000	**2005**	2000	**2005**	2005	**2010**	2005	**2010**	2010	**2015**	2010	**2015**
Debarwa	House connection	25	1. 25	15	17	25	28	17	19	28	30	19	22	30	35
	Yard connection	–	–	20	22	20	22	22	24	22	24	24	27	24	27
	Communal water point	8. 56	41. 7	65	61	15	15	61	56	15	15	56	51	15	15
	Water tanker	15. 61	27. 8												
Mendefera	House connection	24. 11	10. 94	25	29	30	35	29	34	35	40	34	39	40	47
	Yard connection	14. 95	6. 56	30	33	20	22	33	66	22	24	66	61	24	27
	Communal water point	10. 13	29. 2	45	38	15	15	38	0	15	15	0	0	15	15
	Water tanker	16. 39	53. 3												
Adiquala	House connection	20. 45	13. 86	20	23	25	29	23	27	29	34	27	31	34	39
	Yard connection	12. 07	6. 14	30	33	20	22	33	37	22	24	37	69	24	27
	Communal water point	14. 31	63. 6	50	44	15	15	44	37	15	15	37	0	15	15
	Water tanker	–	–												
Dekemhare	House connection	25. 59	5. 67	25	29	30	35	29	34	35	40	34	39	40	47
	Yard connection	15. 67	8. 67	30	33	20	22	33	66	22	24	66	61	24	27
	Communal water point	–	–	45	38	15	15	38	0	15	15	0	0	15	15
	Water tanker	16. 51	78. 1												
Segeneiti	House connection	11. 66	3	15	17	25	28	17	19	28	30	19	22	30	35
	Yard connection	5. 94	5	20	22	20	22	22	24	22	24	24	27	24	27
	Communal water point	8. 79	90. 5	65	61	15	15	61	56	15	15	56	51	15	15
	Water tanker	5. 59	–												
Adi Keyih	House connection	28. 73	4. 95	25	29	30	35	29	34	35	40	34	39	40	47
	Yard connection	12. 64	10. 64	30	33	20	22	33	66	22	24	66	61	24	27
	Communal water point	16. 45	13. 94	45	38	15	15	38	0	15	15	0	0	15	15
	Water tanker	–	78. 86												
Senafe	House connection	10. 3	7. 78	20	23	25	29	23	27	29	34	27	31	34	39
	Yard connection	6. 8	6. 62	30	33	20	22	33	37	22	24	37	69	24	27
	Communal water point	8. 04	83. 8	50	44	15	15	44	37	15	15	37	0	15	15
	Water tanker	16. 49	1. 82												

1): The sums aren't necessarily 100% because of multiple answers and neglected other sources.

Table 5.3.3 Domestic Water Demand

(l/c/d)

Name of the Town	In 2005	In 2010	In 2015
Debarwa	18.8	19.9	22.6
Mendefera	23.1	29.4	34.8
Adiquala	20.5	23.6	30.7
Dekemhare	23.1	29.4	34.8
Segeneity	18.8	19.9	22.6
Adi Keyih	23.1	29.4	34.8
Senafe	20.5	23.6	30.7

5.3.3 Other Water Demand

Total water demand consists of the domestic water demand and non-domestic water demands such as governmental, institutional, commercial and industrial demands. There are no standard figures of these non-domestic water consumption in Eritrea.

As a result of the field survey, the following non-domestic water consumption is obtained.

Table 5.3.4 Non-domestic Water Consumption by Field Survey

Item	Number	Water consumption	
		m^3/d	l/shop/d
Hotel	12	2.65	221
Restaurant	12	2.51	209
Shop	12	2.41	201
Factory	12	11.95	996

On the other hand, there are standard figures of these demands in the similar country, as follows.

School	5 lit/pupil
Hospital, Clinic	100 lit/bed
Hotel	100 lit/bed
Bar, Tea shop, Restaurant	200 lit/shop
Church, Mosque	5 lit/visitor
Office	5 lit/person
Industry (dry)	5,500 lit/ha
Industry (wet)	22,000 lit/ha

Water consumption of 5 lit/person as shown above is considered the basic figure for drinking only. As for water consumption of industry, it is planned for industry area in Debarwa, Mendefera and Dekemhare. Light industry is planned in Mendefera but it is unclear what kind of industry is planned in the remaining two towns.

Finally, non domestic water demand adopted is as follows, based on the field survey, discussion with engineers concerned in Water Resources Department and the standard figures of the similar countries.

Table 5.3.5 Non-Domestic Water Demand

Item	Water Demand
School	5 l/pupil
Hospital, Clinic	100 l/bed
Hotel, Bar, Tea shop, Restaurant	210 l/shop
Church, Mosque	5 l/visitor
Office	5 l/person
Factory	1,000 l/factory
Light industry	5,500 l/ha
Other Industry	15,000 l/ha

Non-domestic water demand except for light industry and other industry is assumed to increase in a geometric ratio of population growth rate. Water demands of light industry and other industry planned for future extension are separated and estimated per hectare based on the town planning data. Therefore, non-domestic water demands in each target year employed the same figure as above, and added the following population growth rate.

Table 5.3.6 Increasing Rate per Year for Non-domestic Water Demand

Unit: %

Name of Town	1997-2005	2006-2010	2011-2015
Debarwa	8.80	7.93	7.32
Mendefera	5.99	5.65	5.44
Adiquala	6.27	5.62	5.22
Dekemhare	5.93	5.60	5.40
Segeneiti	7.15	6.35	5.81
Adi Keyih	5.70	5.15	4.82
Senafe	5.81	5.25	4.90

5.3.4 Loss and Peak Demand

(1) Physical loss

Physical losses caused by water leakage and waste from pipes, reservoirs and taps, illicit connections, etc., are put at 15 %, assuming that the new facilities will be constructed by the target year.

(2) Max. daily and peak hour water demand

Fluctuations of the maximum daily water demand and weekly or daily variations for peak hour water demand due to seasonal or monthly climatic conditions, are taken into consideration. It is found by the field survey that water consumption in rainy season is higher by 22 % than that in dry season. Rainwater is very important source during the rainy season for washing (95%) and drinking (5%).

It is very difficult to investigate the peak hour water demand because of insufficient water source and

obsolete water supply facilities. Well pumps are operated 3~12 hours daily to meet the reservoir capacity, and communal water points are used 2~3 times per day at present. However, water supply condition will be developed under this project, and as a result, communal water points will be decreased, while individual connections (house connections and yard connections) will be increased in future.

These factors, for example, employed for Keren-city Water Supply Project for an approx. 70,000 population are 1.2 for max. daily water demand and 1.5 for peak hourly water demand.

Finally, max. daily water demand and peak hourly water demand are worked out by assuming the following coefficient based on the field survey and the standard figures in Eritrea.

Max. daily water demand = C1 x Average daily water demand
Peak hour water demand = C2 x Max. daily water demand
Coefficient of C1 = 1.2
Coefficient of C2 = 1.5

5.4 Water Supply System

5.4.1 Water Supply System

Existing water sources of six towns except Segeneity are located far from and/or lower than the town. Therefore, water is transmitted from the water sources to the reservoir by pumps and is distributed from the reservoir to customers by gravity. Well pumps are operated daily for 2.5 hours in Debarwa, 4.0 hours in Senafe and 7 - 12 hours in the remaining towns at present. In case water source is far form the town such as Mendefera and Dekemhare, water is directly supplied to the customers by water wagons.

The project plan for the water supply system employs the same system with the existing one as a rule. Water sources are to be groundwater because it is the cheapest source and the water can directly used for drinking without treatment. In case groundwater is insufficient to satisfy the demand and/or located extremely far from the town, surface water will be planned. New water sources and the existing water sources to be used in the project are connected to the reservoir by pipelines, not by water wagons. The reasons are a) there are a few water wagons and these wagons have frequent breakdowns, and b) pipeline systems are more safe and steady than the water wagons. Water of the transmission line from water source to reservoir is supplied by pump and the distribution line from reservoir to water taps is by gravity. The transmission line has no direct connection to the distribution line.

5.4.2 Water Supplied Area

Seven towns under the project have each administrative district and the administrative district consists of sub zones in the town and/or some villages. There are schools, hospitals, shops, hotels, churches, mosques, etc., in the sub zones and villages. The center of the town is divided into some sub zones and many inhabitants are living in these sub zones at present.

Each town has their future town plan and future town extension area beside the center of the town. Almost all villages are close and/or near to the town center and are included in the future town extension areas. However, a few villages are far from the town center and there is no future town plan for such

villages at present.

Under the circumstances, water service areas are divided into following three areas under the project in accordance with the present town and water supply conditions, population, future town plan, topographical features and so on. Finally, the administrative districts including all villages are planned for the water supply facilities under the project.

a) Water service area in the project target year 2005 : the areas are center of the town and essential for rehabilitation and improvement of the existing water supply facilities,

b) Water service area in the project target year 2010 : the areas are close to the town center of. These areas are for the future town extension plan, and water of these areas are supplied by water wagons or water venders at present.

c) Water service area in the project target year 2015 : the areas are far from the town center but in the administration district.

5.4.3 Facility Plan

(1) General

Existing water supply facilities are mostly replaced under the project because of following reasons. However, the existing wells counted as the water sources in the project will be used continuously, and only well pumps will be replaced after developing the existing wells. Reservoirs having enough capacity will be used after rehabilitation.

a) Yield from wells is insufficient to cover the future water demand,

b) Well pumps are obsolete and have breakdowns,

c) Reservoirs have small capacity and insufficient water level,

d) Pipelines are also obsolete, insufficient diameter to distribute the future water demand, not standable to the future increasing pressure, unknown position, etc., and

e) Communal water points are damaged.

(2) Target years for pipeline

Water supply facilities have two types, namely, one is pipeline type which is difficult to expand the system to meet the future water demand such like transmission pipeline and main distribution pipeline, while another is easy to expand such like wells pumps, reservoirs, etc.

The facilities for easy expansion are constructed and enlarged to meet the water demand in the target year. However, in case that expanded capacity is as small as $10m^3$ or less and not economical for construction, the facilities are to be constructed to meet the future demand.

The pipe diameters of the transmission line and main distribution line are enlarged to meet the water demand in the target year; for example, the pipe diameter of 100mm in 2005 is replaced by 125mm in 2010 and by 150mm in 2015 in the same line. Therefore, construction of these pipelines shall consider the future water demand.

The diameters of the transmission pipeline and main distribution pipeline are planned for the water demand in the target year 2010 under the project. The transmission pipeline and main distribution pipeline in the target year 2015 will be equipped with another one line to meet the water demand in the target year 2015. The reasons to employ these diameters are a) it is difficult to expand the facilities to meet the water demand, b) the facilities covering the water demand in the target year 2010 is nearly 20 % increase from those in 2005, and is cheaper than construction of another one line (refer to Appendix D), c) the facilities covering water demand in the final target year 2015 are nearly 40 % increase from those in 2005, and the final future plan is still unclear at present.

(3) Pipe material

Water pressure, soil characteristics and topographical configuration are very important to select pipe material for the transmission pipeline and the distribution pipeline.

Water pressure depends on given topographical configuration and total length of the pipelines, especially for transmission pipelines. Some transmission pipelines are expected durable to more than 100m of dynamic water head, while the distribution pipelines are expected to less than 75m. Soil characteristics in the project areas vary in one town to another. The ground bed of each town consists of the following lithologies and it will be difficult to select different pipe material to meet the lithologies.

Debarwa: unconsolidated soil and weathered laterite,
Mendefera: soil and weathered crack rich basalt,
Adiquala: soil and mostly hard fresh basalt including rock fragments,
Dekemhare: alluvial deposits
Segeneity: soil and heavily weathered granite,
Adi Keyih: clayey soil including fine to coarse gravel,
Senafe: soil and coarse sand including sand stone gravel.

Under these circumstances, following pipe materials are recommendable.

Ductile cast iron pipe for transmission pipeline:
the transmission line is very important and the maximum pressure of the line including water hammer is nearly 1961 kPa (20kgf/cm^2),

PVC pipe for distribution pipeline:
the maximum pressure of the distribution line including water hammer is less than 981 kPa (10 kgf/cm^2).

(4) Power supply

There are main diesel power plants at Mendefera, Dekemhare and Adi Keyih in Debub Region. Electricity in six towns except Debarwa is supplied by these diesel power plants at present.

There is a network plan to connect these diesel power plants with Asmara power plant, and Debarwa will be supplied with electricity by 2000. Therefore, power supply for new water supply facilities in all seven towns will served by these diesel power plant through the network.

(5) Major water supply facility

The following major water supply facilities are planned in the project.

- Intake facility: deep well, shallow well, well pump,
- Transmission facility: transmission pipeline, booster pump, pump pit,
- Distribution facility: reservoir, distribution pipeline,
- Water service facility: individual connection, communal water point,
- Electricity facility: power supply, generator,
- Others: pump house, valves, flow meter.

Basic items of new water supply facilities are planned below.

a) Well

- Diameters of well casing are 150 mm (6 inches) for the yield capacity of 10 lit/s or less, and 200 mm (8 inches) for the capacity exceeding 10 lit/s.
- Material for casing and screen are both PVC pipe.
- Existing wells to be used in the project will be developed.

b) Well pump

- Well pump operation 24 hours daily.
- Type of well pumps are submersible.
- Well pumps for the existing wells for use in the project to be newly replaced.
- One stand-by pump provided in the town.

c) Transmission pipeline

- Pipeline for new installation
- Diameters of pipe in the target year 2005 will be for max. daily water demand in the target year 2010.
- Additional line will be constructed for the water demand in the target year 2015
- Material is ductile cast iron pipe.

d) Booster pump

- Booster pump at less than 130 m head.
- Stand-by pump not planned in the project.
- Type of booster pump is centrifugal.

e) Pump pit

- Pump pit in suction pit for boosting pump.
- Capacity is 30-minutes pumping capacity.
- Min. capacity of the pit as $15m^3$.
- Tank is of reinforced concrete made.

f) Reservoir

- Capacity for grand type is 8-hour max. daily water demand, while that for elevated type is 1-hour demand.

- The reservoirs are reinforced concrete made for ground type and fiberglass reinforced plastics (FRP) made for elevated type.

g) Distribution pipeline
- Pipeline for new installation.
- Diameters of pipe in the target year in 2005 for the max. daily water demand in the target year of 2010.
- An additional line will be installed for the water demand in the target year 2015
- Min. pressure is 7 m.
- Material is PVC pipe.
- Minimum diameter of pipe is 50 mm.

h) Individual connection
- Diameter of pipe is 13 mm.
- Material is polyethylene pipe.
- Flow meter is equipped.

i) Communal water point
- There are 8 taps per communal water point.
- Communal water points for coverage of a radius of 150 m
- Communal water point is made of concrete.

j) Power supply
- Electricity is a main power source for pumps
- No generator planed under the project.

k) Pump house
- Pump house planned for pump panels, the booster pump and generator.
- Pump house is brick made.

l) Others
- Valves (stop valve, air valve, wash out valve, pressure reducing valve, etc.) are installed at the proper position.
- The chlorinating facility is installed on the reservoir.
- Flow meters are installed at the outlet of pumps and reservoirs and at inlet of communal water points and individual connections.

5.5 Sanitation Improvement

5.5.1 Objective and Scope of the Program

The main objective of the Sanitation improvement program is to reduce the water and poor sanitation related diseases and create a healthy and productive society. Ultimately a healthy and productive society will have self sustained economy and a happy family.

This program particularly focus on public and private sanitation facilities improvement and hygienic practices. Hence the scope of the study includes the following areas of sanitation improvement:

- improve public sanitation facilities such as:
  - provision of wastewater and soil waste disposal system
  - provision of solid waste disposal system
  - provision of public and community toilets
  - improve schools, hospitals etc. sanitation facilities
- improve private toilets
- develop sanitation/hygiene educational program
- develop a management structure for sanitation improvement program

5.5.2 General Approach

The general approach of this study on sanitation improvement formulation program is based on the following steps.

a) The first step for the sanitation improvement program formulation is getting a clear picture of the current sanitation and health condition of the town with regard to facilities and practices. Therefore all pertinent information from the grass root to higher official level was gathered by approaching relevant people, referring documents and from socio-economic survey. The type of information collected are on the existing public and private sanitation facilities, economic condition of the town in general and household in particular, sanitation practices and behaviors of the community are assessed.

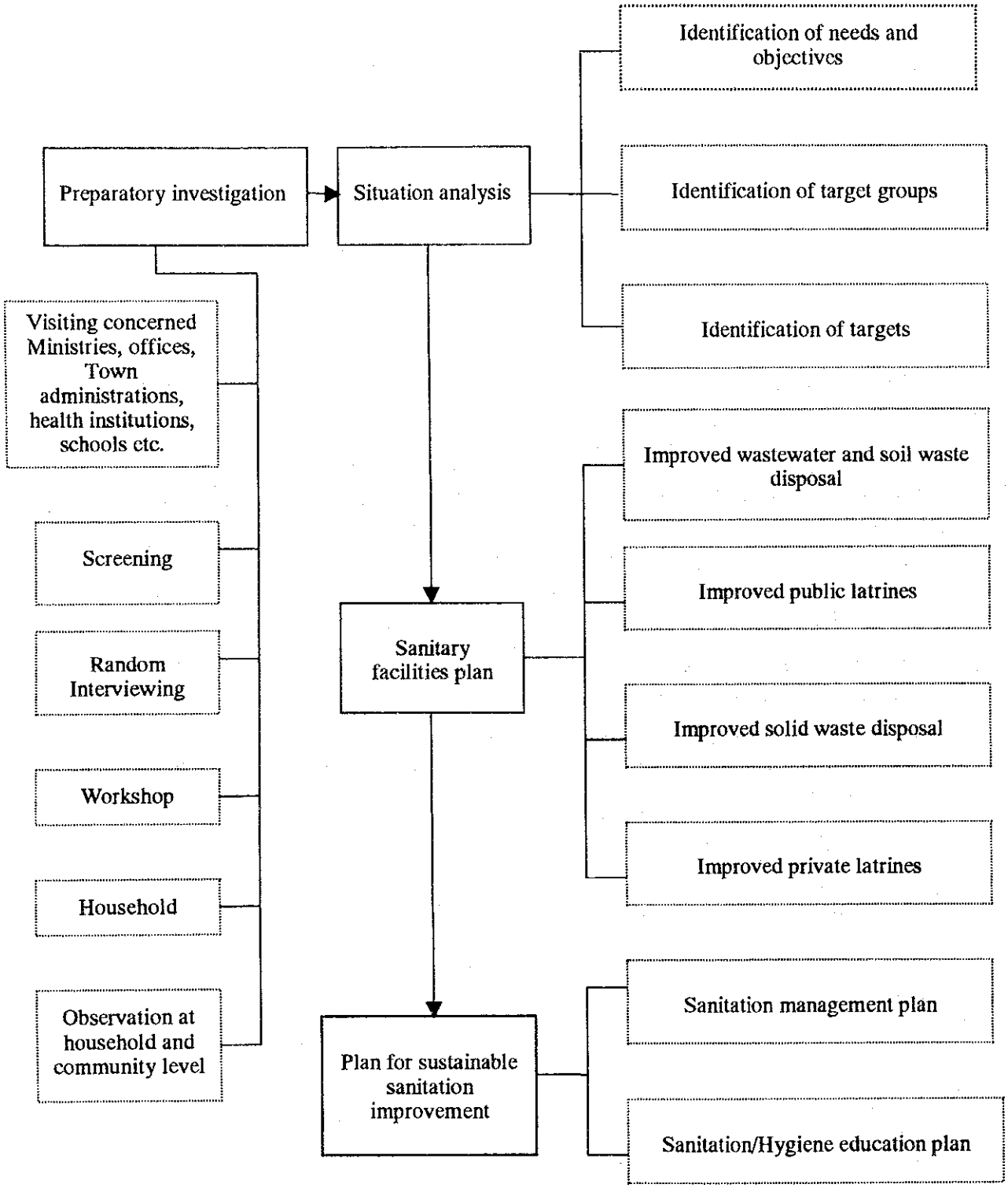
b) Following to the information collection process the situation is analyzed and needs and objectives, the specific targets and the specific target groups are identified.

c) Having a clear picture of the current condition on sanitation, social, cultural, economic etc. aspects the potential developments are foreseen and future plans for improved sanitation facilities program are formulated for three consecutive phases (year 2000-2005, year 2005-2010, and year 2010-2015).

d) Further in this study management and educational plans for effective and sustainable improved sanitation program is proposed.

For details of flow of the study approach please refer Figure 5.5.1.

Figure 5.5.1 Details of the Sanitation Improvement Program Formulation Approach



5.5.3 Areas of Focus and Basic Considerations

The needs and objectives, specific targets of the study and target groups for the sanitation development program are greatly influenced by socio-economic condition of the town and anticipated water demand. Hence the socio-economic study, water demand projections and water supply plans of this study are background for the sanitation improvement program formulation.

Moreover, explicit studies are carried out in areas of:

- Public, institutional and private sanitary facilities with respect to availability, coverage and conditions.
- Communities practice in using sanitary facilities.
- Social, economic, religious and cultural influences on sanitation facilities and usage.
- Availability of common water-born diseases, range of cases of sickness and death.
- Treatment practices for water-born disease.
- Sanitation behaviors in hand washing, utensil keeping, food and water storage, water drawing, infant excreta handling etc.
- Educational programs on sanitation, hygiene and health.
- Community management experiences.
- Community attitude on sanitation improvement programs and willingness to participate
- Government policy and programs on sanitation improvement.
- Existing management structure on sanitation.

The sanitation facilities plans are developed ensuring the economic and technical feasibility and social and cultural appropriateness in the society. The basic factors considered are:

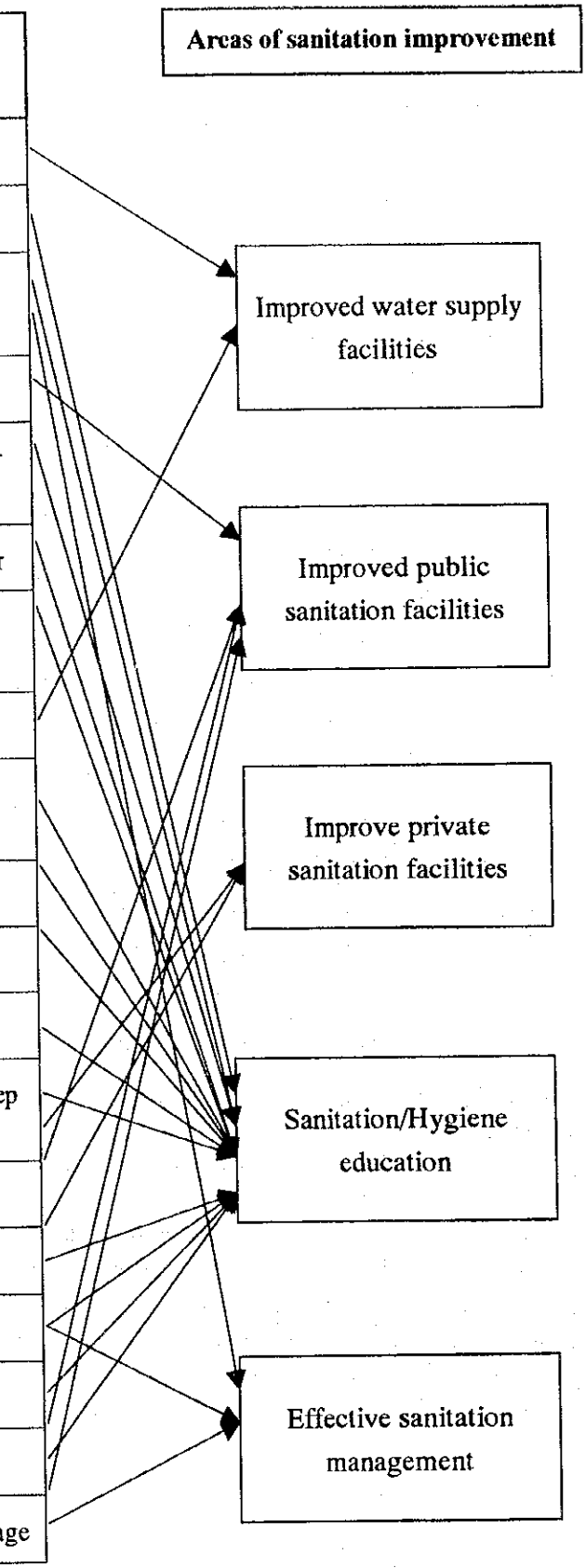
- make life easier and solve felt problems.
- functionally appropriate, easy to operate and maintain.
- affordable and materials easily available;
- in line with the cultural value and behavioral of the users;

The management plan formulated effectively address the operation and maintenance, staff strengthening, evaluation and monitoring aspect of the solid waste, wastewater and soil waste disposal, public and private latrines and sanitation/hygiene educational management.

To maximize the potential benefits of water supply and sanitation improvement programs on health, facilities need to be used and related behavioral risks reduced. Therefore, the sanitation improvement program is coupled with sanitation/hygiene education programs with the objective of establishing links between water and sanitation facilities on one hand and human practices on the other hand, especially with regard to the use, care, and maintenance of the facilities; the preservation of water safety and its use in sufficient quantities; and the safe disposal of wastewater , human and other solid waste.

Figure 5.5.2 Causes of Water-born and Sanitation Related Diseases and Areas of Sanitation Improvement

Causes of water-born and sanitation related diseases
Not having safe water supply
Overlooking of improved water source
Risk of contamination of water by human, nearby latrine, animal
Risk of contamination of water by poor drainage
Contamination of drinking water by unclean vessel or hand contact
Contamination of water by using uncovered container
Contamination of water by unclean storing vessel or not covering
Insufficient quantity of water usage
Contaminating water while drawing of water by dipping hand and using unclean cup
Preparing of food without washing hand
Washing vegetable with unclean water
Not covering food properly
Not washing kitchen utensils with safe water and keep clean
Not using hygienic means for excreta disposal
Unsafe disposal of infant and young children stool
Not cleaning and maintaining hygienic facilities
Not washing hand after defecation
Unsafe wastewater disposal
Washing of excreta into water source through drainage



5.6 Financial and Economic Analysis

5.6.1 Water Prices and Revenues

(1) Determination of water prices

Water prices will be determined by category of customers and by target year based on:

a) Average monthly household income.

b) Distribution of household income by category of customers.

c) Willingness-to-pay for water.

d) The World Bank's recommendation of 4% of household income as the maximum limit of the payment for water.

e) The richer you are, the more you pay per unit volume of water: unit price for water point users < that for yard connection users < that for house connection owners and commerce/industry/institutions.

f) The more you consume, the more you pay per unit volume of water: the same as immediately above.

g) Future growth of household income.

h) Financial sustainability of water supply facilities to be constructed, i.e. sufficient revenues from water charge to cover the O & M and depreciation costs of the facilities.

(2) Projection of revenues

Revenue from water charges will be projected from:

a) No. of households by year and by category of customers

b) Annual water consumption per household by year and by category of customers

c) Water price by year and by category of customers

d) Bill collection rate, of which 95% is proposed

Another revenue source is the revenue from technical service charge. This revenue will be added on the purchase and transportation cost of connections.

The third revenue source is the revenue from meter rent.

Other revenues are the revenues from the sales of materials, contract fee, connection fee, fines, etc. These revenues were not taken into account as they are of minor importance, irregular and unpredictable.

5.6.2 Financial Analysis

Before financial analysis is carried out, the values will be determined based on the following factors (figures in parenthesis are proposed):

a) Project life (20 years for F/S projects; 30 years for M/P projects)

b) Discount rate (10%)

c) Financing conditions for the initial cost, i.e. subsidy or loan (subsidy)

d) Cost bearing by town people, i.e. the type(s) of cost to be borne by them:

i) O & M cost (yes)

ii) Replacement cost of all equipment and facilities (yes)

e) Durable life of equipment and facilities:

i) Pumps and other electro-mechanical equipment (15 years)

ii) Facilities including boreholes, reservoirs, pipes, communal water points,

iii) pumping stations and treatment plants (50 years)

f) Corporate income tax (free)

The initial cost, O&M cost and revenues will be estimated over a period of years, taking into account the above information and conditions.

Financial analysis comprises two forms of criteria: projection of financial statements and estimation of financial criteria.

(1) Projection of financial statements

Income statement, fund statement and balance sheet will be projected annually up to the last year of project life.

At the same time, major financial indicators such as cost revenue ratio, net profit ratio, the ratio of working capital to revenues and the ratio of net profits to total assets will be calculated based on those financial statements.

Financial feasibility of the project will also be evaluated based on the above statements and indicators.

(2) Estimation of financial criteria

Using cost benefit (revenue) streams, financial criteria including NPV, B/C and FIRR will be estimated.

Evaluation based on the values of the above criteria will be made regarding financial feasibility of the project.

5.6.3 Economic Analysis

(1) Estimation of benefits

a) Economic value of water

The major benefits accruing from the implementation of the Project are the reduction of water related diseases and general improvement of the town people on one hand, and the saving of water fetching time on the other.

Such benefits can be reflected in the price of water. Generally, water charge is controlled by the government to the level by far below the real economic value of water. The real economic value of water is usually clarified by the price at which the public is forced to buy water during its extreme scarcity. People in the 7 towns are forced to buy water from the water tank when there is no other alternative. Water cost is at 10 Nfa per cubic meter, which is 2 to 5 times higher than the water directly secured from the individual connection or the communal water point. In case even this alternative is not available, they buy water from the vendor at an exorbitant rate. In Debarwa, where water situation is more acute than in other towns concerned, such water is bought at 16 to 40 Nfa per cubic meter.

From the foregoing, it will be assumed that the level of the real economic value of water is at least 20 Nfa per cubic meter.

b) lcd and population growth in the "without" the project

Population in a town is projected to grow at the average annual rate of 5 percent. This projection has been made possible on the assumption that enough water will be available in future to cater for the rapidly growing population. Supposing water situation were as severe as at present in future, the growth of population would be much less.

It will be assumed in the "without project" case that the per capita per day consumption of water will not improve in the future and also that the growth rate of population will be half compared with the "with project" case.

(2) Economic cost

To carry out economic analysis of the Project, cost at the market prices shall be converted into economic terms.

The standard conversion factor will be assumed as 0.9, which will be applied to the local components of the capital cost.

(3) Economic analysis

Taking the above-mentioned matters into consideration, economic analysis will be performed for the Project in each town after preparing cost benefit streams for the project life period.

Through the economic analysis, the economic parameters such as NPV. B/C and EIRR will be calculated. In starting such analysis the preconditions adopted in the financial analysis will also be applied.

CHAPTER 6 DEVELOPMENT PROGRAM

Based on the strategy on planning mentioned the previous chapter, development programs are formulated as a phased plan to the year 2015, with target years of 2005, 2010, and 2015.

6.1 Population and Water Demand Projection

Based on the population in 1997, informed by the Ministry of Local Government, the population in each target year are projected as marked as Table 6.1.1.

The center of Segeneity is divided into three areas by the main road of Asmara - Adi Keyih and Mai Mogdo. The future town extension area is planned in the northern part of the town. Therefore, water service area are divided into the following three areas to meet the target year requirement (refer to Figure 6.1.1).

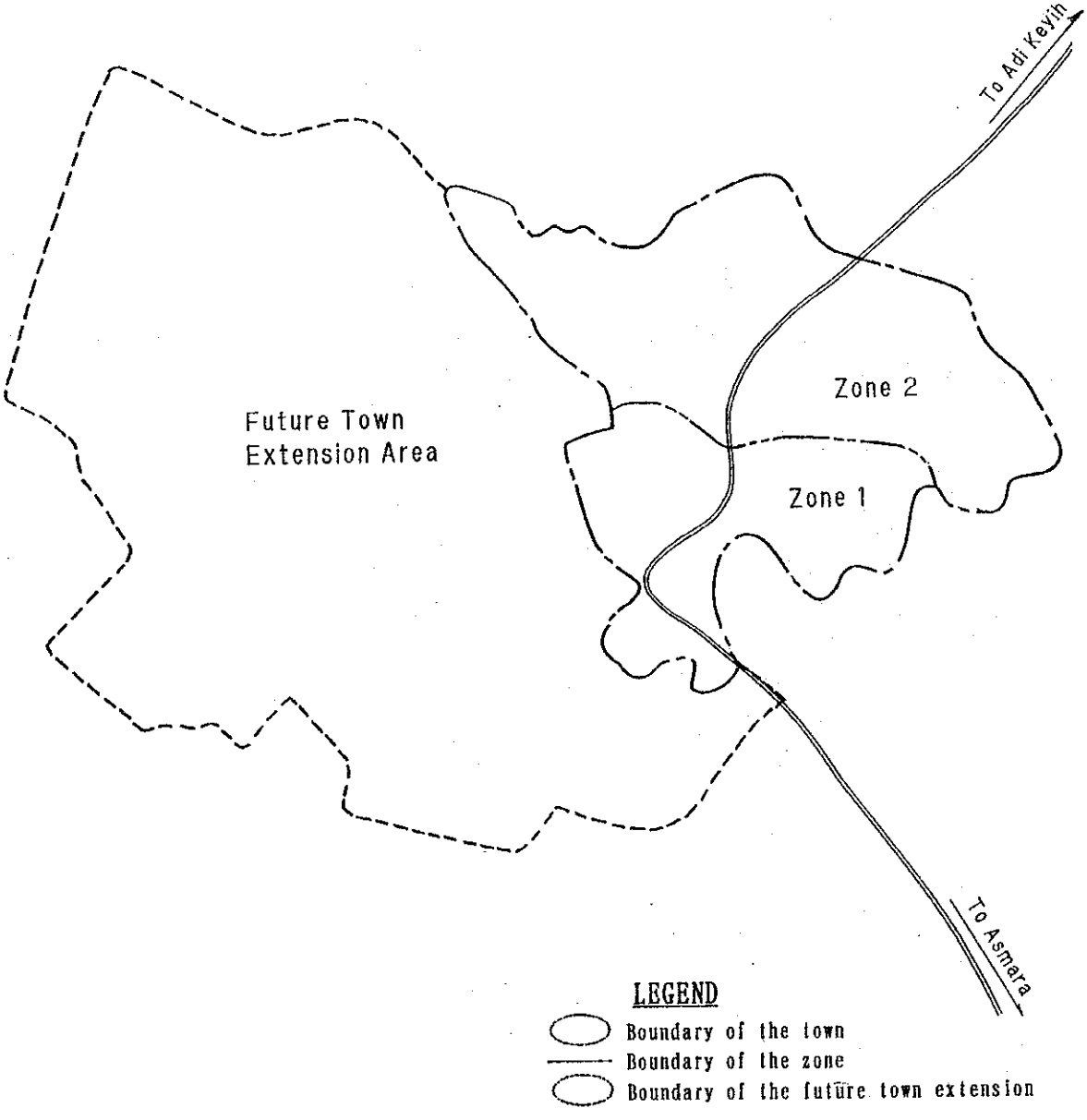
- Target year 2005: Center of the town,
- Target year 2010: future town extension area, and
- Target year 2015: future town extension area.

Water demands are estimated to meet the projected population in the water service area and other factors (refer to Section 5.3.4.). Detailed estimation is shown in Appendix D.

Table 6.1.1 Population and Water Demand

Target Year	2005	2010	2015
Population Projection	10,680	13,680	17,000
Supplied Population	7,270	11,500	17,000
Service ratio (%)	68.1	84.1	100
Average Water Consumption (l/c/d)	36.5	37.5	38.5
Average Daily Demand (m^3/d)	287	431	654
Max daily demand (m^3/d)	344	517	785
Peak hour demand (m^3/hour)	21.5	32.3	49.0

Figure 6.1.1 Outline of the Service Area



6.2 Water Resources Development Plan

6.2.1 Current Water Resources

In the town, the public water source is only one dug-well, code name DW-1 dug behind the town, at southern bank of Mai Mirakat. Two of mechanical pumps are installed in it, sending water to two different reservoirs. Besides of the said public water source, two boreholes and five dug-wells are functioning as private or official water sources.

In Segeneity area, there are four micro dams for agricultural and livestock purposes. However, they are loosing their capacity year by year, and one of them is almost completely silted up.

6.2.2 Potential of Water Resources

(1) Introduction

In general, to evaluate a potential for water resources development, especially for groundwater resources, on a certain area is quite difficult except for the area where has complete hydrological data such as rainfall, surface runoff, groundwater hydrograph, evaporation, etc., recorded for long enough period. Besides those, the properties of controlling aquifer of the area, such as thickness, extension, transmissivity, storage coefficient, etc. shall be required to evaluate the groundwater potential on a certain groundwater basin. Conversely, a water resources potential of an area can be estimated substantially, if such hydrological/hydrogeological data on the area were available. In this case, many water balance equations can be utilized, and a simulation study which is the most reliable way to estimate a water resources development potential can be applied.

Unfortunately, most of such data on around the town are not available at the moment, except for rainfall data. Measurements on surface runoff (the Mereb River) and groundwater level at Test Well (SEG-2) are already started. Pan Evaporation has been measuring at the Mendefera Station. Thus, the circumstances to evaluate a water resources potential, in detail, shall be established in near future. Right now, however, the water potential must be evaluated based on several suppositions.

(2) Potential of water resources

Basically, an origin of all water in a certain basin is rainfall. Considerable part of rainwater evaporates out before surface runoff or percolating through ground. And a part of remaining rainwater flows out through a river, then, only the last remaining part can percolate through ground recharging a groundwater. The maximum groundwater development potential, steadily available as water resources, is to be the volume of yearly recharging. Thus, the groundwater resources potential, the surface water potential as well, can be estimated as follows:

a) Rainfall – (effective) Evapotranspiration = Effective rain (mm)

b) Effective rain x catchment area = Total water source (m^3)

c) Total water source – Surface runoff = Groundwater recharge (m^3)

For Segeneity, monthly mean rainfalls are available (refer to section 4.1.2). Usually, there is no evapo-transpiration data because of difficulty of direct measurement. Evapotranspiration value used to be

converted from Pan Evaporation value, as its 60 to 80%. In this Study, 70% of the converting rate from Pan Evaporation to Evapotranspiration is to be adopted as an average. Normally, a rainfall minus 70% of evaporation shall be an effective rain, and thus, only July and August have an effective rain. However, the river flow of the Mereb starts from June and lasts in October in most of the year, so 10% or 20% of monthly rainfalls at the beginning and the ending of a rainy season are intentionally counted as an effective rainfall.

Then, the effective rainwater must be shared between a surface runoff and a groundwater recharging. In Debub region, there is quite a few runoff observation data; those are only one month measuring data on the Mereb at Debarwa Bridge. Although the data indicated that the runoff coefficient of the Mereb was less than 8%, the monthly rainfall for the data (1997) was almost a half of the mean monthly volume. Runoff coefficient varies in accordance with a rainfall, and so about 16% of mean annual runoff coefficient is supposed for the area. In this case, the final effective rainwater is to be shared between runoff and percolation by 6:4, and the ratio shall be adopted at all of the target areas. Thus, the yearly groundwater recharge amount, that means the maximum available groundwater potential, is estimated as shown in Table 6.2.1.

Table 6.2.1 Estimation of Groundwater Recharge

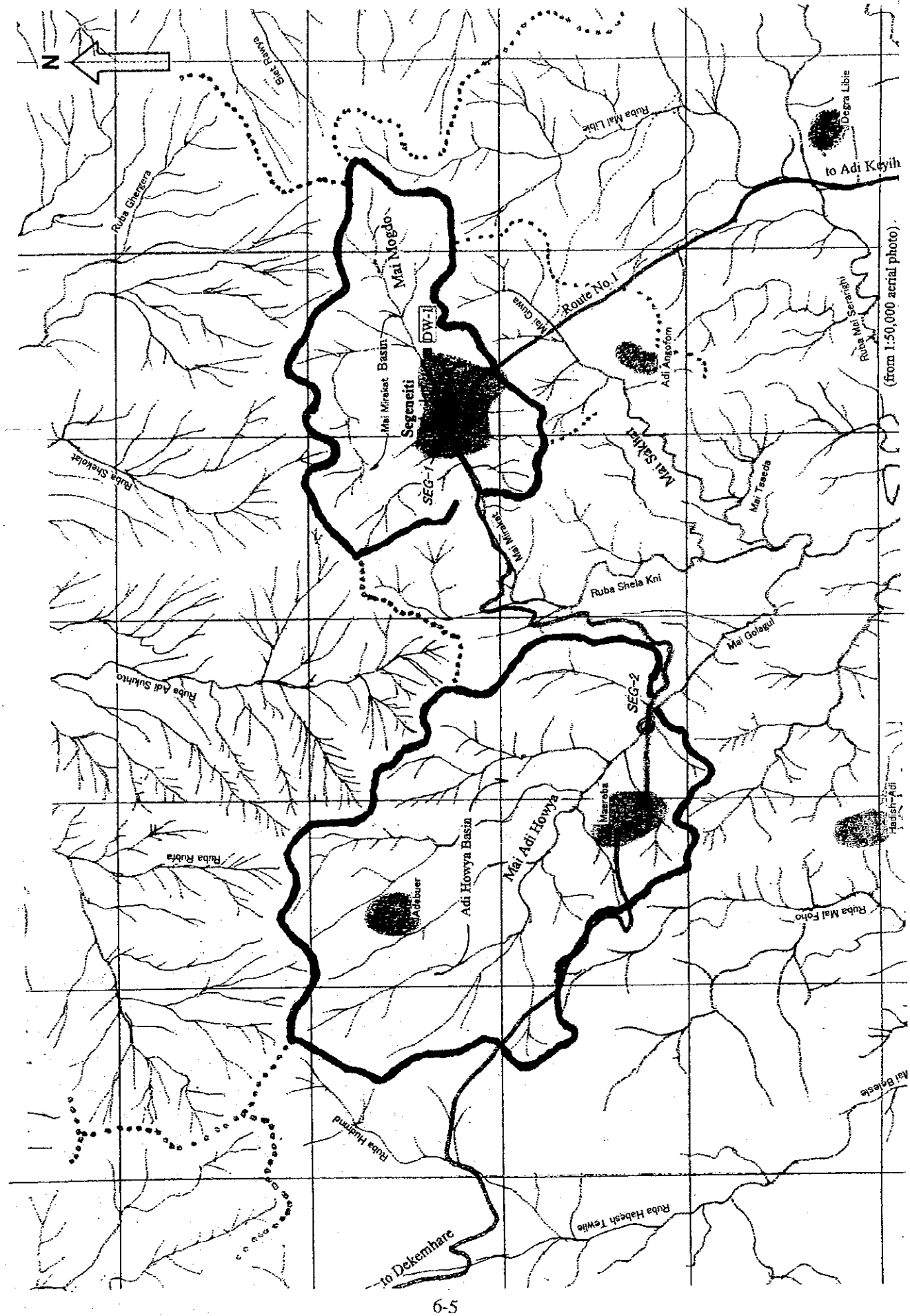
Segeneity	Jun	Jul	Aug	Sep	Oct	Annual (mm)	(%)
Rainfall (mm/m)	31.1	179.5	131.0	15.8	11.2	494.3	100.0%
P.E (mm/d)	5.4	5.6	4.6	5.1	5.0	2,107.9	100.0%
E. Evapotr.(-"-)	117.2	121.5	99.8	110.7	108.5	1,503.8	70.0%
E. Rain (mm/m)	3.1	58.0	31.2	3.2	1.1	96.6	19.5%
Runoff (-"-)	1.9	34.8	18.7	1.9	0.7	57.9	11.7%
Recharge (-"-)	1.2	23.2	12.5	1.3	0.4	38.6	7.8%
Act. E.T. (-"-)	28.0	121.5	99.8	12.6	10.1	397.8	80.5%

Note 1) P.E: Pan Evaporation, E.: Effective, E.T.: Evapotranspiration
Note 2) There are no effective rain during Nov.~May.

As shown in the table, the averaged yearly groundwater recharge is estimated as 38.6 mm/a, which is about 7.8 % of the total rainfall.

The area near around the town is divided into several small sub-basins. Among them, the Mai Mirakat basin in where the current public water source and Test Well SEG-1 are situated has around 5.75 km^2 of catchment area, and the Mai Adi Howya basin in where the SEG-2 locates has about 11.5 km^2 of catchment area, measured on the 1:50,000 aerial map (refer to Figure 6.2.1). That means, the yearly groundwater recharge volume of these basins are calculated as around 0.22 and 0.44 MCM/a, respectively.

Figure 6.2.1 Catchment Area of Segeneity Basin



Finally, a safety groundwater development volume must be considered, because such ground-water recharge occurs during rainy season, mostly within only two months, but water demand continues throughout a year in almost same level. The situation usually prevents a full-use of the maximum water resources potential, in particular in the area where groundwater flows out easily. In the region where has clear rainy and dry seasons, from one-third to one-tenth of the yearly recharge volume shall be taken as a criterion on the maximum groundwater development, depending upon the local condition though. For Segeneity area, the main aquifer is the fissured aquifer type of granite or metavolcanics, usually showing fair to good yield. And in the case of Mai Adi Howya basin, the groundwater hydrograph indicates the groundwater in the plain is not flowing out easily, rather stagnated at southeastern end of the basin where forms a swamp. Such local condition can mitigate the limitation of safety groundwater development drastically.

(3) Water quality

Water qualities of ten samples taken from the existing water supply system, inclusive of some water sources, were analyzed in the laboratory of WRD. The results said almost all of water in the area have good water quality for drinking, excepting was one sample taken from a micro dam which was contaminated by bacteria. Then, another water sample taken from a dug-well indicated rather high EC value of more than 1000 μS/cm.

For the new water sources, groundwater extracted from the Test Wells SEG-1 and 2 were analyzed in the same laboratory. The result of analysis is attached in Appendix and shown as Figure 6.2.2. The data indicate that the water qualities of those boreholes are also good for potable water.

6.2.3 Water Resources Development Plan

(1) Increasing of water demand

Water demand projection was already discussed in the previous section (6.1). And the Study projected out the increasing water demands of Segeneity as 344, 517, and 785 m^3/day in the year of 2005, 2010, and 2015, respectively. Increasing ratio of the water demand is not so high in comparison with the other target towns. The situation of increasing water demand is illustrated in Figure 6.2.3, together with actual water resources development plan explaining in this section.

(2) Water resources development plan

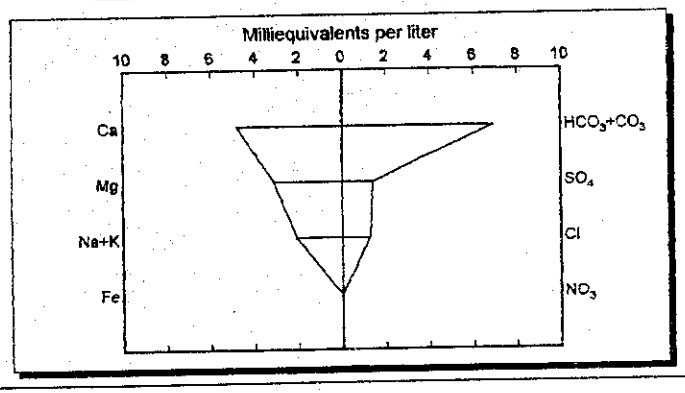
The existing water source has a total yield of around 276 m^3/day, but the yield of newly drilled SEG-2 is estimated as around 622.1 m^3/day, as a safety yield. This volume is far beyond the water demand in 2010, not enough for the demand in 2015 though. The situation leads to the simple water resources development plan that completion of SEG-2 as the new water source and construction of pipeline from here to the reservoir which is set up on the top of mountain at the south of the town. The current water source of DW-1 shall not be connected to the new water supply system in this period, being kept as it was as a spare water source. As mentioned above, SEG-2 can cover the water demand up to the year of 2010, and the volume of 622.1 m^3/day is roughly a half of the yearly recharge volume in this basin.

Figure 6.2.2 Water Quality of SEG-1 and 2

STIFF Diagram

Well Ident SEG-1

Description In the Town



Cations	Ca	Mg	Na	K	Fe
Milliequivalents per liter	4.7904	3.1012	1.8661	0.19433	0.0027
Milligrams per liter	96.00	37.70	42.90	7.60	0.05

Anions	HCO3	CO3	SO4	Cl	NO3
Milliequivalents per liter	6.89855		1.41576	1.26945	0.02097
Milligrams per liter	420.90		68.00	45.00	1.30

Mn	NO2	PO4	F	B	SIO2
0.0146	0.01174		0.0642		
TDS	Hardness	Alkalinity	Conductivity	pH	SAR
	22.1		832.00	6.95	0.9395

Water Type **Calcium Bicarbonate**

Cations (epm) 10.0

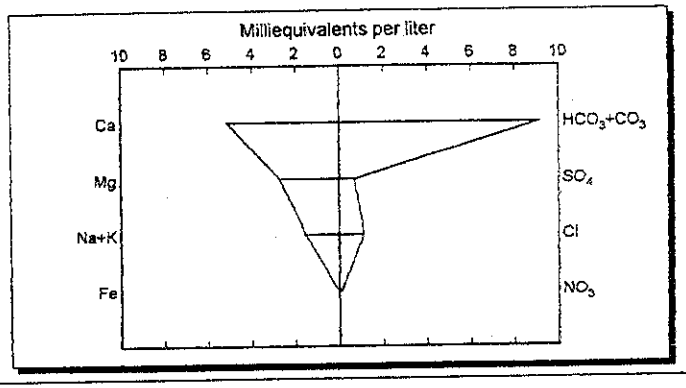
Anions (epm) 9.7

Error Balance 1.53

STIFF Diagram

Well Ident SEG-2

Description At Maaraba



Cations	Ca	Mg	Na	K	Fe
Milliequivalents per liter	5.0898	2.6981	1.5312	0.01534	0.0038
Milligrams per liter	102.00	32.80	35.20	0.60	0.07

Anions	HCO3	CO3	SO4	Cl	NO3
Milliequivalents per liter	9.09809		0.70788	1.12840	0.11452
Milligrams per liter	555.10		34.00	40.00	7.10

Mn	NO2	PO4	F	B	SIO2
0.0146	0.00565		0.0221		
TDS	Hardness	Alkalinity	Conductivity	pH	SAR
	19.8		791.00	6.74	0.7760

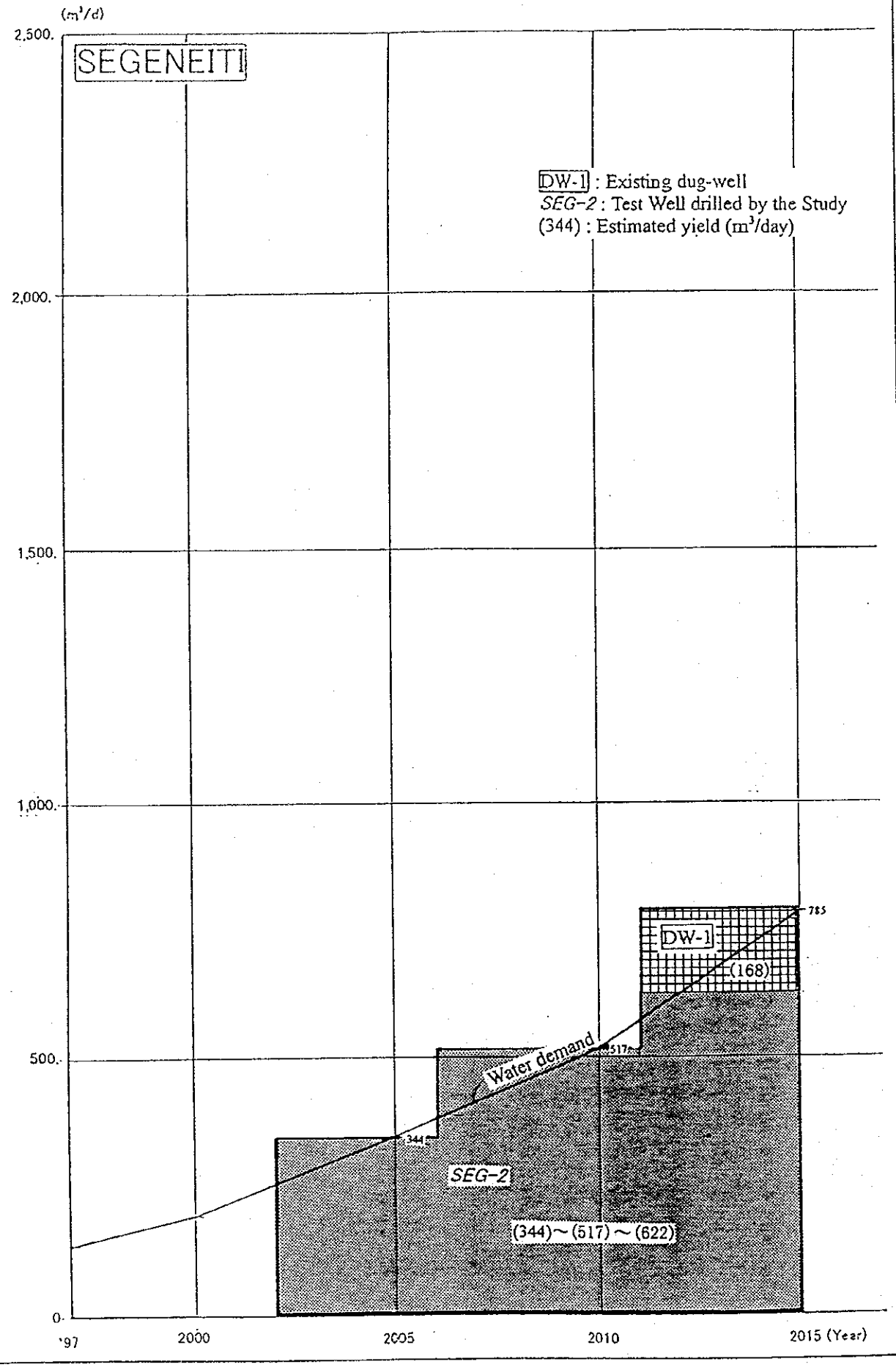
Water Type **Calcium Bicarbonate**

Cations (epm) 9.4

Anions (epm) 11.1

Error Balance 8.41

Figure 6.2.3. WATER DEMAND AND RESOURCES PLAN



To satisfy the water demand for 2015, the existing dug-well of DW-1 shall be involved into the water supply system in this stage. DW-1 has a safety yield of more than 270 m^3/day, and only 60% of the yield (168.0 m^3/day) of the well is required to cover the water demand in 2015, as shown in Figure 6.2.3.

6.3 Water Supply and Sanitation Facility Plan

6.3.1 Water Supply Facility Plan

(1) General

Topographical feature of the town undulates and three areas divided by the main road and the river have slightly higher elevation. Elevation in the southern side of the present town is between 2160m and 2120m, in the northern side is 2150 - 2120m and the future town extension area, where is in the northern part of the town, is 2170 - 2120m. The main roads of Asmara - Adi Keyih and Mai Mogdo running along edges of the town are at lower elevation. Therefore, two reservoirs are planned; one for the existing town area and another for the future extension town area.

The existing water supply facilities could not be used because of following reasons.

- Well pump is obsolete and has breakdowns,
- Reservoir is obsolete and insufficient pressure,
- Pipelines is also obsolete with insufficient diameter to cover the future demand, unknown location and diameter, etc., and
- Communal water points are damaged.

Therefore, all water supply facilities are newly planned under the project.

(2) Facility plan

Water supply facilities of this project consists of intake facilities (borehole and well pump), transmission facilities (transmission pipeline, pump pit and booster pump), distribution facilities (reservoir and distribution pipeline), service facilities (individual connections and communal water points) and others (power supply and control house). These facilities are planned and summarized herein, and detailed calculations for each facilities are shown in Appendix D.

a) Intake facilities

As mentioned in "6.2.3. Water Resources Development Plan", total yield of the existing boreholes DW-1 and test borehole of SEG-2 can cover the water demand in 2015.

Number of borehole and specifications of well pumps in each target year are as follows:

Target year 2005: Test borehole of SEG-2 to be planned.
Spec. of pump at SEG-2: Q=0.240m^3/m, H=135.3m

Target year 2010: No plan of borehole but well pump of SEG-2 to be replaced to meet the water demand.
Spec. of pump at SEG-2: Q=0.360m^3/m, H=78.9m

Target year 2015: Existing borehole of DW-1 to be added and well pumps to be replaced to meet the water demand.
Spec. of pump at SEG-2: Q=0.432m^3/m, H=87.7m
Spec. of pump at DW-1: Q=0.114m^3/m, H=70.6m

b) Transmission facilities

Transmission pipeline is planned from the test borehole of SEG-2 to the new reservoir (reservoir 1) through a boosting station at an edge of the town. In the development plan in 2010, another booster will be planned to transmit water to another new reservoir (reservoir 2) to meet the water demand in 2010. The transmission pipeline of the existing borehole shall be changed to the direction to the new reservoir. The transmission pipeline is connected directly from the new well to the new reservoir by the well pump and boosters.

Two new transmission pipelines are planned and extended to meet the water demand. Booster pumps shall be planned because of the long distance and difference of elevations. The transmission facility plan for each target year is as follows:

Target year 2005: New pipeline from SEG-2 to new reservoir 1 to be planned
Diameter and total length of the pipe:
D=100mm~80mm, L=5,253m
Spec. of new booster pump at BP1: Q=0.240m^3/m, H=96.0m
Number and capacity of pump pit for booster pump:
15m^3 1sets

Target year 2010: New pipeline from the pump pit to new reservoir 2 to be added. Booster pump of BP1 to be replaced to meet water demand.
Diameter and total length of the pipe
D=60mm, L=1,500m
Spec. of new booster pump at BP1': Q=0.360m^3/m, H=78.9m
Spec. of new booster pump at BP1: Q=0.264m^3/m, H=99.3m
Spec. of new booster pumps at BP2: Q=0.096m^3/m, H=98.7m
Number and capacity of pump pit for booster pump to be added.
15m^3 2sets

Target year 2015: One new pipeline from DW-1 to new reservoir 2 to be added. Booster pumps of BP1', BP1 and BP2 to be replaced to meet water demand.
Diameter and total length of the pipe: D=60mm, L=400m
Spec. of new booster pump at BP1': Q=0.432m^3/m, H=87.7m
Spec. of new booster pump at BP1: Q=0.276m^3/m, H=100.9m
Spec. of new booster pumps at BP2: Q=0.156m^3/m, H=122.1m

c) Distribution facilities

A new main reservoir (reservoir 1) is planned beside the existing reservoir in the town and its elevation can cover ,most of the service areas. However, another new reservoir (reservoir 2) for the future extension area shall be planned because some higher parts in the future town extension area can not be covered with sufficient water pressure. The reservoir will be expanded to meet the water demand for each target year.

Distribution pipeline is also newly laid and extended to meet the water demand in the each target year. The distribution facility plan for each target year is as follows:

Target year 2005: Capacity and type of new reservoir 1
V=140m^3, ground type
Diameter and total length of the pipe
D=125mm ~ 50mm, L=11,082m

Target year 2010: Capacity and type of new reservoir 2
V=50m^3, H=12.5m elevated type
Diameter and total length of expansile pipe
D=75mm ~ 50mm, L=12,374m

Target year 2015: Capacity and type of additional reservoir 2
V=80m^3, H=12.5m elevated type for reservoir 2
Diameter and total length of expansile pipe
D=100mm ~ 50mm, L=17,772m

d) Service facilities

Number of individual connections is estimated from the percentage of consumers in each target year. Communal water points are planned close to the area of low income houses and the vicinity. Communal water points are arranged to cover up the area by circles of 150m-radius. Service facility plan for each target year is as follows:

Target year 2005:	Number of individual connections	525 sets
	Number of communal water points	10 sets
Target year 2010:	Number of additional individual connections	227 sets
	Number of additional communal water points	5 sets
Target year 2015:	Number of additional individual connections	330 sets
	Number of additional communal water points	10 sets

e) Others

Power supply for pumps is planed to use the network from diesel power plant in the region. Control houses are planed for the panel for pump, booster pump, generator for future plan, etc. Type A and B of the control house are for well pump, and type C and D are for booster pump. There is a generator room in the Type B and D. Number of control house is as follows:

Target year 2005: Number and type of control house
Type B: 1 set, Type D: 1set,

Target year 2010: Number and type of additional control house
Type A: 1 set

Target year 2015: Number and type of additional control house
Type A: 1 set

Table 6.3.1 Number of Facilities

Item		Unit	Year		
Facility	Description		2005	2010	2015
Intake Facility	New borehole	sets	1		
	Existing borehole	sets			1
	Observation borehole	sets			
	Dam	sets			
	(Sub-total)	sets	1	0	1
Well Pump Facility	Submersible pump		SEG-2, 0.240m3/min 135.3m, 1set	SEG-2, 0.360m3/min 78.9m, 1set	SEG-2, 0.432m3/min 87.7m, 1set
					DW-1, 0.114m3/min 70.6m, 1set
	(Sub-total)	sets	1	1	2
Transmission Pipeline	DCIP 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m			
	ditto 100mm	m	4,168.0		
	ditto 80mm	m	1,085.0		
	ditto 60mm	m		1,500.0	400.0
	(Sub-total)	m	5,253.0	1,500.0	400.0
Booster Pump Facility	Centrifugal pump		BP.1, 0.240m3/min 96.0m, 1set	BP'.1, 0.360m3/min 78.9m, 1set	BP'.1, 0.432m3/min 87.7m, 1set
				BP.1, 0.264m3/min 99.3m, 1set	BP.1, 0.276m3/min 100.9m, 1set
				BP.2, 0.096m3/min 98.7m, 1set	BP.2, 0.156m3/min 122.1m, 1set
	(Sub-total)	sets	1	3	3
Pump Pit	Made of RC		15m3	15m3, 2set	
	(Sub-total)	sets	1	2	0
Reservoir	Made of RC		140m3		
	Made of F R P			50m3, h=12.5m	80m3, h=12.5m
	Existing				
	(Sub-total)	sets	1	1	1
Distrbution Pipeline	P V C 300mm	m			
	ditto 250mm	m			
	ditto 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m	531.0		
	ditto 100mm	m	232.0		44.0
	ditto 75mm	m	954.0	112.0	2,201.0
	ditto 50mm	m	9,365.0	12,262.0	15,527.0
	(Sub-total)	m	11,082.0	12,374.0	17,772.0
Control House		sets	2	1	1
Communal Water Point		sets	10	5	10
Individual Connection		sets	525	227	330
Tempolaty Road	Width 3.0m	m	3,000		400

6.3.2 Sanitary Facility Plan

(1) School sanitation facilities

In Segeneity the sanitation condition in general is very poor condition. For most of the schools do not have proper sanitation facilities. In order to come up with a radical change in sanitation practices within the society one approach of sanitation promotion should be through schools.

Therefore, the main target group in this sanitation improvement program study are students. By targeting students the advantages are both in economic aspect and effectiveness in behavioral change. The economic advantages are achieved by using existing institution, teachers, organized students by age and level of understanding. The effectiveness of the program in schools is proved in some other town in Eritrea. Students learn easily and accordingly change their hygienic behaviors. Follow up to their hygiene/sanitation practice in school is an easy task. On the other hand students` changed perception is believed to influence in particular their family and will also have a compounded effect result in the society.

In this study school sanitation facilities development program along with hygiene education program is envisaged to bring about an improved sanitation facility, hygienic behavioral changes and environmental conditions.

The type of latrine recommended is taking into consideration the cultural, economic, operation and maintenance aspects. The constraints pointed out by the schools for having poor condition latrines and latrines which are out of use are also addressed in this latrine promotion program.

(2) Public sanitation facilities

Provision of public facilities for solid waste, wastewater and storm water drainage, sludge removal and latrines are crucial for environmental sanitation and community public health promotion. Segeneity at present is lacking all these public facilities. Provision of all the necessary public facilities at the first phase of the project may not be economically feasible. However, required improvement of public facilities are discussed bellow.

a) Wastewater and storm water drainage

It is well understood that water supply coverage without parallel improvement of sanitation increases environmental pollution and causes public health problem. Trying to correct the imbalance between the water supply and sanitation on the other hand will create a financial burden to the town. In Segeneity the economic or development level of the people for instance does not allow for a conventional sewerage system provision. Moreover, from the technical point of view the wastewater flow in a sewerage system shall be too low due to anticipated low consumption rate. A very low flow rate results in poor self cleansing of the sewerage system. Segeneity's projected water consumption rate and wastewater generation rate is shown below.

Segeneity's estimated quantity of wastewater is:

- house connection users - 90% of the water demand

- yard connection users - 70% of the water demand

- community water point users - 60% of the water demand

Table 6.3.2 Water Demand and Wastewater Generation Projection

	Consumers (% of hld)			Water demand (l/c/d)			Wastewater generation (l/c/d)		
Mode of supply	2005	2010	2015	2005	2010	2015	2005	2010	2015
HC	17	19	22	28	30	35	25.2	27	31.5
YC	22	24	27	22	24	27	15.4	16.8	18.9
CWP	61	56	51	15	15	15	9	9	9

From the above table in Segeneity in none of the target year the technical requirement for the conventional sewerage system provision is satisfied. Therefore, an on-site drainage system is proposed for Segeneity.

The drainage techniques recommended are soak-away pit and drainage field channels for sludge removal and road side and cross road trenches for storm water drainage.

b) Public latrine

In Segeneity lack of public latrines is one area which contribute to the environmental degradation and poor public health. In this study public facilities under direct responsibility of the town administration are areas under consideration. Hence, from the public health point of view public areas such as market places, bus terminals, stadium etc. are proposed to be provided with public toilets.

c) Refuse disposal

The town administration of Segeneity never had refuse truck. As part of sanitation safe refuse collection and disposal is essential to improved public health. The present situation of Segeneity does not provide these basic services. In this study it is anticipated that Segeneity during the target year 2000-2005 need to have at least one refuse truck to go round and collect garbage and dispose at environmentally safe place outside the town at a reasonable distant place. During target year 2005-2010 and 2010-2015 provision of refuse containers in all areas of the town is proposed.

(3) Private sanitation facilities

The awareness for an improved public health condition should basically be created within the family. Therefore, efforts made to promote private sanitation facilities has great effect to improve environmental sanitation conditions. For small towns such as Segeneity where conventional sewerage systems are not introduced or can not be introduced due to economic and technical aspect, the inhabitants are advised to have appropriate household latrine and on-site wastewater disposal systems.

Segeneity having very low coverage of household latrine, open field defecation is a major factor to the

present poor sanitation condition of the town. Having unhygienic latrine in a house also causes health problem. If actions are not taken in due time the pollution and health problems due to lack of household latrines and unhygienic latrine usage will be aggravated with increase in population.

The action taken by the town administration by introducing rules and regulations for the new house builders with regard to provision of family latrine in their house is highly appreciated and its impact on sanitation improvement is inevitable. However, economic constraint of the owners (builders) is still an obstacle to implement the town administration's new regulations. In socio-economic survey the residents expressed their awareness to the need for private latrine but some of them due to money constraint said they can afford only community latrine only. Hence this study proposes latrines for various groups of the society including those with very low income status.

The kind of latrines recommended are in line with the type of water supply facilities provision. The coverage anticipated is proportional to the water supply facilities coverage. The type of latrines already in use are flush latrine and dry pit latrine only. Therefore, in this project it is recommended to enhance the quality of the toilets in use taking into consideration the economic, social and cultural aspects of the society.

Basically three types of toilet for three modes of water services are recommended as tabulated below. In this study communal latrines are not recommended for the very reason of anticipated difficulty in its management. It is rather recommended shared latrines for up to four families.

Table 6.3.3 Recommended Household Latrines

Mode of water service	Recommended household latrine
House connection users	Cistern flush latrine (CFL)
Yard connection users	Pour flush latrine (PFL)
Communal water point users	Ventilated improved pit latrine (VIP)

Table 6.3.4 Anticipated Coverage of Latrines in Segeneity

Target year	CFL	PFL	VIP
2000-2005	17%	15.4%	24.4%
2005-2010	19%	19.2%	33.6%
2010-2015	22%	21.6%	40.8%

Pit latrines are designed in double pits considering the non availability of vacuum trucks in the town and the inconvenience and unaffordable rates of the truck borrowed from Asmara. The pits are 4 m^3 capacity each. Assuming 0.5 liters per day excreta per person for an average household size of five, 915 liters of excreta is disposed annually. Hence a single pit may serve for four years for a family. When one pit is full the family shift the vent pipe and squatting hole to the second pit and put lid on both squatting and vent holes. The height and the area of the latrines are sized just for economic purpose.

The double pit VIP latrine if used by three or four families it will be affordable for even very low income group. Hence the town administration should encourage the low income group families to built common VIP latrine. For four families of 20 members a single pit will last for a year and the decomposed matter shall be removed every two years.

The flush latrines are recommended to have a septic tank with dry masonry wall for soak-away purpose in order to solve the problem of frequent vacuum truck requirement to some degree. If soak-away is not possible due to impermeable ground formation, the town shall rely on Asmara vacuum truck during the 1st phase of the project up to year 2005.

(4) Number of facilities

The facility plan is derived on the basis of development program. Accordingly the following assumption are considered in the facility plan:

All existing schools with out proper latrine provision need to have latrine by the target year 2000-2005.

At least one new school establishment is assumed in five years period for financial projection.

All existing public places under the town administration such as market places, bus terminal and stadium to be provided public latrine by target year 2000-2005.

The household latrine provision is based on demand, coverage and mode of water service development program for the three target years.

Every five years replacement of vacuum and refuse truck is assumed.

Table 6.3.5 Number of Latrines

	Year 2005	Year 2010	Year 2015
School Latrine - PFL	3	1	1
Public Latrine - CFL	3	1	1
Household Latrine - CFL	363	157	228
Household Latrine - PFL	329	196	209
Household Latrine - VIP	522	397	468

Table 6.3.6 Number of Public Facilities

	Year 2005	Year 2010	Year 2015
Refuse truck (compactor)	1	1	2
Vacuum truck (3,000 liters)	-	1	1
Refuse collecting bins	100	100	100
Refuse collecting container ($8m^3$)	-	25	25

6.4 Institutional Strengthening Plan

6.4.1 Existing Situation

Water and sanitation typically require multisectoral intervention and collaboration in their planning, implementation and management stages. At the central level, the main focal ministries for water and sanitation related affairs are the Ministry of Land, Water and Environment, the Ministry of Local Government and the Ministry of Health. In Segeneity, the town administrations, the former WSS or the new WSA. The Town's Water and Sanitation Committee as a Board and the communal water point and toilet management committees are directly involved.

In this chapter, the national level institutional set-up of the above institutions will be described and recommendations forwarded for strengthening them. This will be followed by the description and recommendation for strengthening water related institutions in Segeneity.

6.4.2 The Ministry of Land, Water and Environment

The Government's decision behind the establishment of the Ministry of Land, Water and Environment (MoLWE) lies in its desire to ensure that its strategic resources of land, water and environment are managed and utilized through appropriate study, documentation and proper upkeep. The new MoLWE has three Departments, one each for water, land and environment.

The former Water Resource Department (WRD) has been reorganized within the new MoLWE. It is now called Water Department (WD) and has two divisions under it: the Water Use Management Division (WUMD) and the Water Resource Assessment Division (WRAD) (Appendix A, Chart 6.1).

(1) Staffing pattern of the WD

Presently, there are 13 experts assigned for the WD and it has not yet been decided in which one of the Units they will be assigned.

(2) Functions of Water Use Management Division (WUMD)

This Division is responsible for drawing up policies and guidelines and for drafting water laws and regulations for the development and management of the country's water resources. There are two Units under this Division: the Water Law Unit (WLU) and the Water Resources Development Unit (WRDU). The former is responsible for drafting laws and regulatory guidelines on water resource utilization. It also issues permits for water related works and renders legal and advisory service to the other Units. The WRDU is responsible for the provision of policy and implementation guidelines for those involved in water resource development and management activities, studies new water basins and catchment areas and supervises national projects that cut across regions or that serve more than one region.

(3) Functions of Water Resource Assessment Division (WRAD)

The responsibilities of this Division are to collect, process and store data on the quality and quantity of available water resources for the efficient planning and implementation of the sector's program. There are three units under this Division, namely the Hydrometeorological Information Service Unit (HMSU), the Water Quality and Pollution Unit (WQPU) and the Water Resource Information Unit (WRIU). As

the name suggests, the first Unit is responsible to undertake hydrometeorological works related to both ground and surface water resources, supervises and monitors the conservation of protection of these resources, and submits collected data and information to the data base center. The investigation of the quality of water collected by the HMSU is the responsibility of the WQPU, and additionally, it measures and monitors pollution levels in collaboration with the Department of Environment and passes on water pollution information to concerned bodies. The responsibilities of the WRIU is to enter, process and analyze data and information secured from the two units, and in collaboration with the Department of Land and Environment and concerned sectors, prepares written materials and maps concerning the quality and quantity of water resources.

(4) Establishment of the Water and Sanitation Authority (WSA)

It is mentioned in Chapter 2 section 2.3.6, that the draft Water and Sanitation Law, envisages the establishment of Water and Sanitation Authority (WSA) whose mandate will be to manage water and sanitation facilities and thus ensure the provision of water supply and sanitation services to both urban and rural areas of the country. One of the most important task or program of the WD will be to see the quick establishment of the WSA.

6.4.3 The Ministry of Local Government

The Proclamation to decentralize regional administrations was out in 1996. However, the process of complete empowering and building the capacities of these regional administrations should be seen as a long term goal. Accordingly, the primary mandate of the Ministry of Local Government (MoLG) is to act as the main coordinating and facilitating body for the regions in their dealings and relationships with the ministries at central level.

MoLG has four Departments: Regional Departments Affairs Department, Administration Department, Council, Municipal and Cooperatives Affairs Department and the Research Department.

(1) Regional affairs department

The Department which is entrusted with water projects implementations is the Regional Affairs Department (RAD/MoLG). Its functions include coordinating and assisting the preparation and implementation of economic and social development projects. More specifically, RAD's tasks would be to facilitate the implementation of regional projects that involve high level expertise at the central level. Examples of such activities include: procurement, bidding/contracting, project implementation, evaluation and follow-up. In the structural organization of RAD, therefore, similar structure exists as of the Departments in the regions, viz., Economic Development, Social Services and Infrastructure Services.

The Units under these three divisions and the staffing pattern is as indicated in Appendix A, Chart 6.2. The Infrastructure Services Division and the Engineering and Project Management Unit under it are responsible for the planning, implementation and follow-up of water projects on behalf of the regions. There are six experts composed of engineers and economists in this Unit.

When there is a major water project to be implemented the RAD/MoLG establishes a project management unit (PMU) which would assume direct responsibility for the implementation of the project. There are five of such PMUs at present for water projects financed by the World Bank, EU, GTZ, KFW

and SDR.

(2) Establishment of the Project Management Unit (PMU)

For the implementation of the water and sanitation supply for the seven towns, it is suggested that a PMU be established under the RAD of the MoLG. It is proposed that the PMU be headed by an expatriate technical expert, one national counter part and three national experts: two engineers in charge of supervision works and one for community organization.

6.4.4 The Ministry of Health

The MoH has three main Departments under it: the health Service Department, the Pharmacy Department and the Research and Human Resources Department. Environmental Health and Sanitation Unit is one of the Units under the Health Service Department (Appendix A, Chart 6.3). It is responsible for developing and revising legislation, policies, standards and guidelines concerning environmental health and sanitation. Additionally it is involved in training of personnel, research and evaluation and rendering technical advise to regions. There are five experts under the Environmental Health and Sanitation Unit each responsible for environmental health, environmental sanitation, quarantine of food, drinks and beverages at airports, environmental pollution and work hazards. The first three experts in particular are responsible for ensuring the safety and adequacy of water, personal, food and environmental hygiene and environmental sanitation concerned with latrines and dry and liquid waste disposal.

6.4.5 Proposal for Institutional Strengthening Plan

(1) The WD in MoLWE will need additional manpower during the periods under considerations if it is to dispense its mandate properly. On the assumption that its staff number will increase by 10 percent every five years, the number will be 14, 15 and 17 by the years 2005, 2010 and 2015 respectively. Additionally, in order to enhance the level of skills of the experts, training for a second degree will be needed at least for five experts, and short term overseas for all the 17 experts within the period of the development program. Possible areas of training could be information collection and analysis, supervision/monitoring and evaluation in underground and surface water resources.

(2) A Project Management Unit (PMU) in MoLG should be established to see the implementation of the water and sanitation projects for the seven towns under study. The PMU will be under RAD/Infrastructure Service Division. There should be one expatriate staff who will head the PMU assisted by one counterpart staff and three experts under them. He and his staff will all be paid by the project. Additionally, it is suggested that training, in procurement, water facility design, design evaluation, etc. will be needed for the staff of the Engineering and Project Management Unit under the Infrastructure Service Division under RAD.

(3) To facilitate the task of the head of the PMU, the three suggested experts to be employed will be: two assistant engineers and one expert on people's participation and community organization/ management. While the latter will be responsible for the software aspect of the project, the two engineers will help to supervise the construction work of the water supply and sanitation facilities in the seven towns.

(4) A 'Water and Sanitation Authority of Eritrea (WSA) should be established as an autonomous body

charged with management of all water and sewerage/sanitation facilities in the country. The establishment of WSA is envisaged in the draft 'Water and Sanitation Law'. It is proposed that the national level WSA should be overseen by a Board whose members should be from the main focal ministries and other interest group in the country. The Board will report to the Minister of the MoLWE. The manager with his support staff will run the office efficiently and in a coast effective manner. It is important to have two main departments under the organizational set-up of WSA: one for urban and another for rural and it is proposed that these two main departments ought to have separate divisions for water supply and for sanitation. Under these two divisions, there will be six units one for each six regions of the country. Towards this end, WSA will have to be vested with ownership and control of all towns' water supply and sanitation assets including infrastructure facilities. It is proposed that each town's WSA management become an autonomous unit with its separate cost center, possibly retaining its won income for maintenance and repair works. In order to minimize costs, WSA should operate with minimum staff. The number of staff in town WSA will be determined as per the requirement of the facilities and number of beneficiaries. The details of the management structure, including maintenance and tariff collection system will have to be worked out in the course of the project implementation.

(5) In the wake of the approval for the establishment of WSA, it would be appropriate that it assists central level and Debub Regions to dispense their respective responsibilities as per the spirit of the Water Law, Water Policy and the Proclamation which allows the establishment of regional administration. For example, it could coordinate all local training of accountants, plumbers and fitters, motor and water meter technicians, electricians, etc.

(6) In the MoH the Environmental Health and Sanitation Unit will be strengthened both at the national and region level, by training 6 sanitation specialists for first degree and 30 assistant sanitarians for diploma to be stationed at the regions and sub-regions.

(7) Most importantly, the functional relationship between regional administration and central level ministries need further refinement and strengthening.

In Table 6.4.1 at the next page is presented a summary of the institutional strengthening plan for the entire period under study. The expected outcome of the proposed management and strengthening plan of Segeneity town will be dealt in chapter seven.

Table 6.4.1 Summary of Proposals for Institutional Strengthening Plan (2005, 2010, 2015): A Summary

Institution	Recommendation
1. MoLWE (Water Department)	**1. Capacity Building** - Office equipment and supplies - Hydrological, hydrometeorological, survey, geological, and related equipment **2. Training** - Long Term Overseas (BA) for a second degree for 6 experts, including one in water sector planning - Short-term training for 17 experts
2. MoLG (RAD/PMU)	**1. Capacity building** - Technical Assistance for one expatriate - Technical Assistance for three engineers and one community organization experts – all nationals. - Office equipment and supplies - Vehicles **2. Training** - Long term training in facility design for 2 experts - Short terms training for three experts in the water infrastructure services?
3. MOH (Environmental Health and Sanitation Unit)	**1. Capacity building** - Office equipment and supplies for region sanitation offices **2. Training** - Long term training for 6 sanitatrians (BA) - Short term (6months)training for 30 assistant sanitarians
4. Water Supply and Sanitation Authority (WSA)	**1. Capacity Building** - Office equipment, supplies and facilities - Transport vehicles - Technical assistance for engineers and community organization experts - Segeneity WSA office building - HQ building, and stores - Seed money for Segeneity sanitation credit program **2. Training** - Short term training of plumbers, fitters, recorders (water meters and generators, pumps, etc.), in Segeneity at community level. - Short term training for bookkeepers of community level water and sanitation committees.
5. Other Public Institutions: Schools, health institutions, Churches, Mosques, public places, etc.	**1. Capacity Building:** - Establishment of water and sanitation groups in these public institutions and construct latrines and piped water sources by the end of the plan period. Its finance will be jointly from institutions themselves, parents, community, etc.

6.5 Project Cost

6.5.1 Project Cost for Water Supply

Project cost consists of the following main facilities and items.

a) Construction cost
   - Intake facilities (borehole, well pump, etc.)
   - Transmission facilities (booster pump, pump pit, transmission pipeline, etc.)
   - Distribution facilities (reservoir, distribution pipeline, etc.),
   - Service facilities (individual connection, communal water point, etc.)
   - Electric facilities (control house, power supply, etc.), and
   - Others (temporary road etc.)

b) Engineering fee,

c) Administration cost

d) Physical contingencies, and

e) Price contingencies

Project costs for local currency component consists of earth works, concrete works, pipe laying works, installation of mechanical and electrical facilities, temporary works, etc., while for foreign currency component consists of materials and equipment, such as pipes and its fittings, valves, pumps control panels, etc..

To the construction cost, percentages for engineering fee and administration cost are assumed as 10% and 2% respectively. Physical contingencies are assumed as 10% of the sum of the construction cost, engineering fee and administration cost. Finally, price contingencies also assume 6% per year. Project costs of each target year are estimated following tables.

Table 6.5.1 Project Cost in 2005

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	13,229	273,277	286,506	
Well pump	10,682	205,195	215,877	
Transmission pipeline	1,086,137	2,962,253	4,048,390	
Booster pump	1,992	123,997	125,989	
Pump pit	62,765	38,970	101,736	
Reservoir	341,400	188,160	529,560	
Distribution pipeline	1,443,369	752,425	2,195,794	
Individual connection	0	0	0	
Communal water point	180,195	68,664	248,859	
Control house	449,911	21,197	471,107	
Temporary road	891,000	0	891,000	
Sub total	**4,480,679**	**4,634,138**	**9,114,818**	
2. Engineering fee	-	911,482	911,482	
3. Administration cost	182,296	-	182,296	
4. Physical contingencies	466,298	554,562	1,020,860	
Total	**5,129,273**	**6,100,182**	**11,229,456**	
5. Price contingencies	979,773	1,165,232	2,145,006	
Ground total	**6,109,047**	**7,265,415**	**13,374,461**	

Table 6.5.2 Project Cost in 2010

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	0	0	0	
Well pump	10,625	194,704	205,329	
Transmission pipeline	305,775	590,095	895,870	
Booster pump	5,824	355,022	360,846	
Pump pit	125,531	77,941	203,471	
Reservoir	75,553	1,329,152	1,404,705	
Distribution pipeline	1,566,799	674,925	2,241,724	
Individual connection	0	0	0	
Communal water point	90,097	34,332	124,429	
Control house	137,822	9,993	147,815	
Temporary road	0	0	0	
Sub total	**2,318,026**	**3,266,163**	**5,584,190**	
2. Engineering fee	-	558,419	558,419	
3. Administration cost	111,684	-	111,684	
4. Physical contingencies	242,971	382,458	625,429	
Total	**2,672,681**	**4,207,041**	**6,879,722**	
5. Price contingencies	1,346,043	2,118,793	3,464,836	
Ground total	**4,018,724**	**6,325,834**	**10,344,558**	

Table 6.5.3 Project Cost in 2015

(Nakfa)

Description	Local C.	Foreign C.	Total	Remarks
1. Construction cost				
Borehole	9,275	85,317	94,593	
Well pump	21,208	371,829	393,037	
Transmission pipeline	81,540	157,359	238,899	
Booster pump	6,080	388,079	394,159	
Pump pit	0	0	0	
Reservoir	95,362	1,722,442	1,817,804	
Distribution pipeline	2,279,769	1,082,001	3,361,770	
Individual connection	0	0	0	
Communal water point	180,195	68,664	248,859	
Control house	137,822	9,993	147,815	
Temporary road	118,800	0	118,800	
Sub total	**2,930,052**	**3,885,683**	**6,815,735**	
2. Engineering fee	-	681,574	681,574	
3. Administration cost	136,315	-	136,315	
4. Physical contingencies	306,637	456,726	763,362	
Total	**3,373,004**	**5,023,982**	**8,396,986**	
5. Price contingencies	3,414,142	5,085,257	8,499,399	
Ground total	**6,787,146**	**10,109,239**	**16,896,385**	

6.5.2 Project Cost for Sanitation

Table 6.5.4 Cost Estimation of Latrines

(Nakfa)

Description		Year 2005	Year 2010	Year 2015
School Latrine - PFL	Construction cost	224,177	74,726	74,726
	Price contingencies	27,708	37,634	75,637
	Total	**251,885**	**112,360**	**150,363**
Public Latrine - CFL	Construction cost	224,177	74,726	74,726
	Price contingencies	27,708	37,634	75,637
	Total	**251,885**	**112,360**	**150,363**
Ground total		**503,770**	**224,720**	**300,726**

6.6 Sustainability of Water Supply Facilities

6.6.1 Capacity Building for WSA

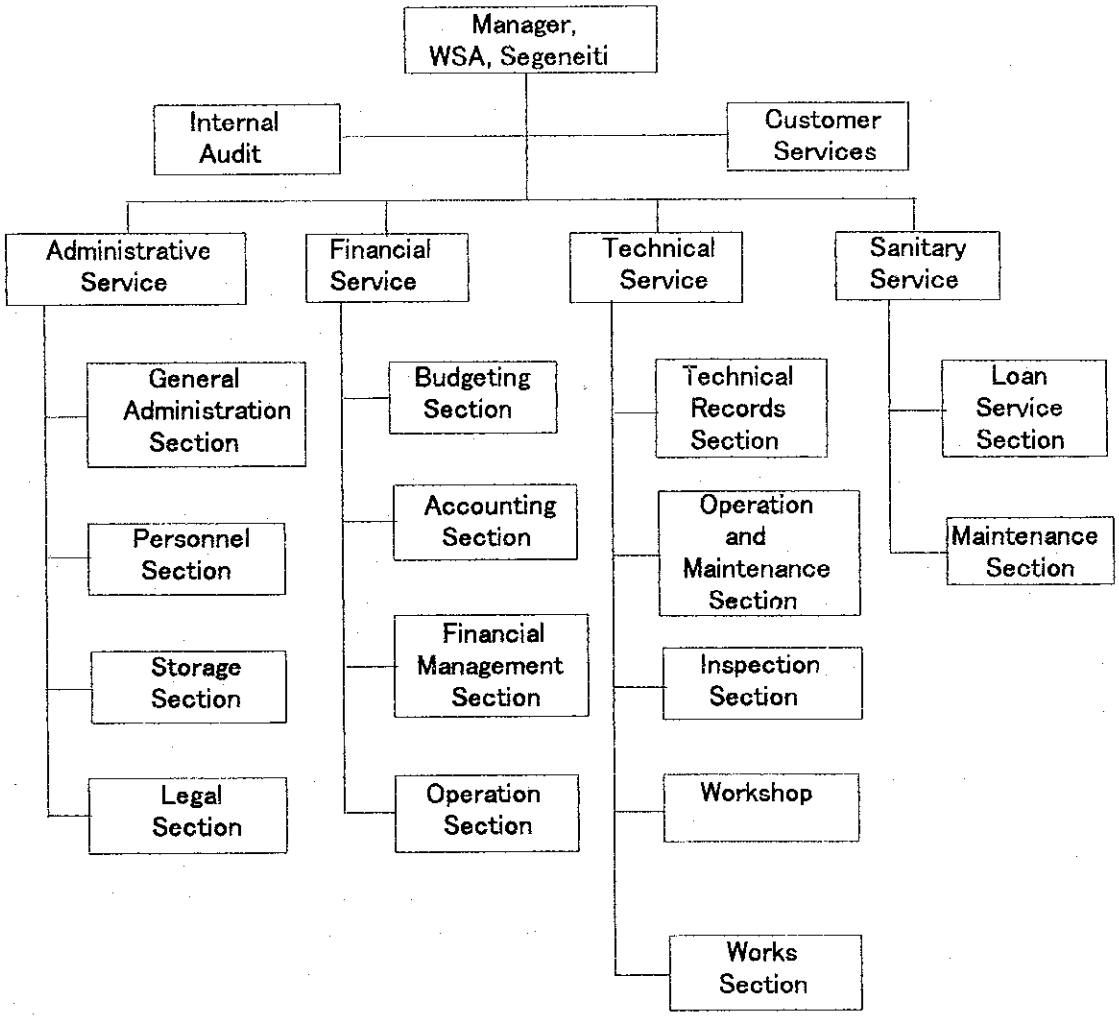
The smooth and successful implementation of the water supply project being envisaged depends on how competent and capable the manpower of WSA Segeneity will be in both qualitative and quantitative terms.

Therefore, personnel planning in functions and numbers of personnel to be required in the future target

years is of paramount importance.

The primary objective of WSA Segeneity is to supply clean and safe water in a sufficient, sustainable and efficient manner. To achieve this, WSA shall be fully competent technically, financially and legally. Figure 6.6.1 shows the organizational set-up of the WSA.

Figure 6.6.1 Proposed Organizational Set-Up of WSA, Segeneity (2015)



Organizationally, WSA Segeneity will ultimately be composed of Manager, Customer Services, Internal Audit, Administration Service, Financial Service, Technical Service and Sanitary Service.

The Manager is responsible for the stable and successful management of WSA Segeneity and represents the WSA in dealing with the committees, the town municipality and National WSA. Customer Service functions as a window or opening for communications with the consumers in general. Internal Audit is essential for a strict observance of rules and regulations in financial management.

Administration Service is composed of General Administration, Personnel, Storage and Legal sections.

General Administration Section is in charge of secretarial/clerical work. Guards and sweepers also belong to this section. Personnel Section is in charge of recruitment, assignment and training of personnel, and remuneration. The National WSA is proposed be to be basically responsible for the training of personnel. However, it is proposed also that a town WSA can re-train or newly train personnel as need arises, using its own fund. Storekeeping and procurement of materials/supplies are done by Storage Section. Such matters as complaints, lawsuits and penalties are taken care of by Legal Section.

Financial Service must be qualitatively and quantitatively fully manned. Its functions encompass budgeting, accounting, financial management and operation. Annual and monthly budget of income and expenditures is prepared by Budgeting Section. Accounting Section prepares financial statements based on daily financial transactions. Financial Management Section analyzes and evaluates financial performances. Operation Section is in charge of meter reading, billing and collection, and cash water selling.

The communal water points are proposed to be managed by the communities themselves. The study team does not elaborate such a proposal in terms of financial and personnel needs. It is assumed that WSA Segeneity helps communities in the management of the facilities in some manner.

Technical Service must also be fully staffed in terms of the numbers and competence. It covers Technical Records, Operations and Maintenance, Inspection and Works sections, and Workshop. Records of equipment and supplies such as acquired date, numbers, plans, dimension, breakdowns and repairs are kept in Technical Records Section. Operation and maintenance of pumping stations, reservoirs, pipelines, communal water points are taken care of by the Operation and Maintenance Section. Inspection of the above-mentioned facilities is regularly carried out by the Inspection Section. Repairing and manufacturing belong to Workshop. Works Section is in charge of rehabilitation/ replacement/construction of facilities.

In addition to the organizations related to water supply, it is proposed that WSA Segeneity provide an intermediary services for the diffusion of sanitary facilities as well as sanitation services. Sanitary Service is composed of Loan Service and Maintenance sections. Loan Service Section provides loan/subsidy to clients for the installation of septic tank toilets, and keep related records. Maintenance Section regularly empties toilets with a vacuum truck, and regularly cleans and maintains drainages.

The total numbers of personnel are proposed to be 19, 28 and 40 in 2005, 2010 and 2015 respectively (Appendix G, Table-1). They were worked out based on the volume of water to be produced.

6.6.2 O&M Cost

(1) Personnel cost

The number of personnel to be required in each target year has been projected based on the volume of water to be produced in a year.

Personnel cost is calculated by multiplying the number of personnel by the average remuneration per employee. The average monthly remuneration in a target year is calculated to be Nfa 616, while the estimated average yearly growth rate of salaries in real terms is 3%, taking into consideration the current

average salary of the Water Supply Service Office (WSSO).

The estimated number of personnel in the target years is shown in Table 6.6.1 and the average remuneration per employee is estimated at Nfa 9,364, Nfa 10,855 and Nfa 12,584 at 1997 prices in years 2005, 2010 and 2015, respectively.

(2) Electricity and fuel cost

All mechanical equipment are operated mainly by electricity. Fuel is also required during emergency. Electricity requirements are calculated based on the volume of water to be produced in each target year.

The electricity cost has been calculated by multiplying electricity requirements in kwh by the unit electricity charge, and by adding 5% of its cost for fuel, in each target year.

The estimated electricity requirements in kwh/day in the target years are shown in Table 6.6.1, and the electricity charge per kwh is Nfa 20.16.

(3) Chemical cost

The chemical, hypochlorite or bleaching powder for disinfection to be consumed in each target year has been projected from the volume of water to be produced in such a year.

The chemical cost is calculated by multiplying chemical requirements in kg in each target year by the unit price of the chemical.

The estimated chemical requirements in the target years are shown in Table 6.6.1, and the unit price of the chemical is Nfa 6.5.

(4) Repairing cost

Maintenance and minor repairing works such as replacement of spare parts for pumps and valves, fixing of water leaking locations, checking of water level in the reservoir, etc. are carried out by the staff in WSA Segeneity. Repairing needs are calculated based on the initial cost for mechanical and electrical works as well as on the initial cost for civil works including pipe laying works in a target year.

Repairing cost is estimated at 1% of the initial cost for mechanical and electrical works, and 0.5% of the initial cost for civil works including pipe laying works, in each target year.

(5) Miscellaneous cost

The miscellaneous cost is assumed at 10% of the sum of the preceding four types of costs.

The results of cost calculation are presented as Table 6.6.1.

Table 6.6.1 O&M Cost

(Unit: Nfa)

Item	Year 2005		Year 2010		Year 2015	
1. Personnel Cost	16 persons	149,823	23 persons	249,674	30 persons	377,532
2. Electricity and Fuel Cost	22.00 kwh/day	161,885	35.00 kwh/day	257,544	47.20 kwh/day	347,316
3. Chemical Cost	897 kg	5,830	1,348 kg	8,761	2,047 kg	13,303
4. Repairing Cost	Initial Cost for Pump 341,866 Nfa Initial Cost for Others 8,772,952 Nfa	52,012	Initial Cost for Pump 908,041 Nfa Initial Cost for Others 13,790,967 Nfa	85,839	Initial Cost for Pump 1,695,237 Nfa Initial Cost for Others 19,819,506 Nfa	127,655
5. Miscellaneous Cost		36,955		60,182		86,581
Total		**406,504**		**662,000**		**952,387**

6.6.3 People's Participation

(1) The path to development: self-reliance and people's participation

People's active participation and self-reliance constitute the main pillars of the Government's development policy. Participation is multi-faceted and may include, and involves almost all stages of the project cycle. For example, in the water sector, communities should be involved right from the planning stage up to the final hand-over/management stage, after the project is completed, if sustainability of community based projects is desired. The most important principle is the inculcation within the community thinking the felling of ownership of the project.

Even today, self-reliance and people's participation, particularly through community organization, is still relevant in the economic and social transformation of Eritrea. Such a move will address the development needs of Eritrea which, cannot be achieved short of mobilizing the manpower and natural resources of Eritrea. However, self-reliance and popular participation cannot be replicated as in the days of the struggle. The EPLF was organized on a socialist ethos, where individuals were not paid for their services and owned nothing for that mater, and "everything to the war front was not a slogan but a survival strategy. Economic reconstruction of the country is much more complex and it will take place in an environment of liberal economy where the macro-economic policy of Eritrea paves the way for the private sector to play a leading role in the economic growth of the country. But the good news about Eritrea is that the new government works hard for self-reliance and popular participation of a kind compatible with market economies. Self-reliance should not be narrowly conceived to imply that everything is to be done by Eritreans only. Self-reliance is when the people take responsibility for their own future and map out strategies appropriate to their situation. Working towards organizing the people towards this endeavor is crucial to pull together people's resources.

(2) Reiteration of principles

In the broad context of this study, people's/community's participation simply refers to placing people at the center of urban water supply and sanitation development efforts. People based development is clearly enunciated in the Government's policy which is based on the five broad development principles

enumerated in Chapter 2 section 2.2. The implications of these five principles for people's participation are quite clear. But to reiterate, the following main points are elucidated:

- Ownership of policies and programs: Projects' sustainability could not be guaranteed unless community/people get a sense of ownership of the programs and projects built in and around their locality in particular and the country in the broader sense. Therefore, such sense of collective ownership need to be built as a culture within the people.
- Participatory politics: This policy principle implies that sustainability of projects becomes questionable if the people are excluded in all the stages of the project cycle, i.e., from the planning, to the implementation and latter on in the management of it. In the case of the project, 'Water Supply and Sanitation in Seven Towns of Debub', people's representative were briefed and their opinions sought right from the inception stage of the study, followed by a second meeting after the progress report was finalized. During these two meetings, extensive discussions were held and views exchanged in which the community representatives expressed their readiness to do whatever was expected of them.
- Good economic management: As the civil service is planned to be efficient, accountable and lean, in like manner, the management of projects including those that involve communities need to be lean, efficient and accountable to their constituencies if projects at these level are to be sustainable.
- Human Resources Development: At the macro level, this involves education and training to enhance the country's skilled manpower base. The implication for people's participation is that if communities are to effectively dispense their share in the planning, implementation and management of projects, they need to be trained and educated informally or formally as appropriate.

(3) Recommendations

Based on the implications drawn from the development principles elucidated above, the following recommendations are made to enhance people's participation, and therefore sustenance of projects in Segeneity for the stipulated development program.

- Continuous sensitization and awareness creation program will need to be an in-built feature of the program for the development of water supply and sanitation in the seven towns.
- The study team recommends on the broad strategy which the Government could follow in ensuring people's participation in the management and administration of water and sanitation facilities.
- Introduce and develop a viable management system for water and sanitation facilities that will be managed by the communities.
- Education and training need to be an in-built system of any program that seeks the active involvement of communities in project planning, implementation and management.

6.6.4 Community Based Management

In the spirit of the principles that govern people's participation as elucidated in section 6.6.3, community based management aims at placing communities at the center of the projects to be implemented, with true user ownership of facilities, including communal facilities. In Segeneity, community based management would, therefore, involve the following principles:

(1) Communities must own and manage the improved as well as unimproved or existing water points and sanitation facilities, with all that such ownership entails. This helps to understand the local values, knowledge and competencies which could eventually assist in the strengthening of community based management.

(2) Hardware and software components of the water supply and sanitation facilities need to be given equal attention. This is all the more important because, dealing with water and sanitation facilities involves managing resources which could be complex activities such as record-keeping, payment, excluding non-payers, punishing offenders, etc. For most communities failure will be common, and systems could fall into a stop and start manner, rather than move smoothly. Therefore, any intervention must recognize that software is not a straightforward task. Periodic failure could be common, even though failure itself needs to be considered as part of the learning process.

(3) The importance of linking hygiene and sanitation interventions with water supply infrastructures, is indeed obvious. However, given the difficulties that water point committee members could face, a separate sanitation committee also needs to be established to manage community toilets and govern on the same principle as that of the water committees.

There exist various interest groups in Segeneity, such as those pertaining to age, sex, income, occupation, values and attitudes. It is important, therefore, not to rely solely on community elders but rather to bring various groups, notably women and young men into the process. The exclusion of these groups may understate important inputs that will consequently undermine management success of community based projects.

(4) Perhaps, one of the considerations often lost in community based management of water and sanitation facilities is that the beneficiaries of services are consumers, and therefore, they have all the right to demand quality service for the value of their money. Attitudes of service delivery agents, including especially private contractors, do often ignore and/or forget to take consumers' interest into account, particularly during the early stages of service delivery (e.g., public water point and public toilet design and location).

(5) Finally, despite uniform opinion and lessons learned regarding the need to have a strong software component to both water supply and sanitation programs, this is often not translated into the relevant commitment in terms of financing and personnel allocation during the project implementation stage. This could simply put the returns to investment of such projects into jeopardy. It is not intended here to suggest how much should be allocated for the software component even after the completion of the project but to stress that the issue of what the software component should deliver be given adequate consideration.

On the basis of the above principles, the following recommendations are given for community based management in Segeneity.

(1) Communities must actually own the improved water points, with all that such ownership entails. In addition, such ownership and management should eventually incorporate unimproved water points into the system.

(2) If community based management is to function in a sustainable manner, both hardware and software

components need to be given equal attention. The complexity of the software tasks should not be underestimated nor the amount of time it takes.

(3) Failure should be recognized to be part of the process; and if there is failure somewhere in the line, it should be considered part of the learning curve in the water and sanitation sector.

(4) In community based management, activities should be focused specifically on building self-reliance, self-confidence, and technical and management skills, and helping to solve problems in such a way that water and sanitation facilities are effectively managed locally.

(5) Participatory appraisal techniques need to supplement committee meetings/contacts with opinion leaders, in the consideration for improvement of software delivery.

(6) Within the context of affordability, service delivery agents need to recognize that communities are consumers and would like to maximize the returns from the money they pay for the service required.

(7) The sustainability of community based management for water supply and sanitation facilities may require software interventions up to five year period with multiple visits and strengthening activities taking place over this period. The final measuring rod for empowerment of the community will therefore lie in the commitment of software fund over time, and not simply at the initial stages of service delivery.

6.7 Sustainable Sanitation Improvement

6.7.1 Sanitation Management Plan

While assessing the present public sanitation condition the very basic problem of Segeneity with respect to sanitation is not lack of facilities provision but misuse of facilities and lack of maintenance. The solution of this basic problem to some extent is addressed in the facilities design stage. The technology adapted are to the level of economy and knowledge of the people. Basic latrine design considerations for easy management are:

- The school and public latrines proposed are in a way which minimize water wastage and avoid frequent breakage of cisterns by replacing the cistern with a simple tap at low level for collecting water with jug and pour flush.
- Misuse of school and public latrines in the absence of attendant is addressed in the proposed latrine by providing iron bar mesh fence which will also provide access for inspection by the attendant while in use.
- The septic tank for the school and public latrines is proposed with dry masonry wall lining for soak-away purpose, to minimize the frequent requirement of vacuum track.
- The household latrines recommended for low income group are self manageable. The proposed type of latrine is a double pit ventilated latrine with exchangeable squatting holes and vent holes. The decomposed matter can be removed by family members from shallow depth pit and can be used as manure.

However, the other basic factor for a sustainable sanitary facility is management plan. At present the

managing body for all public facilities is the town administration. The town administration having big duties and responsibilities, handling such petty jobs to the extent of managing public latrine as observed is not only too much to manage but also ineffective.

Therefore, introduction of autonomous management systems are highly recommended. The town administrator remaining to be the overall inspector of the facilities with respect to the cleanliness and functionality, the management responsibility of public facilities shall be given either to an individual on contractual or rental basis or a community sanitary facilities committee which shall be formed to operate and manage the systems. The first option is preferable for the very reason that the responsibility lies on an individual only. Moreover, the contractual agreement for rent shall include performance bond for any damages and irresponsible acts of the tenant and clause for termination of the agreement.

The public latrines proposed incur minimum cost which is limited to monthly expenses of water, detergent and cleaning material and once in two to three years of de-sludging

For instance, if a latrine gives service for an average of 300 people per day for defecation and 25 cents is charged per visit, the monthly gross income shall amount 2250 Nfa. This amount of money after covering all the expenses provide a good earning for an individual. For Segeneity town administration Nfa 2,250/- is very trivial sum of money but the burden for an effective management is beyond capacity.

The school latrines do require an attendant who follow up the general condition of the latrines and practices of the students in handling and using the latrines. Cleaning and keeping the latrines in good condition however shall be the students responsibility for the very reason of creating hygienic perception and practical change in their behavior on sanitation and hygienic habits.

(1) Solid waste management

The solid waste management at present is the town administrations responsibility with a great deal of cooperation of the people. The cleaning campaign which is conducted once in a while has a good effect in creating sanitation awareness in the society and keeping the town clean. But for more effectiveness it is highly recommended to develop a plan which introduce a waste handling norm which involves the participation of all groups of the society in a day to day life. Such plan includes:

- Provision of refuse collection bins in the public areas and streets.
- Provision of garbage containers in all residential areas.
- Provision of refuse truck.
- Provision of vacuum truck

Provision of the above facilities and developing realistic work plan is the town administration` responsibility while appropriately using the facilities is duty and responsibility of each of the society member in day to day life.

Provision of garbage containers to all residential areas may not be at present economically feasible to Segeneity. In this case the refuse truck may go round to all the residential areas and collect garbage directly from the residents on fixed days and timing.

The management for solid waste which includes collection of refuse and ultimate disposal to an

environmentally safe place outside the town shall be the responsibility of the town administration. However, wide range of cooperation by all groups of beneficiaries is vital for a successful sanitation improvement program.

(2) Wastewater and soil waste management

The kind of wastewater system proposed for Segeneity is on-site disposal. Therefore, the management of wastewater disposal is communities responsibility.

With regard to de-sludging of septic tanks, up to the year 2005 Segeneity town administration may have to rely on the vacuum truck from Asmara for anticipated few number of septic tanks. However, for effective operation private vacuum truck owners should be encouraged.

(3) Proposed sanitation management structure for Segeneity town administration

Segeneity town administration already has sanitation section. However, in this study it is recommended to redefine duties and responsibilities of the section and promote the technical staff know-how.

As shown in the chart below the sanitation section should include Waste disposal division, Public & Household latrine division and Sanitation/Hygiene education division. The duties and responsibilities of each division is defined as follow:

The sanitation section is responsible for pubic relations service and overall control of works and performance evaluation of the three divisions. In addition this section shall be responsible to the staff strengthening of the three divisions. Arranging training programs by looking for fund and institution to promote staff is vital duty of the section.

Duties and responsibilities of Waste disposal division

- Clean the town
- Collect household refuse by going round the town on schedule
- Arrange vacuum truck facility
- Develop monitoring and evaluation technique explicitly on sanitation improvement in the community.
- Monitoring the community solid and wastewater handling
- Follow up violation of regulation by the community such as solid waste disposal to their surrounding area and open field deification.
- Assess environmentally safe area for ultimate solid and soil waste disposal.
- Conduct periodical environmental impact assessment of the disposal area.
- Evaluate and monitor the waste disposal mechanism of factories and industries.
- Regularly clean and maintain drainage system.

Duties and responsibilities of Public & household latrine division

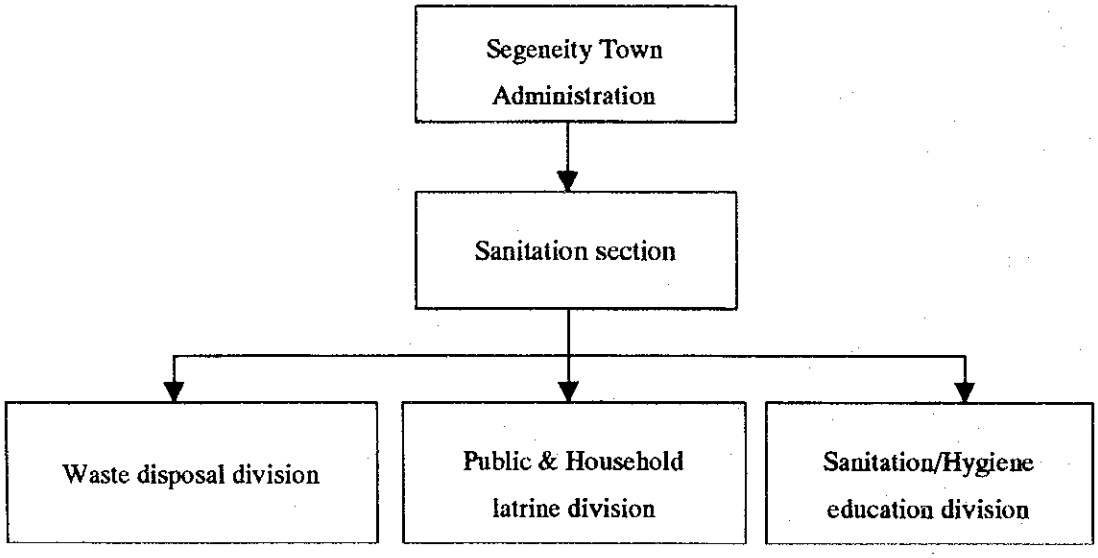
- Assess public and household latrine coverage.
- Assess public areas which require latrine

- Arrange fund for public latrines construction.
- Facilitate low interest and long repayment loan for low income group level household latrine construction.
- Facilitate tendering of public latrine rental contract.
- Evaluation and monitoring of the public and household latrines condition.
- Develop a monitoring and evaluation technique on sanitation improvement of the community with regard latrines.
- Training household latrine builders.
- Giving technical advise to household latrine builders.
- Follow up the repayment of loan.

Duties and responsibilities of sanitation/ hygiene education division

- Arrange educational program for communities.
- Correspond with different bodies with relative field of interest and who could possibly cooperate by giving fund or arrange an educational program such as ministry health, education, and other non governmental organizations.
- Develop a monitoring and evaluation technique on sanitation improvement technique on sanitation improvement of the community with regard sanitation behavioral changes.
- Evaluate and monitor sanitation/hygiene behavioral changes of the community.

Figure 6.7.1 Sanitation Management Structure



6.7.2 Educational Program Development

An effective sanitation improvement program is achieved if and only if the provision of sanitation

facilities and good management plans are backed by a hygiene education program. Compared to facility provision and management plan, developing and conducting an educational program is a difficult task.

The educational program developed should be able to address different groups of beneficiaries by age, sex, education, cultural and religious background. The educational program once developed does not mean the end of it. Every time the program shall be updated to fit to whom it is addressed and the type of teaching mechanism used.

Implementation of the educational programs is rather more difficult than that of developing the program. Choosing appropriate teaching mechanism to fit the addressed target group is very important. The following teaching mechanism can be used for hygiene/sanitation education programs.

Table 6.7.1 Teaching Mechanism and Media

Teaching mechanism	Teaching media
Audio	Radio
Visual	Posters
Audio visual	TV, video films
Communication	Face to face

Easy and less expensive means of conducting the hygiene/sanitation education program is to make use of existing institutions such as schools, churches, mosques, women association, youth association, radio and television stations etc.

School children can be given the education in the schools, and youth association. The hygiene/sanitation aspects need to be included in the students curriculum. In Eritrea organizations such as UNICEF are trying to incorporate the theoretical background of hygiene/sanitation program in the students curriculum. However, from similar project experience in Eritrea the most effective way of teaching children in sanitation and hygiene is to practically make them get used to clean latrine usage, develop hand washing habit after using latrine and cleaning latrine. These are simple norms a student can practice daily in the school, which in a short while expected to change his/her hygiene/sanitation perception and their changed perception is anticipated to be reflected in their family and their society. A latrine attendant or instructor shall be constantly around the toilet, observing and instructing the students to follow simple rules of using latrines. The rules may include only five points:

- To avoid blockage of latrine to make them use only water or paper not stone for anal cleansing
- To put paper used in the basket
- To pour water after using latrine
- To wash hands after using latrine
- To clean latrine by turn daily after class

Church and Mosque are places where elderly people have trust. These institutions if possibly be used to reach elderly people in hygiene/sanitation educational programs effective outcome can be envisaged.

The housewives in Eritrea in general are very tied up with routine home duties such as cleaning, cooking, washing, gardening, shopping etc. Moreover, the social obligation such as helping a relative or neighbor preparing food and drinks for a wedding ceremonies which takes many days, going to funeral which sometime takes place to far away village and visiting the family home for a consecutive days, going to associations, visiting sick person, delivered woman, relatives, going to church etc. are part of the cultural norms of women specially housewives which makes them busy. In addition for a small town like Segeneity fetching water is another burden besides the busy daily life they have. For these reasons an independent hygiene/sanitation program schedule may not be effective and realistic. A more effective and easy way of addressing women might be through the existing radio educational programs which is broadcast during working hour while at the same time carrying out their home duties or through existing institution such as the Eritrean women association, community administration (Mimihidar), church or mosque. Women normally tend to listen the radio educational program, but for those who do not some encouragement by women association or community administration is vital.

In this study the hygiene/sanitation education program development is limited to the preparation of a general educational guideline manual and development of some basic illustrative posters.

The educational emphasis developed in the posters illustrate typical areas for the sanitation improvement of the town. The intended messages to be conveyed in the posters are:

- Explanation on risk of pathogens on health
- Keeping food and water safe from contamination.
- Responsibility of the society on protecting the environment and surface waters from pollution
- Developing habit of hand washing.
- Developing habit of latrine usage
- Demonstration of low cost, safe household latrine.
- Demonstration on household latrine handling.
- Responsibilities in public sanitation facilities usage.
- Risk of infant excreta.
- etc.

The sanitation and hygiene educational manual prepared gives a guideline how to communicate and convey the education to the community. The manual includes the following contents

- How to establish good relationship
- How to analyze the situation and identify community
- How to develop work-plan
- How to select appropriate methods
- How to develop educational method
- How to evaluate the result