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REPUBLIC OF TUNISIA

THE DETAILED DESIGN STUDY
ON
THE RURAL WATER SUPPLY PROJECT
IN
THE REPUBLIC OF TUNISIA

FINAL REPORT

VOLUME II SUPPORTING REPORT

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THE DETAILED DESIGN STUDY
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SUPPORTING REPORT

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ABBREVIATIONS

AGR	District Agricultural Engineering Office, CRDA (Arrondissement du Génie Rural)
ANPE	National Agency for Environment Program (L'Agence Nationale de Protection de l'Environement)
CEM	Defense Ministry Map (Carte d'Etat Major)
CRDA	Regional (provincial level) Directorate General for Agricultural Development (Commissariat Régional au Développement Agricole)
DT	Tunisian Dinar (Dinars Tunisien)
DGGR	Directorate General of Agricultural Engineering, Ministry of Agriculture (Direction Générale du Génie Rurale)
EPR	Department of Rural Potable Water (Direction de l'Eau Potable Rural)
GIC	Group of Water Users (Groupement d'Intérêt Collectif)
GOT	Government Of Tunisia (Gouvernement Tunisien)
GR	Agricultural Engineering Office, AGR (Génie Rural)
INS	National Statistic Institution (Institut National de la Statistique)
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency (Agence Japonaise de Coopération Internationale)
KfW	Kreditanstalt für Wiederaufbau
LCAE	Central Laboratory for Analysis and Test, Ministry of Industry (Laboratoire Central d'Analyse et D'Essai, Ministère de L'industrie)
METAP	Mediterranean Technical Assistance Programme (Banque Mondiale et Programmes d'assistance technique méditerranéenne)
MOA	Ministry Of Agriculture (Ministère de l'Agriculture)
MOI	Ministry Of Interior (Ministère de l'Intérieur)
OECF	Overseas Economic Cooperation fund of Japan (Fonds de Coopération Economique du Japon)
ODA	Official Development Assistance

ONAS	National Office for Purification (L'Office National de l'Assainissement)
OTC	Topography and Cartography Office (Office de la Topographie et de la Cartographie)
PDARI	Integrated Rural Agricultural Development Project (Projet de Développement Agricole Rural Intégré)
PISA	Agricultural Sector Investment Loan Program (Prêt d'Investissement au Secteur Agricole)
SAPROF	Special Assistance for Project Formation provided by JBIC (Assistance Spéciale pour les Projets en Formation)
SONEDE	National Corporation for Water Development and Supply (Société Nationale d'Exploitation et de Distribution des Eaux)
STEG	Tunisian Corporation for Gas and Electricity (Société Tunisienne de l'Electricité et de Gaz)
WHO	World Health Organization (L'Organisation Mondiale de la Santé)

APPENDIX A

SOCIO-ECONOMIC IMPACT STUDY
IN
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APPENDIX A

SOCIO-ECONOMIC IMPACT STUDY
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CHAPTER 1 INTRODUCTION

A sample survey on the socio-economic impacts on the localities in which the water supply systems were already introduced and GICs were established has been carried out to know the variations/changes in the daily lives of beneficiaries and their social-environments, to evaluate these variations/changes, and to facilitate the evaluation for a successful implementation of future similar projects.

Out of the socio-economic impact study, data/information collection and the primary analysis/evaluation of them are carried out by a local consultant sub-contracted under the supervision and advice of the JICA Study Team. The results are further analyzed and the conclusions and the recommendations thereof are brought out by the JICA Study Team.

Due to several constraints encountered, the number of samples studied are limited to two governorates in case of the macro aspects study and four GICs in case of the micro aspects study, although typical samples are chosen.

As this type of study on the socio-economic impacts of the rural water supply program to the already implemented area is the first case in Tunisia, some interesting facts and information (or, lack of it) were observed during the course of the study.

CHAPTER 2 APPLIED METHODOLOGY

To find out the socio-economic impacts and variations/changes thereof, both the regional area and the directly concerned local area should be studied to know both the macro-level socio-economic impacts to the former and the micro-level impacts on individual daily-lives of the beneficiaries in the latter.

Therefore, the study was divided into two parts, namely, Macro Aspects and Micro Aspects.

2.1 Macro Aspects

As positive benefits of the rural water supply program to the regional area, the following items can be expected:

(1) Control of rural population exodus (or, prevention of rapid urbanization of population)
(2) Redressing of the disparity between urban and rural areas
(3) Improvement of rural living standards

Considering these items, the following methodology is applied for the Macro Aspects study.

(1) Two governorates, one from a relatively developed area and another from a developing area should be selected.

(2) Several indicators described below should be studied in both governorates and each data/information should be compared.
  1) The year when the rural water supply program was started
  2) Yearly investment from the initial year up to the present (hereinafter referred to as the Period)
  3) Demographic trends of each year in the present
  4) Household income and/or GDP per capita of each year in the Period
  5) Occurrence of infectious and/or water-related diseases of each year in the Period

6) Remarkable variation/change in living conditions during the Period
7) Other considerable matters taking place during the Period, if any

(3) Making use of the collected data/information including ones from the Micro Aspects study as well, the socio-economic impact by the rural water supply program to the selected governorates should be analyzed and evaluated.

2.2 Micro Aspects

(1) Selection of four existing GICs

In view of the study, typical GICs representing major localities of Tunisia should be selected. It is suggested that one GIC represent each area, e.g. from Northern Area (possibly from Jendouba, Beja or other governorates in the districts), Central East Area (from Mahdia, Sousse, Sfax or other governorates), Central West Area (either from Gafsa, Sidi Bouzid or other governorates) and Southern Area (either from Medenine, Gabes or other governorates). The selected locality should be geographically, culturally, and economically representative to each area.

(2) Socio-economic indicators

Study of the changes in the following socio-economic indicators before and after the introduction of the water supply system and the establishment of the GIC.

1) Population
2) Population of domestic animals including chicken
3) Area of cultivation
4) Production (agricultural, animal husbandry, etc.)
5) Household income
6) Occurrence of infectious and/or water-related diseases
7) Daily works (i.e. time saved for potable water fetching, animal feeding and irrigation water acquisition and diversified working times for other purposes)
8) Other considerable changes of living conditions (such as, increased school attendance of children freed from water fetching works,

increased hygienic and nutrition conditions of households, etc.)

9) Study on the effects of the subproject on the newly implemented tree crops (area, consumed water volume and income of household, etc.)
10) Study on the impact of the subproject on the traditional family plantations which have existed prior to the starting of the project
11) Evaluation of the effects of the rural water supply program on the domestic animals during drought years.

By comparing and analyzing these indicators and results of the studies on the existing GICs, a primary evaluation of the impact on each GIC should be conducted.

2.3 Overall Evaluation and Suggestion to the Future Program

In the nature of the study, overall evaluation of both the Macro Aspects and the Micro Aspects should be conducted, firstly to forecast possible socio-economic variations/changes in the surrounding localities which will be brought out from the future implementation of the rural water supply program and secondly, to facilitate much more effective and smooth implementation of this program.

CHAPTER 3 MACRO ASPECTS

3.1 Selection of Study Area

According to the criteria given in the former section, the following two governorates are selected for the Macro Aspects Study.

(1) Sidi Bouzid in the Central West District
(2) Nabeul in the North East District

Sidi Bouzid is mainly agricultural and rural. It develops slowly and tends to integrate the aspects of modern economy: creation of small local industries, development of different public services and of road infrastructure.

On the other hand, Nabeul is rather urbanized in spite of the existence of very important agricultural and rural sector. The most important economic activities here are those to do with the services and the secondary sectors: tourism, industry, handicrafts workshops. It is also developing towards capital-intensive manufacturing industries.

These two governorates have in common the availability of rural water system in important numbers and have enough stable GICs which function fairly well.

3.2 Description/Comparison of Two Governorates Selected

As is mentioned in the above, governorates selected for the Macro Aspects Study are: Sidi Bouzid in Central West District and Nabeul in North East District.

Sidi Bouzid is mainly rural, having rural population share of 72% at present in the total, contrary to that of only 29% in Nabeul. They can be also compared to the national level of 37% in rural area.

In Sidi Bouzid, the industrialization level is still weak and only 11% of work forces are found in the industrial sector (or, the Secondary sector) compared with the national average level of 20 %. On the other hand, 22% of Nabeul’s work forces are engaging in the industrial sector.

The services sector (or, the tertiary sector) in both governorates is developing rapidly in these several years, but this sector employment haws reached only 15% of the work forces in Sidi Bouzid while Nabeul's share is 24% of the total.

On the contrary to the above, the work forces in the agricultural sector (or, the Primary sector) represent 42% of the total in Sidi Bouzid and 31% in Nabeul.

The low economic development in Sidi Bouzid is reflected in the higher percentage of non-permanent jobs. In fact, those who designated one's profession to be "family supporting" amounts to 17% in Sidi Bouzid compared to that of 7% in Nabeul.

Looking into the occupational status, the employers represent only 1% of the occupational population in Sidi Bouzid compared to that of 3.6% in Nabeul, while the free workers (small grocers, handicraftsmen and other similar categories) whose economic activities are in a limited stage represent as much as 32% of the total in Sidi Bouzid compared to that of 18% in Nabeul.

Sidi Bouzid is a governorate where extensive cattle breeding is conducted as it is characterized by fewer rainfall scarcely exceeding 250 millimeters per year, which makes ordinary irrigated agriculture difficult. Its population of sheep represents around 10% of the total in Tunisia. In Nabeul, on the other hand, cattle-breeding is intensively conducted.

In addition to the above, although Nabeul has a quite productive agricultural sector (intensive sheep breeding, vegetable production, etc. and cereal production per hectare is four times higher than that of Sidi Bouzid), its economic activity is much more varied and modernized, and it is characterized with its industrial and tertiary sectors.

3.3 Outcome of the Study

3.3.1 Sidi Bouzid

(1) Summary of Enquiries

Table A.3.1 summarizes some economic indicators and the answers to the questionnaires made by the JICA Study Team

(2) Preliminary Assessment

Preliminary assessment of the socio-economic impacts of rural water supply project in Sidi Bouzid is as follows:

1) The creation of rural potable water supply system and its continuous development bring out a considerable socio-economic change which characteristically appears in the life-style level and diversification and/or consolidation of income sources in the governorate.
2) The covering ratio of rural water supply increased from 68.4 % in 1994 to 80.1 % in 1999.
3) The power supply ratio to rural households shows a remarkable increase of 51.3 % in 1994 to 82.0 % in 1999.
4) In this governorate, of which economy is based essentially on agriculture, especially tree-crops and livestock, the number of sheep population increased from 538,285 in 1995 to 694,283 in 2000, recording annual average growth rate of 5.22%.
5) The level of income per capita, although it is still under the national average level, also remarkably improved from 976DT/p. in 1994 to 1,308DT/p. in 2000.
6) In the above mentioned context, the number of beneficiaries of the rural potable water supply system also increased sensibly, from 12,958 in 1994 to 15,914, which represents an increase of 22.8%.
7) Average annual income of those GICs in the governorate during 1996 – 1999 (4 years) is nearly 259,400DT which well covers average annual

expense of 242,200DT during the same period.

8) It can be said that the GICs are financially very well maintained covering all the current expenses which had been covered by the State before the implementation of the program and are becoming autonomous

(3) Positive Impacts Observed

1) The development of consumption and satisfaction of human basic needs in good quality water.
2) The valorization of human beings: Since the use of traditional uncovered wells, non-purified natural water drained from small streams, if any, unprotected family tanks collecting rainfalls, etc., without any consideration of health-care has been lowering the value of human beings to the level of animals.
3) The improvement of hygiene through the use of better quality potable water has reduced water-related diseases such as typhoid and viral hepatitis of which number of patients remarkably decreased in recent years.
4) Traditional community activities are revitalized and solidarity is developed through joining into the GICs activities.
5) The consideration in relying on oneself has seen a certain development through taking charge of water management as well as maintaining and taking care of potable water systems.

3.3.2 Nabeul

(1) Summary of Inquiries

Table A.3.2 summarizes some economic indicators and the answers to the questionnaires made by the Study.

(2) Preliminary Assessment

Preliminary assessment of the socio-economic impacts of rural water supply project in Nabeul is as follows:

1) The creation of rural potable water supply system and its continuous development brings out a considerable socio-economic change which characteristically appears in the life-style level and diversification and/or consolidation of income sources in the governorate.
2) The covering ratio of rural water supply increased from 73.9% in 1994 to 87.0% in 1999.
3) The power supply ratio to rural households shows a satisfactory increase of 84.9% in 1994 to 98.8% in 2000.
4) In this governorate, of which economy is partly agricultural but also diversified to a certain degree into the secondary and tertiary sectors, its per capita income level increased from 1,600DT/p. in 1994 to 2,145DT/p. in 2000.
5) As the area is rather developed and having not much share of rural population (34.1% in 2000 compared to the national level of 37.4%), and the covering ratio of rural water supply is already in the higher level, number of households enrolled by the program only increased from 8,890 in 1996 to 9,062 in 1999.
6) The total income of GICs in this area is stagnating in the very recent years while the expense of them surging up. It makes it impossible for the GICs to cover all the operation/maintenance costs by their own income in recent years (especially 1998 and 1999). This, however, does not necessarily mean that the function of GICs is not working. In the year 1996, the GICs recorded a considerable amount of surplus and average annual income and expense during 1996 – 1999 shows fairly even figures of 232,900DT/an. and 235,200DT/an. leaving only 2,300 DT/an. of deficit, which is less than 10% of the income.

(3) Positive Impacts Observed

As the positive socio-economic impact of the rural water supply program to the beneficiaries of the area, almost same things as has been described in the case of Sidi Bouzid can be said but to somewhat limited extent. It may be partly because the area is already rather developed and the socio-economic impact to the already decreasing rural population is seemed slow to appear, and partly because the daily life even in rural area is already reaching to a much more improved level compared to Sidi Bouzid.

Taking this into consideration, positive impacts observed in the area are described as follows:

1) The development of consumption and satisfaction of human basic needs in good quality water.
2) The valorization of human beings: Since the use of traditional uncovered wells, non purified natural water drained from small streams, if any, unprotected family tanks collecting rainfalls, etc. without any consideration of health-care has been lowering the value of human beings to the level of animals.
3) The improvement of hygiene through the use of better quality potable water has reduced water-related diseases such as typhoid and viral hepatitis of which number of patients remarkably decreased in recent years.
4) Traditional community activities are revitalized and solidarity is developed through joining into the GICs activities.
5) The consideration in relying on oneself has seen a certain development through taking in charge of water management as well as maintaining and taking care of water systems.

3.4 Conclusions and Recommendations

(1) Present Conditions of Rural Water Supply in Tunisia

At present, potable water supply ratio in Tunisia is estimated to be 75.6% in 2000, which is improving rapidly compared to that of 70.1% in 1994. However, there exists a great gap of the ratios between the urban and rural areas. As is shown in Table A.3.3, the supply ratio in urban area, of which population accounts 62.7% of the total, is very high at 98.4% while the rural area with the population share of

37.3% only shows as low as 31.9%, although efforts to improve the situation took place in recent years and is rapidly developing the ratio.

Looking into the regional level, the worst district is Central West with larger portion of rural population and lesser rate of rural water supply, especially in Kasserine and Sidi Bouzid where the major economic activities rest on agriculture and livestock breeding. Same things can be said to the North West Region especially in Le Kef and Siliana but to some extent lesser account.

Those districts as Tunis, North East and Central East, which are supposed to be rather developed, attain better rural water supply ratios compared to the national average excluding Bizerte (North East) and Sfax (Central East).

In the remaining two southern districts, where the water resource is supposed to be scarce, rural water supply rates are much higher than the national average (excluding Gafsa). It may be occurred because of smallness and density of the rural population until now, and some difficulties in developing rural water supply further are foreseen as the remaining unsupplied population may be distributing in largely scattered patterns.

Table A.3.4 indicates the projection of water supply ratio in the 9th development plan by governorate and Table A.3.5 compares the projection and the actual performance of the rural areas so far.

Of course, there will be many and different types of difficulties in attaining a set of objective figures area by area that following is not explaining the performances of each Governorates but a plain comparison of projection and actual status to facilitate promoting further development of rural potable water supply.

In this viewpoint, out of 21 governorates having rural population, 7 of them (Ben Arous, Sidi Bouzid, Tozeur, Mahdia and Gabes fair well and Jendouba and Kebili better) have either attained the set objectives or doing better than those, while remaining 14 are left behind especially in Nabeul, Zaghouan, Sfax, Gafsa and Medenine. However, this is only referring to the percentages and not mentioning the actual number of population who are supplied potable water in the rural areas.

Table A.3.6 summarizes the actual number of rural population by status of potable water supply and Table A.3.7 extracts the actual increase of rural population, actual increase of population newly supplied potable water and the balance between them. For example, the increase of potable water supplied to rural population during 1994 and 2000 is calculated to be 281,400, while the increase of rural population itself during the same period counts 127,900. As a result, actual and new beneficiary of potable water supply during the same period can be limited to 153,400 offset by the growth of population.

In this regard, such as Jendouba, Kairouan, Sidi Bouzid, Mahdia, Sfax, Medenine and Tataouine could be said to be doing well, newly supplying to more than 10,000 rural population while Kasserine cannot cope with the increase of rural population and is recording minus figure in actual and new beneficiaries. Also in Nabeul, increase of both rural population and beneficiary of potable water supply just matched and recorded nil actual and new beneficiaries. In other governorates, there recorded more or less several thousands of actual and new beneficiaries. A special case is in Medenine where the rural population decreased during the period by 3,500, and at the same time increasing its water supply beneficiaries by 14,800, a large number of actual and new beneficiaries only surpassed by Kairouan and Mahdia recorded superficially. It must be noted that this figure in Medenine should not be treated as the same nature of the other governorates.

(2) Relationships with Present Rural Water Supply Status by Governorates and Selected Two Governorates in this Study

From the viewpoint of rural water supply status the two governorates selected are quite different from each other. In Sidi Bouzid, potable water supply rate in the rural area is only 17.9% in 2000 compared to 31.9% of national average and far higher 40.9% of Nabeul. (refer to Table A.3.3) However, compared to the set objectives of the 9th Development Plan, Sidi Bouzid is doing far better than Nabeul (refer to Table A.3.5) and in case of actual and new beneficiaries, it records far larger increase in number of population while Nabeul is stagnating (refer to Table A.3.7).

Thus, the conclusions of the study can be directly brought out from the preliminary assessments and positive impacts of each case, and several recommendations will be made to facilitate further development of the program in the following section.

(3) Conclusions and Recommendations

It is concluded that the rural water supply program brings out a considerable socio-economic change into governorate level of rural society, most of which is positive and/or favourable.

In terms of economic concern, production in agriculture and/or livestock breeding has considerably increased although to what extent the program contributed to the growth is not yet measured. In the same sense, average per capita income of the studied governorates has also increased considerably compared to before and after the introduction of the program. Also a diversification of income sources as well as work force structure is recognized to some extent.

From the viewpoint of financial aspects of GICs, the income usually covers most part or even all of the expenses for operation and maintenance, making it possible for them to be autonomous (if the initial cost for the construction of facilities and the establishment of GICs are covered by the State).

In terms of social concern, not only potable water supply but also such public services as power supply and road connection to the rural areas are either increased or strengthened.

Availability of reliable water brings out much more hygienic and health concern into the community and water-related diseases are tangibly decreased while human self-respect is improved considerably.

Another social impact which is brought out by the establishment of GICs is a revitalization and reunifying of traditional community activities through joining and self-managing of the GICs activities, as well as the individual consideration of relying on oneself through management and maintenance of water supply systems.

It is still too early to conclude if the rural water supply program has contributed to prevent rural population exodus. Although the share of rural population to the total is decreasing, actual number of rural population is still in the process of growth (though the growth rate is lower than the national average), and not much urbanization is recognized in recent years, it is difficult to measure the causes of such phenomenon unless some kind of effective indicators are introduced and utilized.

Some constraints encountered during the course of this sub-study were:

1) Non availability of epidemiological data, either governorate level or District level due either faulty data collecting system or circulating system or both of them
2) Difficulties in obtaining financial data concerning income and expense of individual GICs especially for those established before 1996.

Following considerations are recommended to facilitate further development of the rural water supply program and much more effective and smooth introduction of rural water supply systems.

1) Establishment of data monitoring, collection, compilation, and processing system: in this case, data not limited to that which is directly concerned to rural water supply systems but also including various general socio-economic indicators.
2) Establishment of built-in baseline data/indicator monitoring, collection, compilation, and processing system into every GICs which will be established in the future. Those data/indicator to be monitored, collected, compiled, and processed should be exclusively discussed in a specifically designed independent study. In case of already existing GICs, outputs of this study should be introduced as a part of daily

operation/maintenance of existing water supply systems.

3) To generalize and materialize the output of this data, one section or chamber should be set to each governorates and a coordinating section for national level should be established within the Ministry of Agriculture, possibly in DGGR.
4) Other than those data/indicator for measuring tangible effects of the rural water supply program, consideration should be paid for social and psychological aspects which are in most case intangible and difficult to describe and evaluate quantitatively. Thus, the sensitisation activities should be incorporated into the daily activities of each GICs even after their establishment as a part of project cycle management considerations.
5) As the sub-study revealed that the present rural water supply program is giving positive and favourable socio-economic changes into the community, further promotion and development of the program is recommended with the above mentioned considerations in mind.

CHAPTER 4 MICRO ASPECTS

4.1 Selection of Study Area

At the first stage, the following eight GICs were nominated to be studied (and in fact surveyed during the term of the study) taking into account the representative both in national and regional levels.

(1) GIC [Beni Meslem] in Bizerte, District of North East
(2) GIC [Rttakaddouma] in Le Kef, District of North West
(3) GIC [Ouled Alouane] in Sousse, District of Central East
(4) GIC [Ouled El Haj] in Mahdia, District of Central East
(5) GIC [Ksar El Hammem] in Sidi Bouzid, District of Central west
(6) GIC [Ouled El Haj Boualleg] in Gafsa, District of South West
(7) GIC [Maghraouia] in Medenine, District of South East
(8) GIC [Modhar] in Medenine, District of South East

Out of these eight nominated sites, Nos. (1), (3), (5) and (8) are selected with regard to the duration of each GIC (about 10 years or more) and the availability of data/information on its daily management and usage of water.

However, it should be noted that several constraints are observed in the case of Macro Aspects Study such as:

(1) Non-availability of epidemiological data, either at the governorate level or at the delegation level possibly due to lack/shortage of statistical management of such data and/or lack/shortage of recording system on the part of medical institution.

(2) Shortage of statistical data/information on financial and managerial aspects of GICs especially of the latest years.

The preliminary assessment is made on the basis of this as its limits.

4.2 Description of the Study Area and Outcome of the Study

4.2.1 GIC "Beni Meslem"

(1)	Name of GIC	: Beni Meslem
(2)	Region	: North East
(3)	Governorate	: Bizerte
(4)	Delegation	: Bizerte Sud
(5)	Surface	: 600 ha
(6)	Operation Date	: 1991

The GIC Beni Meslem (GIC Description Form is shown in Table A.4.1) was created in 1991. It is an extension of the SONEDE network. Water source is a tube well. The investment cost of the project is of 23,000DT. GIC manage a small network of 1.6km. This system provides water to 65 families through 5 communal taps, 7 yard taps, 2 individual connections: 1 primary school and 1 dispensary.

The water costs is between 0.4DT/m^3 and 0.5DT/m^3.

The water volume consumed has jumped from 3,000m^3 in 1996 to 12,270m^3 in 1999. The average of everyday consumption by inhabitant has jumped from 25 liters in 1996 to 102 liters in 1999.

This increase is due to:

(1) The increase of the cultivated surfaces in tree culture (olive tree) which has an appropriate irrigation system
(2) The increase of the number of the sheep population and mainly the expansion of cattle breading (milky), a high water consumer
(3) Vegetable garden facilities whose proportion has jumped from 5% to 20%
(4) The improvement of housing conditions

Between 1996 and 1999 the expenses of GIC tripled, going from 772DT to 2,015DT which is due, on the one hand, to the increase of the consumption and the exploitation expenses, and on the other hand by the more and more confirmed involvement of GIC to take care not only of the management expenses, but also of the expenses of operation and maintenance.

At the same time the GIC incomes has also tripled, going from 1,044DT in 1996 to 3,241DT in 1999. This income sufficiently covers the expenses which show the development of community spirit.

However, GIC cannot yet cover the total fees of the budget for exploitation particularly those of up keeping and maintenance of which main part is taken care of by other parties

4.2.2 GIC "Ouled Alouane"

(1) Name of GIC : Ouled Alouane
(2) Region : Central East
(3) Governorate : Sousse
(4) Delegation : Sidi El Heni
(5) Surface : 2,400 ha
(6) Operation Date : 1990

The GIC Ouled Alouan (GIC Description Form is shown in Table A.4.2) was created in 1990. It is an extension of the SONEDE network. The investment cost of the project is of 78,000DT. GIC manage a small network of 5.4km. This system provides water to 120 families through *potences*.

The water costs is 1DT/m^3.

The water volume consumed has jumped from 35.40m^3 in 1996 to 46.90m^3 in 1999. The average of everyday consumption by inhabitant has jumped from 15 liters in 1996 to 40 liters in 1999.

This increase is due to:

(1) The increase of the cultivated surfaces in tree culture (olive tree) which has

an appropriate irrigation system

(2) The increase of the number of the sheep population

(3) Vegetable garden facilities whose proportion has tripled from 5% to 15%

(4) The reduction of the water cost and distances to fetch it in

Between 1997 and 1999 the expenses of GIC jumped from 2,868DT to 3,400DT which is due, on the one hand, to the increase of the consumption and the exploitation expenses and on the other hand by the more and more confirmed involvement of GIC to take care not only of the management expenses, but also of sum of the expenses of care and maintenance.

At the same time the GIC's income has jumped from 4,062DT in 1996 to 5,152DT in 1999. This income covers sufficiently the expenses which show the development of the spirit of the community. However, this GIC cannot cover the total fees of the budget for exploitation particularly those of the operation and maintenance.

4.2.3 GIC "Ksar El Hammem"

(1) Name of GIC : Ksar El Hammem

(2) Region : Central West

(3) Governorate : Sidi Bouzid

(4) Delegation : Regueb

(5) Surface : 13,000 ha

(6) Operation Date : 1990

The GIC Ksar El Hammam (GIC Description Form is shown in Table A.4.3) was created in 1990 in order to manage a system of rural drinkable water and which was made on a tube well. The investment cost of the project was 482,000DT. This system provides water to 370 families and it consists of a tube well, a pumping station, a distribution network that is 31.9km long and has 5 tanks. The distribution of the water is made possible by one communal tap, 7 *potences*, 42 yard taps, and 9 individual connections for public facilities.

GIC sells water between 0.4DT/m^3 and 0.5DT/m^3.

The average produced volume of water is of 50,769 m^3, which gives an average everyday consumption of 76 liters per inhabitant.

This rather high rate of consumption is caused by:

(1) The increase of the cultivated surfaces in tree culture which benefits from an appropriate irrigation system
(2) The increase of the number of sheep population and particularly the expansion of cattle breeding (producing milk), a high water consumer
(3) Vegetable garden facilities
(4) Henhouse facilities
(5) The improved housing conditions

Between 1997 and 1999 the expenses of GIC jumped from 6,233DT to 8,768DT which is due, on the one hand to the increase of the consumption and the exploitation expenses included, and on the other hand by the more and more confirmed involvement of GIC to take care not only of the management expenses, but also of the expenses of operation and maintenance.

The GIC's income has jumped from 12,730DT in 1997 to 14,814DT in 1999. This income covers sufficiently the expenses which show the development of the spirit of the community.

However, the GIC cannot yet cover the total fees of the budget exploitation particularly those of up keeping and maintenance.

4.2.4 GIC "Modhar"

(1) Name of GIC : El Modhar
(2) Region : South East
(3) Governorate : Medenine
(4) Sub Division : Beni Khedeche
(5) Surface : 4,500 ha

(6) Date of Being Put Into Service : 1990

The GIC El Modhar (GIC Description Form is shown in Table A.4.4) was created in 1990 in order to manage a system of rural drinkable water of which water source is a shallow well. The investment cost of the project was 120,372DT. This system provides water to 119 families and it consists of a shallow well, a pumping station, a distribution network which has 9.078km long pipeline and has one tank. The distribution of the water is made possible by 11 communal taps, a *potence*, 41 yard taps and 8 individual connections for public institutions;

GIC sells water between 0.3DT/m^3 and 0.45DT/m^3.

The average produced volume of water is of 10,300m^3, for an average daily consumption of 46 liters per inhabitant.

This rather high rate of consumption is caused by:

(1) The increase of the number of sheep and particularly the expansion of the cattle breeding
(2) The development of facilities for vegetables gardening
(3) The improving conditions of housing
(4) The servicing is assured to small barracks and customs guard.

Between 1997 and 1999 the yearly average expenses of GIC are of 3,000DT with a slight increase per year due to the increase of the consumption and the exploitation expenses relative to it. And also by the more and more confirmed involvement of the GIC which is represented in its taking charge not only the managing expenses but also some of the expenses of the operation and the maintenance of the system.

At the same time the annual average income of the GIC is of 3,250DT. These incomes are sufficient to cover the spending which show the development of community spirit.

However, the GIC cannot yet cover the total fees of the budget for exploitation and especially those of the maintenance.

4.3 Outcome of the Study

4.3.1 GIC "Beni Meslem"

The creation of the water system managed by the GIC of Beni Meslem has allowed the beneficiary population to have a better quality of water (a ground water instead of shallow well service). In fact the consumption of households has increased by four times during these four years, which generated the following:

(1) The family health care has been positively affected because the drainage system of the used water in houses have jumped from 20% before the creation of the project to 45% after the creation of the project.
(2) The proportion of household that has kitchens has jumped from 30% before the creation of the project to 70% after the project.
(3) Women have more free time. Set from water fetching, the woman divides her free time between housekeeping and children.
(4) Tree culture which is a more stable source of income than cereal culture positively developed thanks to irrigation during draught.
(5) Exodus of population did not occur with an improved water availability.
(6) The cattle breeding becomes better thanks to the development of imported cows (milky race).

The system of drinkable water with other economic and social factors allowed the stabilization of the population and the reduction of migration towards coastal and neighboring cities. The economical consequences of the exodus decreased from 5% to 2%

We should note, however, due to the increase of water consumption, the drainage for used water systems is still under implementation. In fact 55% of householders do not yet have the facility. In addition, the systems already existing are not in compliance with standards. Very often there are pits instead of septic tanks. If we do not remedy the present condition, the site as the environment would be polluted as well as the environment.

4.3.2 GIC "Ouled Alouane"

The creation of the water system managed by the GIC of Ouled Alouan has allowed the beneficiaries a reduction in time spent to fetch water and a decrease in fatigue:

(1) An important reduction of water cost
(2) The use of conventional water source such as a shallow well, etc. have reduced their need to store water
(3) A better availability for people to spend time in agriculture particularly in arboricultural

In addition, the water supply system has generated the following in the community:

(1) The family health care has been positively affected because the drainage systems of the used water in houses have jumped from 30% before the creation of the project to 70% after the project.
(2) The proportion of households that have kitchens has jumped from 20% before the creation of the project to 90% after the project.
(3) The cattle breeding of imported race (milky) is slowly introduced

However, water consumption is relatively weak because of the charge required by SONEDE.

4.3.3 GIC "Ksar El Hammem"

The creation of the water system managed by the GIC of Ksar El Hammam has allowed the beneficiaries to have a better quality of water (a groundwater instead of shallow well service).

In fact the consumption per capita averages 60 to 80 liters per day, which generated the following:

(1) The family health care has been positively affected because the drainage systems of the used water in houses have jumped from 20% before the realization of the project to 90% after the project.

(2) The proportion of the buildings in stone has jumped from 30% before the realization of the water supply system to 90% after the project.

(3) The proportion of households that have kitchens has jumped from 25% before the creation of the project to 80% after the project.

(4) The noticeable increase of sheep population.

(5) The promotion of henhouses which represent a new source of income and which contribute to stabilize the population.

(6) The development of many handicraft activities for women represented by weaving carpet and traditional blankets at home.

(7) Slight decrease of the agricultural activities of women taken over by men, set free from the water fetching. This beneficial change has encouraged women to look for a more profitable activity.

(8) A small business such as local groceries, handicraft, etc. generates a noticeable improvement of the incomes per family.

(9) The tree cultivation, a source of a more stable income than cereal cultivation has developed due to irrigation, especially in a dry season.

The system of drinkable water with other economic and social factors allowed the reduction of migration towards coastal and neighboring cities

4.3.4 GIC "Modhar"

The creation of the water supply system managed by the GIC of El Modhar has allowed the beneficiaries to have a better quality of water than collected rainwater and to benefit from a bigger quantity.

In fact, the permanent presence of water in the households brought the following:

(1) The family health care has been positively affected because the draining systems of the used water in houses have jumped from only 1% before the creation of the project to 45% after the project.

(2) The proportion of households that have kitchens has jumped from 2% before the creation of the project to 45% after the project.

(3) The noticeable increase of sheep population

The combination of drinkable water system with other socio-economic factors such as electricity, paved path linking the area of the project with the village of Beni Khdeche allowed to stabilize the population and to reduce the migration and exodus.

4.4 Conclusions and Recommendations

As are described in every preliminary evaluation of every GICs studied here, socio-economic changes brought out by the introduction of the GIC are remarkably great and in favor of individual beneficiaries and their community.

In economic terms, it brings out increase of income supported by diversification of income sources such as the development of tree culture and increase in number of livestock.

Cost of $1m^3$ of supplied water is greatly reduced causing much more consumption of reliable water that brings above mentioned income increase.

In social terms, hygienic and health consideration is remarkably improved with much improved quality and quantity of water supply at the same time bringing out improved kitchen and drainage facilities. Daily calendar activities are more positively affected, reducing time for fetching water causing diversification of activities into cultivating, housekeeping, children care and may be resting also causing economically favorable impacts. With improved public services not only in water supply but also power supply, improved means of transport (roads) and educational, administrative and commercial institutions, together with increased income level, population exodus to urban area is considerably reduced.

Although it is not described here, the solidarity of the community is supposed to be much strengthened through joining into daily operation/maintenance activities of the GIC.

All those positive and favorable impacts occurred in a rather short time proving the needs and function of the rural water supply program and the rural water supply system at the sites where it was implemented.

Considering that nearly two-thirds of the rural population has not yet benefited from the program, further promotion and development of the program is strongly recommended to cover majority of the rural population, if not all of them.

However, as has been discussed in the Macro Aspects Study of Chapter 3 and in the Micro Aspects Study of Chapter 4, existing shortage/lack of available data/indicators /information is apparent in every level of administration and actual management of GICs. It is, therefore, recommended to formulate a built-in socio-economic data/indicators/information monitoring, collection, compilation and processing system into the management system of GICs, preferably utilizing the result of an independent study for the system concerned. In that case, the system should be formulated so as to be able to incorporate it into already existing GICs.

At present, financial balance between income and daily operation/maintenance expense is doing fairly well in every GICs studied. However, they cannot cope with the costs, either for initial investment of facilities or for exploitation of water resources. In this field of financing, support from the State should be maintained for a considerable time period.

Tables

Table A.3.1 Enquiry to Sidi Bouzid Governorate

Governorate	**SIDI BOUZID**							
Localization	CENTRAL WEST							
Surface (ha)	698 400							
Date of beginning								
		1994	1995	1996	1997	1998	1999	2000
Data on the GIC of Governorate	Total number of GIC	-	-	94	102	100	93	-
	Nb. Subscribed family	-	-	12958	13247	14446	15914	-
	Nb.of users	-	-	71269	72856	79453	87527	-
	Nb. of BF & brackets	-	-	566	566	588	630	-
	Nb. Public Administration as users	-	-	188	190	207	216	-
	Nb. Linking up to lodging	-	-	362	390	390	400	-
	Water volume consummated per year (m^3)	-	-	1387997	1605755	1315926	1112463	-
	Yearly incomes of GIC (DT)	-	-	202404	278475	282447	274238	-
	Yearly expenses paid by GIC (DT)	-	-	183607	253876	271526	259658	-
Social economical factors during the period	Population (1000)							
	Male	190.4	194.5	198.3	202.2	206.1	210.1	214.1
	Female	186.7	190.7	194.5	198.3	202.1	205.9	209.8
	Total	377.1	385.2	392.8	400.5	408.2	416.0	423.9
	Rate of rural population (%)	78	77	76	75	74	73	72
	Average yearly incomes per inhabitant							
	DT/year	976	1025	1761	1130	1186	1246	1308
	DT/	-	-	-	-	-	-	-
	Impacts of diseases (Description)							
In all Tunisian territory	Typhoid fever	315	340	252	123	108	-	-
	Viral hepatitis	5990	6147	5850	4806	4286	-	-
Important changes in life style during the period	Livestock							
	Sheep		538285	566616	596438	627830	661222	694283
	Cows	41007	43050	45203	47462	59270	62234	65345
	Rate of drinkable water service rate (%)	68,4	73,5	73,5	74,6	77,3	80,1	-
	Rate of electricity service STEG (%)	51,3	58,3	63,5	69,3	77,2	82,3	-
	Girls schooling (2nd secondary level)	15534	16824	18653	19421	20198	21006	-
Final assessment of the impacts occurred by the implementation of rural water project	Other important questions appeared during the period (positive or negative)							

Table A.3.2 Enquiry to Nabeul Governorate

Governorate	**NABEUL**							
Localization	NORTH EAST							
Surface (ha)	278 200							
Date of beginning								
		1994	1995	1996	1997	1998	1999	2000
Data on the GIC of Governorate	Total number of GIC	-	-	56	52	59	58	-
	Nb. Subscribed family	-	-	8890	8184	9062	9062	-
	Nb.of users	-	-	44450	40920	45310	45310	-
	Nb. of BF & brackets	-	-	389	369	422	424	-
	Nb. Public Administration as users	-	-	103	105	118	117	-
	Nb. Linking up to lodging	-	-	1590	3160	4443	641.9	-
	Water volume consummated per year (m^3)	-	-	647779	722039	898002	1005250	-
	Yearly incomes of GIC (DT)	-	-	259220	192696	227793	251998	-
	Yearly expenses paid by GIC (DT)	-	-	184062	194082	279352	282776	-
Social economical factors during the period	Population (1000)							
	Male	296.6	302.8	307.4	312.0	316.6	321.3	325.8
	Female	282.0	287.9	292.2	296.6	301.1	305.4	309.8
	Total	578.6	590.7	599.6	608.6	617.7	626.7	635.6
	Rate of rural population (%)	35	34	33	32	31	30	29
	Average yearly incomes per inhabitant							
	DT/year	1600	1680	1764	1852	1945	2042	2145
	DT/	-	-	-	-	-	-	-
	Impacts of diseases (Description)							
In all Tunisian territory	Typhoid fever	315	340	252	123	108	-	-
	Viral hepatitis	5990	6147	5850	4806	4286	-	-
Important changes in life style during the period	Livestock							
	Sheep	152310	159925	161310	169375	177844	181310	190375
	Cows	65500	68775	72214	75824	79616	82510	86636
	Rate of drinkable water service rate (%)	73.9	75.9	82.2	84.1	85.9	87.0	-
	Rate of electricity service STEG (%)	84.9	88.9	93.1	96.4	97.2	98.8	-
	Girls schooling (2nd secondary level)	18817	2002	21540	23493	25687	27912	-
Final assessment of the impacts occurred by the implementation of rural water project	Other important questions appeared during the period (positive or negative)							

Table A.3.3 Potable Water Supply Ratio by Governorate (year-end)

(unit : %)

District	Governorate	1994			1995			1996			1997			1998*			1999**			2000***		
		Totality	Urban	Rural	Totality	Urban	Rural	Totality	Urban	Rural	Totality	Urban	Rural	Totality	Urban	Rural	Totality	Urban	Rural	Totality	Urban	Rural
Tunis	Tunis	97.9	97.9	-	97.9	97.9	-	97.9	97.9	-	97.9	97.9	-	98.1	98.1	-	98.6	98.6	-	98.7	98.7	-
	Ariana	91.6	97.8	61.5	92.2	98.3	62.7	92.8	98.4	64.4	93.0	98.5	65.1	93.4	98.6	66.2	93.6	98.6	67.2	94.2	99.2	67.7
	Ben Arous	95.1	98.2	63.2	95.6	98.4	66.1	95.6	98.4	66.4	96.0	98.6	66.4	96.5	98.9	70.4	96.9	99.2	70.4	97.1	99.4	70.5
	(Average)	**95.5**	**97.9**	**62.0**	**95.8**	**98.1**	**63.6**	**95.9**	**98.1**	**65.0**	**96.1**	**98.2**	**65.5**	**96.3**	**98.4**	**67.3**	**96.7**	**98.7**	**68.0**	**97.0**	**99.0**	**68.4**
North East	Nabeul	71.1	87.0	38.2	73.7	90.3	39.1	75.6	92.4	40.3	76.6	93.9	40.4	77.5	95.4	40.4	77.7	95.7	40.6	78.6	96.9	40.9
	Zaghouan	53.9	98.7	28.8	55.0	99.1	30.2	55.3	99.3	30.8	55.4	99.5	31.0	55.9	99.6	31.8	56.1	99.7	32.6	56.2	99.8	33.2
	Bizerte	68.8	96.8	24.5	69.3	97.3	24.8	70.1	97.5	25.9	70.3	97.6	26.1	70.7	97.9	26.5	71.2	98.1	26.9	72.3	99.2	27.7
	(Average)	**68.2**	**91.7**	**31.0**	**69.9**	**93.6**	**31.7**	**71.2**	**94.9**	**32.7**	**71.8**	**95.8**	**32.9**	**72.4**	**96.7**	**33.3**	**72.7**	**96.9**	**33.7**	**73.5**	**98.0**	**34.3**
North West	Beja	54.9	98.5	24.9	55.3	99.3	25.6	56.0	99.7	26.1	57.4	99.7	27.7	58.3	99.7	28.9	58.8	99.7	29.2	59.5	99.7	29.5
	Jendouba	39.1	99.2	18.4	40.6	99.6	20.1	42.1	99.6	21.5	42.7	99.7	22.1	43.8	99.8	23.2	44.8	99.8	24.3	45.8	99.8	25.2
	Le Kef	51.4	89.2	15.0	51.8	89.5	15.3	52.4	89.7	15.7	53.3	90.0	17.0	55.1	92.3	17.9	56.1	93.5	18.8	56.4	94.1	19.0
	Siliana	41.9	95.6	14.2	42.9	97.0	14.7	43.9	98.0	15.3	44.2	98.3	15.8	44.7	98.5	16.4	45.0	98.7	17.4	45.2	99.0	18.3
	(Average)	**46.4**	**95.3**	**18.5**	**47.3**	**95.9**	**19.5**	**48.3**	**96.3**	**20.4**	**49.1**	**96.5**	**21.2**	**50.2**	**97.3**	**22.2**	**50.9**	**97.7**	**23.0**	**51.5**	**97.9**	**23.5**
Central West	Kairouan	42.2	98.3	16.1	43.0	98.8	16.6	44.8	99.1	18.6	46.4	99.2	20.4	47.9	99.4	22.2	49.4	99.6	23.8	50.2	99.7	24.4
	Kasserine	39.7	92.8	6.8	40.9	95.1	7.1	41.9	97.0	7.1	42.8	97.7	7.8	43.7	98.4	8.6	44.2	98.6	8.9	44.7	98.7	9.3
	Sidi Bouzid	28.0	93.4	10.3	29.6	94.0	10.6	30.3	94.5	11.0	31.4	95.0	12.4	33.5	95.5	14.4	35.3	95.7	16.5	36.7	96.4	17.9
	(Average)	**37.7**	**95.2**	**11.7**	**38.5**	**96.4**	**12.1**	**39.7**	**97.4**	**13.0**	**41.0**	**97.7**	**14.3**	**42.5**	**98.2**	**15.9**	**43.8**	**98.4**	**17.4**	**44.6**	**98.6**	**18.2**
Central East	Sousse	91.5	98.5	64.7	92.3	99.1	66.4	93.0	99.8	66.5	93.0	99.8	66.6	93.2	99.9	67.0	93.4	99.9	67.8	93.7	99.9	68.2
	Monastir	96.7	96.7	-	97.8	97.8	-	97.8	97.8	-	98.4	98.4	-	98.6	98.6	-	99.0	99.0	-	99.6	99.6	-
	Mahdia	55.5	88.6	26.5	59.0	89.8	31.8	62.0	92.7	34.8	64.3	95.1	36.7	67.4	97.1	40.6	68.7	97.3	42.7	69.8	97.7	44.0
	Sfax	70.4	95.2	18.9	72.4	96.8	22.1	73.0	96.8	23.2	73.4	97.1	24.3	74.1	97.8	25.4	74.7	98.4	26.5	75.0	98.9	27.0
	(Average)	**77.9**	**95.8**	**29.8**	**79.9**	**96.9**	**33.4**	**80.8**	**97.4**	**34.9**	**81.5**	**97.9**	**36.1**	**82.4**	**98.5**	**37.9**	**83.0**	**98.8**	**39.1**	**83.5**	**99.3**	**39.6**
South West	Gafsa	75.9	98.3	18.7	76.7	98.5	19.4	77.0	98.7	20.0	77.5	99.0	20.6	78.2	99.3	21.2	78.7	99.3	22.2	79.6	99.8	23.9
	Tozeur	95.0	99.5	82.3	95.9	99.5	85.8	96.3	99.6	87.0	96.6	99.6	87.8	97.0	99.6	89.2	97.2	99.7	89.6	97.5	99.8	90.5
	Kebili	89.5	99.1	77.5	90.3	99.5	79.1	90.4	99.5	79.3	90.5	99.6	79.2	91.7	99.6	81.9	92.2	99.7	82.8	92.7	99.8	83.6
	(Average)	**82.4**	**98.7**	**47.4**	**83.3**	**98.9**	**49.3**	**83.6**	**99.1**	**49.6**	**84.0**	**99.2**	**50.2**	**84.8**	**99.4**	**51.7**	**85.2**	**99.5**	**52.8**	**85.9**	**99.8**	**54.1**
South East	Gabes	77.5	96.8	39.7	78.3	97.2	41.2	79.0	97.4	42.3	80.2	97.9	44.2	81.2	98.3	45.9	82.1	98.5	47.8	83.0	98.9	49.3
	Medenine	61.6	80.5	28.5	65.5	85.1	30.6	67.2	85.4	31.3	68.4	86.0	33.4	70.8	88.0	36.4	71.8	89.1	37.5	73.1	90.2	39.3
	Tatouine	61.7	83.6	30.9	63.9	84.3	35.2	66.2	84.9	39.5	68.3	85.9	43.0	71.1	88.4	45.9	72.8	89.5	48.2	74.7	91.1	50.5
	(Average)	**67.6**	**87.3**	**32.9**	**70.1**	**89.7**	**35.1**	**71.5**	**90.0**	**36.8**	**72.8**	**90.6**	**39.0**	**74.8**	**92.0**	**41.5**	**75.8**	**92.8**	**43.1**	**77.1**	**93.7**	**44.8**
AVERAGE TUNISIA		**70.1**	**95.3**	**25.1**	**71.4**	**96.2**	**26.5**	**72.4**	**96.7**	**27.6**	**73.2**	**97.0**	**28.6**	**74.2**	**97.6**	**30.0**	**74.9**	**97.9**	**31.1**	**75.6**	**98.4**	**31.9**

Source : "Rapport Annuel sur les Indicatoeurs d'Infrastructure 1999" (Institut National de Statistique : INS, Min. du Developpement Economique)

* semi-approved figures ** probable figures *** projected figures

Table A.3.4 Projected Potable Water Supply Ratio in the 9th Development Plan (1997～2001)

(Unit : %)

District	Governorate	1997			1998			1999			2000			2001		
		Totality	urban	rural	Totality	urban	rural	Totality	urban	rural	Total	urban	rural	Totality	urban	rural
Tunis	Tunis	98.8	98.8	-	98.9	98.9	-	99.0	99.0	-	99.6	99.6	-	99.8	99.8	-
	Ariana	93.0	98.5	65.5	93.6	99.0	66.0	94.4	99.6	66.8	94.8	99.8	67.9	95.1	99.8	69.1
	Ben Arous	96.2	99.1	65.0	96.5	99.3	65.5	96.7	99.4	65.6	96.9	99.4	66.6	97.1	99.4	68.0
	(Average)	**96.5**	**98.8**	**65.4**	**96.8**	**99.0**	**65.9**	**97.1**	**99.2**	**66.5**	**97.6**	**99.6**	**67.5**	**97.8**	**99.7**	**68.8**
North East	Nabeul	77.3	94.4	40.9	78.5	95.8	41.3	78.8	95.8	42.0	79.6	96.4	42.2	80.6	97.3	43.0
	Zaghouan	57.1	99.6	32.5	58.2	99.7	33.7	58.9	99.7	34.8	59.8	99.8	35.8	61.2	99.9	37.4
	Bizerte	70.5	96.8	26.7	70.8	96.8	27.0	71.4	97.3	27.4	72.5	98.2	28.3	73.1	98.2	29.3
	(Average)	**72.4**	**95.7**	**33.7**	**73.2**	**96.5**	**34.2**	**73.7**	**96.6**	**34.9**	**74.6**	**97.3**	**35.6**	**75.5**	**97.8**	**36.5**
North west	Beja	57.1	99.4	27.5	58.2	99.5	28.8	58.9	99.6	29.7	59.1	99.7	29.7	59.7	99.8	30.1
	Jendouba	42.8	99.7	22.2	43.2	99.7	22.5	44.4	99.7	23.8	45.1	99.8	24.3	46.1	99.9	25.4
	Le Kef	53.8	91.0	17.1	55.4	92.6	18.0	56.7	94.3	18.6	57.3	94.3	19.3	58.1	94.9	19.8
	Siliana	45.3	98.5	16.6	46.0	98.6	17.0	47.4	99.1	18.6	47.8	99.3	18.9	48.5	99.7	19.2
	(Average)	**49.4**	**96.7**	**21.5**	**50.3**	**97.3**	**22.1**	**51.4**	**98.0**	**23.2**	**51.9**	**98.0**	**23.7**	**52.7**	**98.3**	**24.3**
Central west	Kairouan	45.9	99.1	20.1	47.3	99.2	21.7	48.6	99.3	23.3	49.8	99.5	24.6	50.6	99.5	25.4
	Kasserine	42.7	97.6	7.8	43.4	97.8	8.4	44.2	97.9	9.1	44.7	98.1	9.6	45.1	98.2	9.8
	Sidi Bouzid	31.7	96.3	12.1	32.8	96.8	12.9	33.8	97.4	13.8	34.7	97.9	14.5	35.2	98.1	14.8
	(Average)	**40.9**	**98.0**	**14.1**	**41.9**	**98.2**	**15.2**	**43.0**	**98.4**	**16.3**	**43.9**	**98.6**	**17.2**	**44.5**	**98.7**	**17.7**
Central East	Sousse	93.0	99.5	67.4	93.3	99.6	68.1	93.5	99.6	68.5	93.7	99.7	69.2	94.3	99.8	71.0
	Monastir	98.5	98.5	-	99.0	99.0	-	99.3	99.3	-	99.4	99.4	-	99.7	99.7	-
	Mahdia	63.4	94.3	35.9	65.2	95.3	37.8	66.8	96.7	39.5	68.5	98.4	40.9	70.1	99.0	42.9
	Sfax	74.2	97.9	24.7	74.9	97.9	26.1	75.7	97.9	27.9	76.5	98.1	29.4	77.1	98.2	30.4
	(Average)	**81.7**	**98.1**	**36.2**	**82.4**	**98.4**	**37.6**	**83.1**	**98.6**	**39.1**	**83.9**	**98.9**	**40.4**	**84.6**	**99.1**	**41.9**
South west	Gafsa	77.7	99.3	24.0	78.4	99.8	24.5	78.7	99.8	24.9	79.1	99.8	25.4	79.5	99.8	25.9
	Tozeur	96.3	99.7	86.7	96.6	99.7	87.5	96.8	99.7	88.3	96.9	99.8	88.4	97.0	99.8	88.7
	Kebili	92.0	99.9	81.9	92.2	99.9	82.3	92.6	99.9	83.0	92.7	100.0	83.1	93.0	100.0	83.6
	(Average)	**84.4**	**99.5**	**51.7**	**84.9**	**99.8**	**52.3**	**85.2**	**99.8**	**52.8**	**85.5**	**99.8**	**53.3**	**85.8**	**99.8**	**53.8**
South East	Gabes	79.9	97.6	44.0	80.6	98.2	44.9	81.4	98.7	45.8	82.0	99.1	46.3	82.5	99.4	46.6
	Medenine	68.0	86.8	34.2	69.0	86.8	36.7	70.0	86.9	38.8	71.1	87.6	40.5	72.2	88.3	41.8
	Tatouine	68.4	89.5	42.1	70.9	91.8	44.7	73.1	92.9	48.3	74.9	93.6	51.2	76.6	95.5	52.2
	(Average)	**72.5**	**91.4**	**39.1**	**73.6**	**91.9**	**41.0**	**74.7**	**92.3**	**43.0**	**75.8**	**92.6**	**44.5**	**76.7**	**93.6**	**45.4**
AVERAGE TUNISIA		**73.4**	**97.4**	**28.9**	**74.2**	**97.7**	**29.9**	**74.9**	**98.0**	**31.0**	**75.7**	**98.4**	**31.9**	**76.3**	**98.6**	**32.6**

Source : "Rapport Annuel sur les Indicateurs d'Infrastructure 1999"(Institut National de la Statistique : INS)

Table A.3.5 Comparison of Potable Water Supply Ratio in the Rural Area (Actual Performance and the Projection by the 9th Plan)

(Unit : %)

District	Governorate	1997			1998			1999			2000		
		Actual	Projection	*balance*	Actual	Projection	*balance*	Actual	Projection	*balance*	Actual	Projection	*balance*
Tunis	Tunis	-	-	-	-	-	-	-	-	-	-	-	-
	Ariana	65.1	65.5	*-0.4*	66.2	66.0	*0.2*	67.2	66.8	*0.4*	67.7	67.9	*-0.2*
	Ben Arous	66.4	65.0	*1.4*	70.4	65.5	*4.9*	70.4	65.6	*4.8*	70.5	66.6	*3.9*
	(Average)	**65.5**	**65.4**	***0.1***	**67.3**	**65.9**	***1.4***	**68.0**	**66.5**	***1.5***	**68.4**	**67.5**	***0.9***
North East	Nabeul	40.4	40.9	*-0.5*	40.4	41.3	*-0.9*	40.6	42.0	*-1.4*	40.9	42.2	*-1.3*
	Zaghouan	31.0	32.5	*-1.5*	31.8	33.7	*-1.9*	32.6	34.8	*-2.2*	33.2	35.8	*-2.6*
	Bizerte	26.1	26.7	*-0.6*	26.5	27.0	*-0.5*	26.9	27.4	*-0.5*	27.7	28.3	*-0.6*
	(Average)	**32.9**	**33.7**	***-0.8***	**33.3**	**34.2**	***-0.9***	**33.7**	**34.9**	***-1.2***	**34.3**	**35.6**	***-1.3***
North west	Beja	27.7	27.5	*0.2*	28.9	28.8	*0.1*	29.2	29.7	*-0.5*	29.5	29.7	*-0.2*
	Jendouba	22.1	22.2	*-0.1*	23.2	22.5	*0.7*	24.3	23.8	*0.5*	25.2	24.3	*0.9*
	Le Kef	17.0	17.1	*-0.1*	17.9	18.0	*-0.1*	18.8	18.6	*0.2*	19.0	19.3	*-0.3*
	Siliana	15.8	16.6	*-0.8*	16.4	17.0	*-0.6*	17.4	18.6	*-1.2*	18.3	18.9	*-0.6*
	(Average)	**21.2**	**21.5**	***-0.3***	**22.2**	**22.1**	***0.1***	**23.0**	**23.2**	***-0.2***	**23.5**	**23.7**	***-0.2***
Central west	Kairouan	20.4	20.1	*0.3*	22.2	21.7	*0.5*	23.8	23.3	*0.5*	24.4	24.6	*-0.2*
	Kasserine	7.8	7.8	*±0.0*	8.6	8.4	*0.2*	8.9	9.1	*-0.2*	9.3	9.6	*-0.3*
	Sidi Bouzid	12.4	12.1	*0.3*	14.4	12.9	*1.5*	16.5	13.8	*2.7*	17.9	14.5	*3.4*
	(Average)	**14.3**	**14.1**	***0.2***	**15.9**	**15.2**	***0.7***	**17.4**	**16.3**	***1.1***	**18.2**	**17.2**	***1.0***
Central East	Sousse	66.6	67.4	*-0.8*	67.0	68.1	*-1.1*	67.8	68.5	*-0.7*	68.2	69.2	*-1.0*
	Monastir	-	-	-	-	-	-	-	-	-	-	-	-
	Mahdia	36.7	35.9	*0.8*	40.6	37.8	*2.8*	42.7	39.5	*3.2*	44.0	40.9	*3.1*
	Sfax	24.3	24.7	*-0.4*	25.4	26.1	*-0.7*	26.5	27.9	*-1.4*	27.0	29.4	*-2.4*
	(Average)	**36.1**	**36.2**	***-0.1***	**37.9**	**37.6**	***0.3***	**39.1**	**39.1**	***±0.0***	**39.6**	**40.4**	***-0.8***
South west	Gafsa	20.6	24.0	*-3.4*	21.2	24.5	*-3.3*	22.2	24.9	*-2.7*	23.9	25.4	*-1.5*
	Tozeur	87.8	86.7	*1.1*	89.2	87.5	*1.7*	89.6	88.3	*1.3*	90.5	88.4	*2.1*
	Kebili	79.2	81.9	*-2.7*	81.9	82.3	*-0.4*	82.8	83.0	*-0.2*	83.6	83.1	*0.5*
	(Average)	**50.2**	**51.7**	***-1.5***	**51.7**	**52.3**	***-0.6***	**52.8**	**52.8**	***±0.0***	**54.1**	**53.3**	***0.8***
South East	Gabes	44.2	44.0	*0.2*	45.9	44.9	*1.0*	47.8	45.8	*2.0*	49.3	46.3	*3.0*
	Medenine	33.4	34.2	*1.2*	36.4	36.7	*-0.3*	37.5	38.8	*-1.3*	39.3	40.5	*-1.2*
	Tatouine	43.0	42.1	*0.9*	45.9	44.7	*1.2*	48.2	48.3	*-0.1*	50.5	51.2	*-0.7*
	(Average)	**39.0**	**39.1**	***0.1***	**41.5**	**41.0**	***0.5***	**43.1**	**43.0**	***0.1***	**44.8**	**44.5**	***0.3***
AVERAGE TUNISIA		**28.6**	**28.9**	***-0.3***	**30.0**	**29.9**	***0.1***	**31.1**	**31.0**	***0.1***	**31.9**	**31.9**	***±0.0***

Source : "Rapport Annuel sur les Indicateurs d'Infrastructure 1999" (Institut National de la Statistique : INS)

Table A.3.6 Actual Rural Population by Water Supply by Governorate (year-end figures

(unit : '000 pp.)

District	Governorate	1994			1995			1996			1997			1998			1999*			2000**		
		Total Rural	Supplied	Unsupplied	Total Rural	Supplied	Unsupplied	Total Rural	Supplied	Unsupplied	Total Rural	Supplied	Unsupplied	Total Rural	Supplied	Unsupplied	Total Rural	Supplied	Unsupplied	Total Rural	Supplied	Unsupplied
Tunis	Tunis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ariana	108.8	66.9	41.9	111.2	69.7	41.5	112.4	72.4	40.0	114.3	74.4	39.9	115.9	76.7	39.2	117.4	78.9	38.5	118.8	80.4	38.4
	Ben Arous	38.8	24.5	14.3	39.6	26.2	13.4	39.8	26.4	13.4	40.3	26.8	13.5	40.7	28.7	12.0	41.0	28.9	12.1	41.3	29.1	12.2
	(sub-total)	**147.6**	**91.4**	**56.2**	**150.8**	**95.9**	**54.9**	**152.2**	**98.8**	**53.4**	**154.6**	**101.2**	**53.4**	**156.6**	**105.4**	**51.2**	**158.4**	**107.8**	**50.6**	**160.1**	**109.5**	**50.6**
North East	Nabeul	207.3	79.2	128.1	209.8	82.0	127.9	211.1	85.1	126.0	212.7	85.9	126.8	214.2	86.5	127.7	215.6	87.5	128.1	216.8	88.7	128.1
	Zaghouan	95.3	27.4	67.9	96.3	29.1	67.2	96.7	29.8	66.9	97.1	30.1	67.0	97.8	31.1	66.7	98.5	32.1	66.4	99.1	32.9	66.2
	Bizerte	201.7	49.4	152.3	203.7	50.5	153.2	204.5	53.0	151.5	205.6	53.7	151.9	206.8	54.8	152.0	207.8	55.9	151.9	208.7	57.8	150.9
	(sub-total)	**504.3**	**156.0**	**348.3**	**509.8**	**161.6**	**348.3**	**512.3**	**167.9**	**344.4**	**515.4**	**169.7**	**345.7**	**518.8**	**172.4**	**346.4**	**521.8**	**175.5**	**346.4**	**524.6**	**179.4**	**345.2**
North West	Beja	190.2	47.4	142.8	190.7	48.8	141.9	190.9	49.8	141.1	191.2	53.0	138.2	191.2	55.3	135.9	191.4	55.9	135.5	191.5	56.5	135.0
	Jendouba	307.2	56.5	250.7	309.6	62.2	247.4	311.0	66.9	244.1	312.4	69.0	243.3	313.5	72.7	240.8	314.4	76.4	238.0	315.1	79.4	235.7
	Le Kef	145.2	21.8	123.4	145.6	22.9	122.7	145.6	22.9	122.7	145.6	24.8	120.8	145.6	26.1	119.5	145.7	27.4	118.3	145.8	27.7	118.1
	Siliana	167.9	23.8	144.1	168.4	25.8	142.6	168.4	25.8	142.6	168.6	26.6	142.0	168.6	27.7	140.9	168.7	29.4	139.3	168.7	30.9	137.8
	(sub-total)	**810.5**	**149.5**	**661.0**	**814.3**	**159.7**	**654.6**	**815.9**	**165.4**	**650.5**	**817.8**	**173.4**	**644.3**	**819.0**	**181.8**	**637.1**	**820.1**	**189.1**	**631.1**	**821.1**	**194.5**	**626.6**
Central West	Kairouan	379.4	61.1	318.3	383.3	63.6	319.7	385.6	71.7	313.9	388.8	79.3	309.5	391.4	86.9	304.5	393.9	93.7	300.2	396.0	96.6	299.4
	Kasserine	245.1	16.7	228.4	248.4	17.6	230.8	250.7	17.8	232.9	253.1	19.7	233.4	255.2	21.9	233.3	257.2	22.9	234.3	259.0	24.1	234.9
	Sidi Bouzid	300.3	30.9	269.4	303.9	32.2	271.7	306.2	33.7	272.5	308.8	38.3	270.5	310.8	44.8	266.0	312.7	51.6	261.1	314.3	56.3	258.0
	(sub-total)	**924.9**	**108.7**	**816.1**	**935.6**	**113.4**	**822.2**	**942.5**	**123.2**	**819.3**	**950.7**	**137.3**	**813.4**	**957.5**	**153.6**	**803.8**	**963.7**	**168.2**	**795.6**	**969.3**	**177.0**	**792.3**
Central East	Sousse	100.4	65.0	35.4	101.8	67.6	34.2	103.0	68.5	34.5	104.1	69.3	34.8	105.0	70.4	34.7	105.9	71.8	34.1	106.6	72.7	33.9
	Monastir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mahdia	190.7	50.5	140.2	192.8	61.3	131.5	194.5	67.7	126.8	196.2	72.0	124.2	198.2	80.5	117.7	200.0	85.4	114.6	201.7	88.7	113.0
	Sfax	282.1	53.3	228.8	285.7	63.1	222.6	287.8	66.8	221.0	290.3	70.5	219.8	292.8	74.4	218.4	295.1	78.2	216.9	297.3	80.3	217.0
	(sub-total)	**573.2**	**168.8**	**404.4**	**580.4**	**192.0**	**388.3**	**585.3**	**203.0**	**382.3**	**590.5**	**211.8**	**378.8**	**596.0**	**225.3**	**370.8**	**601.0**	**235.4**	**365.6**	**605.6**	**241.7**	**363.9**
South West	Gafsa ①	87.0	16.3	70.7	87.6	17.0	70.6	88.0	17.6	70.4	88.2	18.2	70.0	88.4	18.7	69.7	88.4	19.6	68.8	88.4	21.1	67.3
	Tozeur	26.1	21.5	4.6	26.4	22.7	3.7	26.5	23.1	3.4	26.6	23.4	3.2	26.8	23.9	2.9	27.0	24.2	2.8	27.1	24.5	2.6
	Kebili	60.4	46.8	13.6	61.1	48.3	12.8	61.7	48.9	12.8	62.3	49.3	13.0	62.7	51.4	11.3	63.1	52.2	10.9	63.5	53.1	10.4
	(sub-total)	**173.4**	**84.6**	**88.9**	**175.2**	**88.0**	**87.2**	**176.2**	**89.6**	**86.6**	**177.2**	**90.9**	**86.2**	**177.9**	**94.0**	**83.9**	**178.5**	**96.0**	**82.5**	**179.1**	**98.7**	**80.3**
South East	Gabes	111.0	44.1	66.9	112.1	46.2	65.9	112.6	47.6	65.0	113.2	50.0	63.2	113.6	52.1	61.5	113.9	54.4	59.5	114.2	56.3	57.9
	Medenine②	149.9	42.7	107.2	151.2	46.3	104.9	142.8	44.7	98.1	144.0	48.1	95.9	144.8	52.7	92.1	145.6	54.6	91.0	146.4	57.5	88.9
	Tatouine①	57.9	17.9	40.0	58.6	20.6	38.0	59.0	23.3	35.7	59.4	23.2	36.2	59.8	27.4	32.4	60.0	28.9	31.1	60.3	30.5	29.8
	(sub-total)	**318.8**	**104.7**	**214.1**	**322.0**	**113.1**	**208.8**	**314.4**	**115.6**	**198.8**	**316.6**	**121.3**	**195.3**	**318.2**	**132.2**	**186.0**	**319.6**	**137.9**	**181.6**	**320.8**	**144.3**	**176.6**
TOTAL TUNISIA		**3452.6**	**863.7**	**2588.9**	**3487.9**	**923.7**	**2564.3**	**3498.7**	**963.5**	**2535.3**	**3522.8**	**1005.6**	**2517.1**	**3544.0**	**1064.7**	**2479.2**	**3563.2**	**1109.9**	**2453.4**	**3580.5**	**1145.1**	**2435.5**

Source : "Rapport Annuel sur les Indicatoeurs d'Infrastructure 1999" (INS, Min. du Developpement Economiqu

* probable figures   ** provisional figures

① extention of 1994 figures   ② extention of 1996 figures

Table A.3.7 Actual and New Beneficiary of Rural Water Supply

(unit : '000 pp.)

District	Governorate	1994～'95			1995～'96			1996～'97			1997～'98			1998～'99			1999～2000			1994～2000		
		Increased Rural Population	Increased Water Supply	Actual and New Increase	Increased Rural Population	Increased Water Supply	Actual and New Increase	Increased Rural Population	Increased Water Supply	Actual and New Increase	Increased Rural Population	Increased Water Supply	Actual and New Increase	Increased Rural Population	Increased Water Supply	Actual and New Increase	Increased Rural Population	Increased Water Supply	Actual and New Increase	Increased Rural Population	Increased Water Supply	Actual and New Increase
Tunis	Tunis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ariana	2.4	2.8	0.4	1.2	2.7	1.5	1.9	2.0	0.1	1.6	2.3	0.7	1.5	2.2	0.7	1.4	1.5	0.1	10.0	13.5	3.5
	Ben Arous	0.8	1.7	0.9	0.2	0.2	0.0	0.5	0.4	-0.1	0.4	1.9	1.5	0.3	0.2	-0.1	0.3		-0.1	2.5	4.6	2.1
	(sub-total)	**3.2**	**4.5**	**1.3**	**1.4**	**2.9**	**1.5**	**2.4**	**2.4**	**0.0**	**2.0**	**4.2**	**2.2**	**1.8**	**2.4**	**0.6**	**1.7**	**1.7**	**0.0**	**12.5**	**18.1**	**5.6**
North East	Nabeul	2.5	2.8	0.3	1.3	3.1	1.8	1.6	0.8	-0.8	1.5	0.6	-0.9	1.4	1.0	-0.4	1.3	1.2	0.0	9.5	9.5	0.0
	Zaghouan	1.0	1.7	0.7	0.4	0.7	0.3	0.4	0.3	-0.1	0.7	1.0	0.3	0.7	1.0	0.3	0.6	0.8	0.2	3.8	5.5	1.7
	Bizerte	2.0	1.1	-0.9	0.8	2.5	1.7	1.1	0.7	-0.4	1.3	1.1	-0.1	1.0	1.1	0.1	0.9	1.9	1.0	7.0	8.4	1.4
	(sub-total)	**5.5**	**5.6**	**0.1**	**2.5**	**6.3**	**3.8**	**3.1**	**1.8**	**-1.3**	**3.4**	**2.7**	**-0.7**	**3.0**	**3.1**	**0.0**	**2.8**	**3.9**	**1.2**	**20.3**	**23.4**	**3.1**
North West	Beja	0.5	1.4	0.9	0.2	1.0	0.8	0.3	3.2	2.9	0.0	2.3	2.3	0.2	0.6	0.4	0.1	0.6	0.5	1.3	9.1	7.8
	Jendouba	2.4	5.7	3.3	1.4	4.7	3.3	1.4	2.1	0.8	1.1	3.7	2.5	0.9	3.7	2.8	0.7	3.0	2.3	7.9	22.9	15.0
	Le Kef	0.4	1.1	0.7	0.0	0.0	0.0	0.0	1.9	1.9	0.0	1.3	1.3	0.1	1.3	1.2	0.1	0.3	0.2	0.6	5.9	5.3
	Siliana	0.5	2.0	1.5	0.0	0.0	0.0	0.2	0.8	0.6	0.0	1.1	1.1	0.1	1.7	1.6	0.0	1.5	1.5	0.8	7.1	6.3
	(sub-total)	**3.8**	**10.2**	**6.4**	**1.6**	**5.7**	**4.1**	**1.9**	**8.0**	**6.2**	**1.2**	**8.4**	**7.2**	**1.2**	**7.3**	**6.0**	**1.0**	**5.4**	**4.5**	**10.6**	**45.0**	**34.4**
Central West	Kairouan	3.9	2.5	-1.4	2.3	8.1	5.8	3.2	7.6	4.4	2.6	7.6	5.0	2.5	6.8	4.3	2.1	2.9	0.8	16.6	35.5	18.9
	Kasserine	3.3	0.9	-2.4	2.3	0.2	-2.1	2.4	1.9	-0.5	2.1	2.2	0.1	2.0	1.0	-1.0	1.8	1.2	-0.6	13.9	7.4	-6.5
	Sidi Bouzid	3.6	1.3	-2.3	2.3	1.5	-0.8	2.6	4.6	2.0	2.0	6.5	4.5	1.9	6.8	4.9	1.6	4.7	3.1	14.0	25.4	11.4
	(sub-total)	**10.8**	**4.7**	**-6.1**	**6.9**	**9.8**	**2.9**	**8.2**	**14.1**	**6.1**	**6.8**	**16.3**	**9.6**	**6.4**	**14.6**	**8.1**	**5.6**	**8.8**	**3.3**	**44.4**	**68.3**	**23.8**
Central East	Sousse	1.4	2.6	1.2	1.2	0.9	-0.3	1.1	0.8	-0.3	0.9	1.1	0.1	0.9	1.1	0.1	0.7	0.9	0.2	6.2	7.7	1.5
	Monastir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mahdia	2.1	10.8	8.7	1.7	6.4	4.7	1.7	4.3	2.6	2.0	8.5	6.5	1.8	4.9	3.1	1.7	3.3	1.6	11.0	38.2	27.2
	Sfax	3.6	9.8	6.2	2.1	3.7	1.6	2.5	3.7	1.2	2.5	3.9	1.4	2.3	3.8	1.5	2.1	2.1	-0.1	15.2	27.0	11.8
	(sub-total)	**7.2**	**23.2**	**16.1**	**5.0**	**11.0**	**6.0**	**5.2**	**8.8**	**3.5**	**5.5**	**13.5**	**8.0**	**5.0**	**10.1**	**5.2**	**4.6**	**6.3**	**1.7**	**32.4**	**72.9**	**40.5**
South West	Gafsa ①	0.6	0.7	0.1	0.4	0.6	0.2	0.2	0.6	0.4	0.2	0.5	0.3	0.0	0.9	0.9	0.0	1.5	1.5	1.4	4.8	3.4
	Tozeur	0.3	1.2	0.9	0.1	0.4	0.3	0.1	0.3	0.2	0.2	0.5	0.3	0.2	0.3	0.1	0.1	0.3	0.2	1.0	3.0	2.0
	Kebili	0.7	1.5	0.8	0.6	0.6	0.0	0.6	0.4	-0.2	0.4	2.1	1.7	0.4	0.8	0.4	0.4	0.9	0.5	3.1	6.3	3.2
	(sub-total)	**1.6**	**3.4**	**1.8**	**1.0**	**1.6**	**0.6**	**0.9**	**1.3**	**0.4**	**0.7**	**3.1**	**2.3**	**0.6**	**2.0**	**1.4**	**0.6**	**2.7**	**2.2**	**5.5**	**14.1**	**8.6**
South East	Gabes	1.1	2.1	1.0	0.5	1.4	0.9	0.6	2.4	1.8	0.4	2.1	1.7	0.3	2.3	2.0	0.3	1.9	1.6	3.2	12.2	9.0
	Medenine②	1.3	3.6	2.3	-8.4	-1.6	6.8	1.2	3.4	2.2	0.8	4.6	3.8	0.8	1.9	1.1	0.8	2.9	2.1	-3.5	14.8	18.3
	Tatouine①	0.7	2.7	2.0	0.4	2.7	2.3	0.4	0.1	-0.5	0.4	4.2	3.8	0.2	1.5	1.3	0.3	1.6	1.3	2.4	12.6	10.2
	(sub-total)	**3.1**	**8.4**	**5.3**	**-7.6**	**2.5**	**10.0**	**2.2**	**5.7**	**3.5**	**1.6**	**10.9**	**9.3**	**1.4**	**5.7**	**4.4**	**1.4**	**6.4**	**5.0**	**2.0**	**39.6**	**37.5**
TOTAL TUNISIA		**35.3**	**60.0**	**24.7**	**10.8**	**39.8**	**29.0**	**23.9**	**42.1**	**18.2**	**21.2**	**59.1**	**37.9**	**19.4**	**45.2**	**25.7**	**17.3**	**35.2**	**17.9**	**127.9**	**281.4**	**153.4**

Table A.4.1 Beni Meslem GIC Description Form

Description	Before SAEP creation	After SAEP creation
Population	330	330
Number of family who benefit for water	66	66
Different type of source of water source	Natural source	Extension linking up from
Water quality	Rather bad	Good
Water sufficient quantity	Sufficient	Insufficient
People who are in charge of water transport	Mostly women	All the members of the
Distance to achieve to find water	2 Km	20 to 300 meters
Time spent for water transport	1 to 3 hours	5 to 10 minutes
The quality of the infrastructure in the area of the project		
Path	Not paved	Paved path
School	1	1
Mosque	1	1
Dispensary	1	1
Electricity	90%	100%
Sheep population		
Cattle local race	80	100
Cattle imported (milky cows)	15	70
Sheep / Caprinae	30	170
Horse and donkey	0	0
Poultry	200	200
Cultivated surface (ha)		
Cereal growing (ha)	300	300
Fruit trees (ha)	700	1200
Others : vegetable gardens (ha)	3	5
The average Income per year per family	**1500**	**2000**
Different sources of incomes		
· Cereal grown	40%	42%
· Tree culture	25%	30%
· Cattle breading	20%	25%
· Henhouses	10%	1%
· Others (exodus)	5%	2%
Effects of hydrias diseases		
Typhoid Fever		
Viral Hepatitis		
Intestinal infection by the children		
Little stones in kidney		
Others causes of parasites		
Changes in the activities calendar		
Different sorts of men activities :		
· Water transport	0%	0%
· Agriculture	50%	60%
· Cattle breading	40%	40%
· Business	0%	0%
· Towns Exodus	10%	0%
Different sorts of women activities :		
· Water transport	30%	5%
· Agriculture	25%	25%
· Cattle breading	25%	25%
· Handy crafts	0%	0%
· housekeeping	10%	25%
· Children bringing up	10%	20%
Other important changes in life conditions		
Average cost per m^3 of water (TD/m^3)	free	0.435
Average consumption of water per inhabitant per day	5	45
House stone built / The total number of the houses	60%	80%
Individual draining of used water /house	20%	45%
Sanitary bloc (Shower W/C)/house	25%	55%
Kitchen /house (%)	30%	70%
Small gardens /household	5%	20%
Improvement of the cattle breeding	10%	40%
Small handicrafts and scale activities	0	0
Girls Schooling (%)	45%	80%
Business development (grocers) (units)	1	2

Table A.4.2 Ouled Alouan GIC Description Form

Description	Before SAEP creation	After SAEP creation
Population	342	586
Number of families who benefit from water	70	120
Different type of source of water source	Public brackets SONEDE	Linking up SONEDE
Water quality	Good	Good
Water quantity sufficient	Insufficient	Sufficient
People who are in charge of water transport	Chief family Water sellers	All the members of the
Distance to achieve to find water	3 to 4 Km	20 to 250 m
Time spent for water transport	1 to 3 hours	5 to 10 minutes
The quality of the infrastructure in the area of the project		
Path	Not suitable for vehicles	Paved path
School	1	1
Mosque	0	0
Dispensary	0	1
Club for teenagers	0	1
Electricity	90%	100%
Sheep population		
Cattle local race	0	0
Cattle imported race (milky cows)	0	15
Sheep / Caprinae	2080	3850
Horse and donkey	85	15
Poultry	0	6000
Cultivated surface (ha)	40	40
Cereal growing (ha)	300	300
Fruit trees (ha)	460	772
Others : vegetable gardens (ha)	0	2
The average Income per year per family	**1600**	**2800**
Different sources of incomes		
· Cereal grown	10%	10%
· Tree culture	35%	50%
· Cattle breading	5%	10%
· Henhouses	0%	10%
· Others (exodus)	50%	20%
Effects of hydrias illness		
Typhoid Fever		No case reported
Viral Hepatitis		
Intestinal infection by the children		
Little stones in kidney		
Others disease caused by parasites		
Changes in the daily calendar activities		
For men :		
Water transport	20%	0%
Agriculture	50%	60%
Cattle breading	20%	30%
Others	10%	10%
For women :		
Water transport	0%	5%
Agriculture	30%	20%
Cattle breading	20%	15%
housekeeping	20%	25%
Children care	20%	25%
Handy crafts	10%	10%
Other important changes in life conditions		
Average cost per m^3 of water (TD/m^3)	5	1
Average consumption of water per inhabitant per day	15 to 20	35 to 40
House stone built / The total number of the houses	80%	90%
Individual draining of used water system /house	30%	70%
Sanitary bloc (Shower W/C)/house	25%	80%
Kitchen /house (%)	20%	90%
Small gardens /household	5%	20%
Improvement of the cattle breeding /household	0%	10%
Small handicrafts and scale activities	0	0
Girls Schooling (%)	60%	70%
Business development (grocers) (unities)	0	1

Table A.4.3 Ksar El Hammem GIC Description Form

Description	Before SAEP Creation	After SAEP creation
Population	1010	1850
Number of families who benefit of water	203	370
Different types of water sources	Over ground wells	Drilling
Water quality	Bad	Good
Sufficient water quantity	Insufficient	Sufficient
People who are in charge of water transport	Family chefWater sellers	All members of family
Distance to achieve to find water	10 Km	0 to1 Km
Time spent for water transport	6 to 8 hours	0 to 1 hour
The quality of the infrastructure in the area of the project		
Path	No good for driving	Paved paths to 70 %
School	1	4
Mosque	0	4
Dispensary	0	1
Electricity	None	100%
Sheep population		
Cattle local race	10	30
Cattle imported race (milky cows)	0	200
Sheep /Caprinae	2500	4000
Horse and donkey	100	150
Poultry	0	10
Cultivated surface (ha)		
Cereal (ha)	1000	1000
Tree culture (ha)	900	3000
Others : family vegetable gardens (ha)	0	5
The average income per year by family (DT)	**1500**	**3000**
Different sources of incomes :		
· Cereal grown	20%	10%
· Tree culture	20%	30%
· Cattle breeding	30%	35%
· Business	0%	15%
· Others (exodus)	30%	10%
Effects of hydrias diseases		
Typhoid fever		
Viral Hepatitis		
Intestinal infection among children		
Stones in kidney		
Other diseases caused by parasites		
Changes in the daily calendar activities		
Different types of men activities :		
· Water transport	10%	5%
· Agriculture	20%	30%
· Cattle breeding	30%	40%
· Business (agricultural business - handicrafts)	0%	25%
· Exodus to other cities	40%	0%
Different types of women activities		
· Water transport	0%	5%
· Agriculture	40%	20%
· Cattle breeding	30%	15%
· Handicrafts	10%	30%
· Ménage	10%	15%
· Children care	10%	15%
Other important changes in life style		
Average cost per m^3 of water (TD/m^3)	3 to 7	0.400 to 1
Average consumption of water /l (per inhabitant per/day)	5 to 10	60 to80
House built with stone (%)	30%	90%
Individual draining of uses water system/house	20%	90%
Sanitary bloc (Shower/WC)/house	15%	80%
Kitchen	25%	80%
Family Gardens (%)	0%	5%
Introduction of cattle breeding (%)	0%	60%
Small handicrafts and scale activities (units)	0	13 (poultries & handicrafts
Girls schooling (%)	10%	60%
Grocers (unit)	0	2

Table A.4.4 El Modhar GIC Description Form

Description	Before SAEP Creation	After SAEP creation
Population	294	593
Number of beneficiary family	59	119
Type of water point	Individual Majels (rain	Over ground wells
Water quality	No treatment	Good and bleach
Water quantity	Irregular	Sufficient
Taking care of water transport	Household	Head of the family
Distance for getting water	To the home	0 to 100 meters
Time spent to carry water	None	0 to 30 minutes
The state of the infrastructure in the area of the project		
Path	Prepared paths	paved paths
School	1 modest school	1 big school
Mosque	1	1
Dispensary	0	1
Electricity	60%	100%
Sheep population		
local race cattle	0	0
Imported race cattle (milky cows)	0	0
Sheep cattle	1000	2500
Equide	10	0
Poultry	0	0
Cultivated surface (ha)	4	5.5
Cereal agriculture (ha)	0.5	0.5
Fruit trees (ha)	3.5	5
Others : (family vegetable gardens /ha)	0	0
Average annual income per family (TD)	**1500**	**2000**
Income structure		
· Cereal agriculture	10%	5%
· Tree culture	15%	20%
· Breeding	30%	40%
· Business	20%	25%
· Others (exodus & migration)	25%	10%
Effect of hydria disease		
Typhoid fever		
Hepatitis		
Children Intestinal infections		
Kidney stone & Other diseases		
Other disease such as parasites		
Change in the daily calendar of activities		
Type of men activities		
· Water transport	10%	5%
· Agriculture	30%	30%
· Cattle breeding	35%	40%
· Business	5%	15%
· Exodus & Migration	20%	10%
Different type of women activities :		
· Water transport	0%	5%
· Agriculture	10%	10%
· Cattle breeding	30%	25%
· Handicrafts	30%	30%
· Housekeeping	15%	15%
· Children care	15%	15%
Other important changes in life style		
Average cost per m^3 of water (TD/m^3)	Free 3 to 5	0.3
Average consumption of water (litters/day/inhabitant)	5 to 15	40 à 50
Building with stone (%)	30%	65%
Individual system of used water draining /house	10%	80%
Sanitary commodities (Shower-WC)/house	1%	45%
Kitchen	2%	45%
Settlement of small family gardens (%)	0%	3%
Introduction of cattle breeding (%)	0%	0%
Small scale handicrafts activities	0	0
Girls schooling (%)	55%	70%
Grocers/Café (small scale)	1	3

APPENDIX B

WATER SOURCES

APPENDIX B

WATER SOURCES

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CHAPTER 1 INTRODUCTION

Tunisia is bordered by the Mediterranean Sea to the north, and the Sahara Desert to the south. The terrain consists of wet mountains and alluvial plain in the north-west, semiarid plain in the Central, and arid land in the South. Most precipitation occurs in the North West in the winter season. Therefore, surface water resources are commonly utilized by dams on the main rivers in the North. On the other hand, groundwater is developed all over Tunisia.

The high salinity deep groundwater is the only water resources left in the South as there is no potential surface water so suitable potable water supply is an issue. On the other hand, non-conventional water is produced from the sewerage treatment plants and the desalinization of brackish groundwater. Water requirement in Tunisia are classified into four types as follows:

Water Requirements for the Year 1996 (in million cubic meters)

	Domestic use	Agriculture	Industry	Tourism	Total
Conventional water	290	2090	104	19	2503
Non-conventional water	0	25	0	0	25
Total	290	2115	104	19	2528
%	11.5	83.6	4.1	0.75	100

Source: Water 2000 Ministry of Agriculture

According to this table, agriculture has the biggest water requirements compared to the domestic use, which is about 12% of total water requirements.

CHAPTER 2 WATER RESOURCES AND METEOROLOGICAL CONDITION IN TUNISIA

2.1 Surface Water Resources

Surface water resources in Tunisia mainly occur at the forest area in Far North and North areas by favorable rainfall in the winter. The source of the data is already given below the table so just say "Surface Water Resource in Tunisia" are tabulated below by region.

Surface Water Resources in Tunisia (in million cubic meters)

	Far North	North	Center	South	Total
Surface water resources	960	1230	320	190	2700
Resources with salinity less than 1.5g/L	960	836	153	6	1955
% of good quality water	100	68	48	3	72

Source: Water XXI: strategy for the water sector in Tunisia- long -term 2030- Ministry of Agriculture 1998

Based on this table, surface water in Far North and North areas has good quality and high potential; however, it has low potential and poor quality in Center and South. Therefore, excess surface water resources in Far North and North are conveyed to the Center by very long water transmission pipelines for water supply systems of urban areas.

2.2 Groundwater Resources

Groundwater resources in Tunisia are divided into shallow groundwater and deep groundwater. The shallow groundwater is classified as phreatic aquifer, which is located at less than 50m in depth. The deep groundwater is classified as confined aquifer, which is located at more than 50m in depth. Most deep groundwater pumped up from the deep tube well is extracted from depth levels ranging between 100m and 400m.

According to the General Department for Water Resources (DGRE), about 670 million cubic meters of water are abstracted per year from 203 shallow groundwater systems at the present time. On the other hand, 2,313 deep tube wells are used for agriculture (74%), domestic use (18%), and industry (8%).

The groundwater potential in Tunisia is as follows:

Groundwater Resources Potential in Tunisia (in million cubic meters)

Type	North		Center		South		Total
Phreatic Aquifer	395	65 %	222	42%	102	12%	719
Confined Aquifer	216	35%	306	58%	728	88%	1250
Total	611	100%	528	100%	830	100%	1969

Source: DGRE (1995/1996) inventory

Based on this table, the phreatic aquifer is predominant in the North and the confined aquifer is predominant in the South. Generally, groundwater in Tunisia has rather high salinity compared with surface water. According to the DGRE (1993), 92% of shallow groundwater have a salinity of more than 1.5g/L. On the other hand, 80% of deep groundwater have a salinity of more than 1.5g/L.

2.3 Meteorological Condition

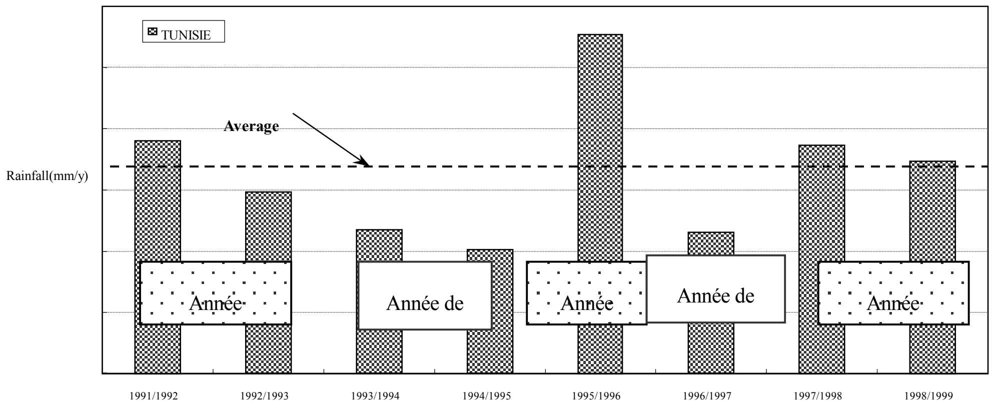
The water sources potential and water demand in Tunisia is strongly effected by the rainfall pattern, because the climate of Tunisia is characterized by Mediterranean climate in the North and coastal area and semi arid climate at the inland area in the South. Most rainfall occurs in the North West in the winter season; however, drought years have been frequent recently. Therefore, the following meteorological data were collected and analyzed to understand the water resources situation in Tunisia.

2.3.1 Rainfall Data

Figure B.2.1 shows the rain gauge station points in Tunisia. There are 44 stations for the whole the country, so nation wide rainfall observation can be made. Meteological data is collected from *Ministere De L'agriculture, Direction Generale Des Ressources En Eau, Direction Eaux De Surface*. They issue '*La Situation Pluviometrique Et Hydrologique En Tunisie*' on a monthly, seasonally, and yearly basis. Rainfall is observed and analyzed using the data from 1991 to August 1999.

2.3.2 Trend of Rainfall for Last 8 Years

The rainfall data from 1991 to 1999 were studied to see rainfall pattern by year. All the data is attached in Table B.2.1. Rainfall in 1995 was the heaviest among 8 years, and it recorded 554mm. The rainfall volume exceeds the national average rainfall (339mm) largely. Rainfall in 1991 and 1998 also exceeded the average. On the other hand, the rainfall in 1993, 1994, and 1996 are less than the average. Thus, annual rainfall for 8 years fluctuates each year. The rainfall volume for this 8 years is illustrated as follows:



Rainfall Tendency from 1991 to 1999

As a result of this study, it is concluded that rainfall tendency in Tunisia is to repeat heavy rain year and little rain year in turn.

2.3.3 Regional Rainfall Property

The rainfall data from September 1998 to August 1999 which is the latest annual data, is studied in order to grasp the rainfall features by area. All the data are shown in Tables B.2.2, B.2.3 and B.2.4.

National annual average is 338mm, with the North area exceeding the average rainfall. Ain Draham raingauge station in Jendouba shows the largest figure (1,657mm), while Nafta raingauge station in Tozeur shows the smallest figure (72mm). Heaviest rain falls in Jendouba among the governorates in Tunisia, reaching 859mm. On the other hand, Kebili has the least rainfall, it is only 92mm.

National area is divided into 6 regions, namely, North East and North West, Central East and Central West, and South East and South West. Rainfall data is studied by three grouped areas. Rainfall in north areas is heavier than the other areas, it ranges from 500mm to 600mm. The figures of central areas are around 250mm, and south areas are around 150mm respectively. It can be confirmed that rainfall volume decreases southward.

Also, rainfall is analyzed by seasons to see seasonal characteristics. 45% of annual rainfall concentrates in winter (Dec~Feb), then in autumn (Sep~Nov) 36%, spring (Mar~May) 15%, and summer (Jun~Aug) 5%. Seasonal rainfall tendency can be applied to whole areas, 70~80% of annual rainfall falls in autumn and winter. In case of the monthly basis rainfall analysis, January has the heaviest rainfall in a year, and it becomes 30% of annual volume.

CHAPTER 3 WATER SOURCES OF SUBPROJECTS

There are 41 water sources in the Project 2001 covering 43 subproject areas as listed below. Number of water sources for the respective type and their brief descriptions are given in the following section. The top three types of water sources in the table correspond to surface water, spring, and groundwater, respectively. The 4th and 5th types of water sources are designated from administrative definition, thus, their nature of water source may vary.

For the water sources numbered from 1 to 4, suitability of the water quality for drinking purpose has not been established, therefore, samples from those sources were collected and subjected to physico-chemical and microbiological analysis in the study. Suitability of water quality was discussed referring the national draft guidelines for drinking water of Tunisia and WHO's guidelines.

The Type of Water Sources and Locality

	Type of Water Source	Region	Number		Governorate
1	Dam	North	1	1	Jendouba
2	Spring	North	2	2	Beja, Le Kef
3	Deep Tube Well	North	9	16	Le Kef, Bizerte, Zaghouan, Kairouan, Kasserine
		South	7		Sidi Bouzid, Gabes, Gafsa
4	GR Extension	North	4	6	Kairouan, Jendouba
		South	2		Gabes, Gafsa
5	SONEDE Connection	North	9	16	Zaghouan, Nabeul, Beja, Ariana, Ben Arous Beja
		South	7		Medenine, Gabes, Mahdia
	Total		41		

3.1 Surface Water

Surface water in Tunisia is historically utilized for irrigation water resources by the dam reservoir; however, recently the percentage of water supply resources in the total surface water resources use are rapidly increasing because water supply systems have come into wide use recently. However, discharge rate of surface water is dramatically affected by amounts of rainfall, and water quality of surface is easily influenced by human activity and changes in the natural environment. Therefore, development of surface water should take care of quantity and quality.

In the Study area, three subprojects in Jendouba, i.e. Ouled Dhifallah, Maalim and Jouaouda 1/Battaha under an unified water supply system of Complex AEP Barbara is to be supplied with the water of the Barbara Dam, which has a reservoir volume of 80 million cubic meter. The height of crest is 193.500m above sea level and surcharge level is 192.400m above sea level. The high water level is 182.000m above sea level and low water level is 160.000m. The Barbara Dam was completed in September 1998 in Zouitina at upper reach of Barbara river basin in Jendouba 11km west of Ain Draham for irrigation and potable water. The potable water will be taken near dam site. The irrigation area is about 2,100ha and allowable intake for water supply project is 16.10l/s including two other neighboring subprojects.

3.2 Spring

Spring water in Tunisia is widely used from ancient time for irrigation and domestic use by the inhabitants. Spring is groundwater that flows continuously from a fissure of rock or the sandy layer coming out at the surface of ground. The discharge rate of spring occurrence depends on the rainfall, and water quality of spring is easily influenced by human activity. Therefore, development of spring should take care of seasonal fluctuation of the discharge rate and protection of spring sources from human activity. In the study area, two subprojects are to be supplied with the waters of the spring which located at Beja and Le Kef.

3.2.1 Beja

Fatnassa subproject in Jendouba is to be supplied with the waters of the Spring Ain Juibi which is already developed by Ermil Network. Ain Juibi is located at 12km south of Nafza. The allowable intake for Fatnassa subproject is 5.0l/s including Ermil Network.

3.2.2 Le Kef

M'Hafdhia – Ghraissia subproject in Le Kef is to be supplied with the waters of Ain Snan Spring. The Ain Snan Spring is located 40km south by southwest of Le Kef. The allowable intake for M'Hafdhia – Ghraissia subproject is 2.0l/s.

3.3 Tube Well

Groundwater sources in the subprojects are developed by 16 tube wells in 8 governorates from the North to the South as shown in Table B.3.1. The depth of tube wells varies from 33m to 673m. The shallowest well is located at Tergulech subproject in Bizerte which classifies as a phreatic aquifer. The deepest well is located at Blahdia subproject in Sidi Bouzid. Therefore, aquifer types are generally categorized as confined aquifer except Tergulech subproject. The aquifer consists of Tertiary to Quaternary limestone or Tertiary to Jurassic sandstone.

The pumping discharge rate ranges from 1.8l/s to 22l/s. Usually, limestone aquifer shows high transmissibility and a large quantity of discharge rate. The maximum specific capacity and transmissibility are shown at tube well of Smadah subproject in Bizerte. These are 31.40l/s/m and 316.2m^2/day respectively. The static water level ranges from 7.4m to 158.0m. However, annual fluctuation of the groundwater level should be considered to select the pump.

As Table B.3.1 shows that the discharge rate of pumping tests are enough to supply each subproject. An abstraction of groundwater from each well should not exceed an allowable pumping water level, which is determined by depth of screen top plus 2 m for pump's submergence to protect the precious aquifer from over pumping. However, pumping water level of Chaamaba - O.El Asssel -Hmaidia in Le Kef occurred below allowable pumping water level after 24 hours pumping. Therefore, appropriate pumping plan is necessary to conserve groundwater resources. The designed pumpage considering the concept of the rural water project that the standard pump operating hours are 16 and pumpage is always less than the pumping discharge rate at the pumping test.

3.3.1 Zaghouan

The aquifers of Rouissa/ Bousa in Zaghouan consist of sandstone and static water level indicated about 35.0m below surface. The pumping discharge rate well No. 117342 is 7l/s at the pumping test. The pumping water level of this yield occurred above allowable pumping water level. Therefore, this discharge rate is recommended for the production well.

3.3.2 Bizerte

The aquifers of Bizerte consist of limestone and static water level range from 7.4m to 11.0m below surface. The pumping discharge rate of well No. 9316/1 is 14l/s and well No. 9317/1 is 15.7l/s at the pumping test. The pumping water level of this well No. 9317/1 for Tergulech subproject occurred just below the allowable pumping water level. However, this aquifer belongs to phreatic aquifer and drawdown is very limited. Therefore, this discharge rate is recommended for the production well. The limestone aquifers in Bizerte has high transmissibility and spread very shallow depth, so contamination from surface must be taken into consideration for drinking use.

3.3.3 Le Kef

The aquifers of Chaamba - O.El Assel - Hmaidia in Le Kef consist of limestone with marl and static water level indicated about 79.8m below surface. The pumping discharge rate of well No. 6957/3 is 1.8l/s at the pumping test. The pumping water level of this yield occurred below allowable pumping water level after 24 hours pumping. This discharge rate may exceed the potential of aquifer. However, there are no alternative water sources in this area. Consequently, this is a sensitive problem and requires careful pumping plan.

3.3.4 Kairouan

The aquifers of Hmidet in Kairouan consist of sandstone and static water level indicated about 65.8m below surface. The pumping discharge rate of the well No. 19666/4 is 12l/s at the pumping test. The pumping water level of this yield occurred above allowable pumping water level. Therefore, this discharge rate is recommended for the production well.

3.3.5 Kasserine

The aquifers of Kasserine consist of limestone and sandstone, and static water level range from 7.0m to 150.18m below surface. The pumping discharge rates vary from 4.5l/s to 22.0l/s at the pumping test. The static and pumping water level of well No. 19631/4 for Dayyasia subproject occurred at deep portion of borehole, however there remain enough thickness of aquifer below the pumping water level. Therefore, this discharge rate is recommended for the production well. The pumping water level of well for Oued Lagsab subproject occurred just below the allowable pumping water level. Therefore, this discharge rate is allowable to abstract from this well without serious problems. The pumping water level of other wells occurred above allowable pumping water level. Therefore, these discharge rates of other wells are recommended for the production well.

3.3.6 Sidi Bouzid

The aquifers of Sidi Bouzid consist of limestone and sandstone, and static water level range from 44.0m to 158.0m below surface. The pumping discharge rate of four deep tube wells range from 6.5l/s to 20.0l/s at the pumping test. The pumping water level of these yields occurred above allowable pumping water level at each tube well. Therefore, these discharge rates of four tube wells are recommended for the production well.

3.3.7 Gafsa

The aquifers of Gafsa consist of sandstone, and static water level of well No. 19393/5 and 9624/5 are 26.0m and 43.0m below the surface, respectively. The pumping discharge rates of two deep tube wells are 3.3l/s and 4.6l/s at the pumping test. The pumping water level of these yields occurred above allowable pumping water level at each tube well. Therefore, these discharge rates of two tube wells are recommended for the production well.

3.3.8 Gabes

The drilling depth of deep tube well for Baten Trajma is not yet reached the designation drilling depth of 272m due to drilling problems and stopped at 252m in the middle of October 2000. Therefore, the well is not completed and final well data are not available. However, potential aquifer has been found below 206m. Therefore, water sampling was carried out to confirm of water quality for drinking purpose by manual sampler. The static water level is about 88m below the surface at the water sampling on October 18, 2000.

3.4 GR Extension

GR Extension means the extension of the Agricultural Engineering Office (GR or AGR) water supply system using existing water source. As a practical matter, GR Extension is independent from existing GR water supply system, but shares water sources with existing GR water supply system. However, some GR Extensions are combined to existing GR network. The regulations of DGGR consequently requires that water source plan for GR Extension should obtain the consent of existing GR, because water source of existing GR generally consists of deep tube well that is exploited for irrigation purpose but also for water supply by the Ministry of Agriculture and being managed by GIC. Therefore, allowable intake from existing water sources (deep tube well or spring) of GR for GR Extension are estimated from remaining discharge potential of existing water sources. The allowable intake of 6 GR Extensions of 4 governorates is as follows

(1) Jendouba

Subproject Name	Allowable Intake (l/s)	Existing system name
Chouaoula	3.0	Beldia GR

(2) Kairouan

Subproject Name	Allowable Intake (l/s)	Existing system name
Chelalga	11.0	Stailia GR
Gudifett	10.0	Thousbtia GR
Zgainia	3.0	Rmadhnia GR

(3) Gafsa

Subproject Name	Allowable Intake (l/s)	Existing system name
Henchier Edhouaher	4.0	Henchir Edhouaher GR

(4) Gabes

Subproject Name	Allowable Intake (l/s)	Existing system name
Ezzahra	1.5	Mzata GR

3.5 SONEDE Connection

SONEDE Connection indicates the water source of subprojects which are connected to the network of SONEDE water supply system. SONEDE water supply systems are widely developed in Tunisia from urban water supply to rural water supply. About 1475 SONEDE potable water systems are established for the rural area. In addition, 304 GR systems are connected to the SONEDE network. These are called SONEDE Connection.

The water sources of SONEDE are composed of various sources that consist of surface water, spring, and groundwater. The surface water are main water source of SONEDE and usually developed by dam reservoirs in the north and conveyed to main urban areas and rural areas from the north to the south. Several springs are developed in the North and the Central as water resources of SONEDE, but service areas are limited compared with surface water. Groundwater is precious and important water source in the Central and the South. The deep groundwater for SONEDE water supply system are developed by deep tube wells in the high potential confined aquifers and convey to the each service area by long conveyance pipelines.

SONEDE Connection is required to obtain the agreement on connecting the new potable water supply project to existing SONEDE's network from SONEDE. Based on the agreement, water intake (discharge rate) and water head (pressure) at the connecting point are informed from District office of SONEDE to AGR office.

Water quality of supplied water is regularly checked and controlled by SONEDE following the national draft guideline for drinking water of Tunisia. Therefore, water sources of SONEDE Connection can be supplied to beneficiary without any treatment. The allowable intake of 16 SONEDE Connections of 8 governorates is as follows;

(1) Ariana

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Faidh El Amrine - Sidi Ghrib	1.13	Menzel Habib
Hmaiem Essoufla	0.50	Hmaiem
Tyayra	1.00	Cite Sfaxi

(2) Ben Arous

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Ouled Ben Miled and Ouled Saad	2.00	Chaouech Saaed
Sidi Fredi	1.00	Glia

(3) Nabeul

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Sidi Hamed	2.00	Eau du Nord (Harboun)

(4) Zaghouan

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Jimla	2.00	M'raih

(5) Beja

Subproject Name	Allowable Intake (l/s)	SONEDE system name
El Garia	0.30	Resrvoir R500 El Garia
El Garrag	1.70	El Aouidi

(6) Mahdia

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Complexe Bousslim	27.0	Ouled Chamakh
Complexe El Altha	8.50	Neffatia

(7) Gabes

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Chaabet Ejiayer	2.00	Mtmata Nouvella

(8) Medenine

Subproject Name	Allowable Intake (l/s)	SONEDE system name
Bougueddima	4.50	El Jorf pipeline
Chouamekh - R.Ennagueb	7.50	Halg Jmel
Echgiuiguia	5.00	Tajerjamet
Tarf Ellil	3.50	Ben Garden pipeline

CHAPTER 4 WATER QUALITY ASSESSMENT OF WATER SOURCES

4.1 Introduction

The JICA Study Team conducted the water quality assessment covering 41 water sources included in the Project 2001 covering 43 subprojects during the basic study phase. Among 41 water sources, those categorized in dam, spring, deep tube well and GR extension totaling 25 were sampled and subjected to laboratory analysis for bacteriological and physico-chemical parameters. However, two subprojects i.e. Maalim and Jouaouda 1/Battaha in Jendouba were not analyzed, because they are to be supplied from Barbara Dam water through Ouled Dhifallah subproject under an unified water supply system of Complex AEP Barbara. The quality of the remaining 16 water sources, which is under jurisdiction of SONEDE, was in principle reviewed only from standpoint of legal requirement imposed on water supplier with supporting monitoring data because internal control is being carried out on regular basis by SONEDE.

However, for the water source of the Sidi Hammed subproject in Nabeul, though it falls within SONEDE Connection, water samples were taken for analysis because the water supply system of the subproject was designed to take untreated water from the transmission pipe connecting a reservoir in Beja to the treatment facility in Tunis.

Type of Water Source and Analysis

<table>
<tr><th></th><th colspan="2">Type of Water Source</th><th colspan="2">Number</th><th>Data source of assessment</th></tr>
<tr><td>1</td><td colspan="2">Dam (Reservoir)</td><td colspan="2">1</td><td>Laboratory analysis</td></tr>
<tr><td>2</td><td colspan="2">Spring</td><td colspan="2">2</td><td>Laboratory analysis</td></tr>
<tr><td>3</td><td colspan="2">Deep Tube Well</td><td colspan="2">16</td><td>Laboratory analysis</td></tr>
<tr><td>4</td><td colspan="2">GR Extension</td><td colspan="2">6</td><td>Laboratory analysis</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">SONEDE Connection</td><td>Untreated Water</td><td rowspan="2">16</td><td>1</td><td>Laboratory analysis</td></tr>
<tr><td>Treated Water</td><td>15</td><td>Monitoring Data</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">41</td><td>-</td></tr>
</table>

4.2 Methodology

4.2.1 Sampling Procedure

(1) Preparation of Sampling Manual

A sampling manual was prepared by JICA Study Team in advance to serve as technical guidelines for the local consulting firms responsible for sampling works in the succeeding period.

(2) General Sampling Procedures

Samples for physico-chemical testing
Water samples for physico-chemical parameters were taken by pump or manual water sampler and stored in bottles made either by Polyethylene Terephthalate (PET) or glass having securely fitting stoppers or caps. EC, pH and temperature were recorded on the spot. Samples were transported and delivered to the laboratories as immediately as possible, usually on the day or the succeeding day within 24 hours. During the transportation, samples were kept under cool and dark ambient conditions.

Samples for biological testing
Sample bottles made by glass were sterilized at the laboratory responsible for biological analysis in advance. Outlets were wiped with clean cloth and water was run for at least 1-2 minutes before sampling. Outlets were sterilized with the flame from a cigarette lighter prior to sampling where possible.

(3) Sampling Design for Reservoir

In the water sampling of the reservoir in Jendouba, particular considerations were given to seasonal and spatial variations of water quality.

a) As strong rainfall on the upper reach of reservoir was likely to induce significant seasonal variations in turbidity, it was judged necessary to take water sample from the reservoir in Jendouba during the rainy season to reflect the water quality in the most turbid period.

b) As for the spatial variation, as the depth of water intake position was predetermined, horizontal variations was focused rather than vertical variations.

In this context, water sampling was undertaken at the beginning of May corresponding to the latter part of the rainy season of the area and the samples were taken both from the riverine (upper reach of dam reservoir) and the lacustrine (lower reach of dam reservoir) zones considering lateral heterogeneity in their physico-chemical and biological water quality parameters. The riverine zone is always being subjected to influence of influx from a channel in contrast with the lacustrine.

4.2.2 Laboratory Analysis

(1) Parameters

The laboratory analysis covered the following 33 parameters. These parameters are presented in accordance with the categories given in the national draft guideline for drinking water (*"PNT 09.14 (1983) QAULITE DES EAUX DE BOISSON")*.

1	Bacteriological quality		
	a. Total coliform b.Thermotolerant coliform	c. Escherichia coli d. Faecal streptococci*	
2	Toxic Chemical Substances (Provisoinal Values)		
	a. Arsenic b. Cadmium	c. Cyanid d. Mercury	e. Lead
3	Chemical substances that likely induce health problems		
	a. Fluoride	b. Nitrate	
4	Acceptability Aspects		
	a. Color b. Odor c. Turbidity d. pH e. Chloride	f. Copper g. Magnesium h. Manganese i. Iron j. Zinc	k. Hardness l. Sulfate m. Calcium
5	Other Supporting Data		
	a. Chromium (VI) b. Total Dissolved Solids c. Ammonium	d. Sulfide e. Sodium f. Potassium	g. Nitrite h. Bicarbonate(HCO3) i. Carbonate(CO3)

* Faecal streptococci are not included in the national draft guideline

(2) Laboratory Undertook the Analysis

The analysis was carried out at *Laboratoire central d'analyse et d'essai* (LCAE). LCAE is a governmental institute under the Ministry of Industry providing technical services such as physical, chemical and microbial analyses. The department of Chemical analysis obtained a certificate from the *Comite Francais d'Accreditation* (N 1-0634).

(3) Analytical Methods Adopted in the Study

Most of the analyses were undertaken following 'AFNOR', the French standard method. They were summarized in Table B.4.1 with brief technical information concerning the analytical procedures and quantification limit.

4.2.3 Basis of Assessment

DGGR refer the *"PNT 09.14 (1983) QAULITE DES EAUX DE BOISSON"* as a basis of assessment of water quality for rural water supply projects. Ministry of Health has control of drinking water based on the draft guideline. However, this document is a draft guideline for drinking water in which has not been acknowledged as the enforceable national drinking standard. Therefore, DGGR assess the water quality by comparison of human health risk based on the draft guideline with benefits of water supply project. The digest of the draft guidelines was presented in the Table B.4.2.

Accordingly in the Study, the water quality assessments for drinking purpose were carried out based on the *"PNT 09.14 (1983) QAULITE DES EAUX DE BOISSON"* which considered the above mentioned conditions. Le projet de directives pour la qualité d'eau publiées par l'Organisation Mondiale de la Santé (2ème édition) sont aussi référées s'il y a lieu.

4.3 Results and Assessment

The analysis results are given in Table B.4.3.

4.3.1 Overall Assessment

Among 41 water sources, bacteriological and physico-chemical analytical results are available for 26 water sampling points which consist of one dam, two springs, 16 deep tube wells and 6 GR extensions, and one untreated water source of SONEDE connection. The total dissolved solid (TDS) for all samples range between 169 and 1,845 mg/L, which were below the maximum acceptable range of draft guideline for drinking water of Tunisia (2,000-2,500 mg/L).

For water sources in the northern area, levels of TDS are generally below 1,000 mg/L, on the other hand in the southern area, levels of TDS are generally over 1,000 mg/L which indicated the presence of high sulfate, chloride and cations such as calcium and sodium in the aquifer of southern area. However, the lowest TDS (169mg/L) is found at the very deep well (716m in depth) of Blahdia in southern area.

In comparison between the surface water sources and the groundwater sources, the former was proved to be more vulnerable to human activity as indicated by data of one water source in Le Kef categorized in spring which appeared to be contaminated by nitrate, while the quality of the latter was more susceptible to geological settings.

The following 12 water sources out of 26 water sampling points did not meet the draft guideline values for drinking water.

Governorate	Subproject
Jendouba	Chouaoula
Le Kef	M'hafdhia – Ghraissia, Chaamba – O.El Assel - Hmaidia
Kairouan	Zgainia
Kasserine	Daaysia
Sidi Bouzid	Mahrouga, Amairia, Bouchia, Blahdia
Gabes	Ezzahra, Baten Trajma
Gafsa	Khanguet Zammour

The parameters that did not meet the draft guideline values included lead (Pb), fluoride (F), nitrate (NO_3^-), pH, calcium (Ca), sulfate (SO_4^{2-}), chloride (Cl^-), turbidity and iron (Fe). Quality of these water sources were judged inadequate for potable use based on the draft guideline.

The following part is devoted to description of effects of these constituents on public health and consumers' acceptability.

4.3.2 Bacteriological Quality

All the water sources are judged acceptable as drinking water sources from bacteriological aspects provided that the water is disinfected before distribution.

E.coli was detected at the following water sources.

Governorate	Subproject	Type of Water Source	E.Coli
Gabes	Baten Trajma	Deep Tube Well	>1000

The well for the Baten Trajma subproject had not been completed when the sample was collected. In addition, sample collection was undertaken manually by a simple sampling appliance because engine-driven pump could not be installed for sampling under such circumstance, thereby, stagnant water inside the well might have been withdrawn. These inadequate circumstances associated with sampling procedure may account for the high counts of coliform of the sample. It is suggested to take sample for bacteriological test after well is completed.

Thermotolerant coliform was detected for some water samples analysed in this study, faecal streptococci, generally regarded as supporting indicator of faecal pollution, was also detected for most of the water samples. In addition, such water sources as reservoir, spring and shallow groundwater are always at the risk of contamination by human and animal excreta. Therefore, effective disinfecting process is a precondition of water distribution.

Considering the fact that most of the water sources, to a greater or lesser extent, appeared to be contaminated or at the risk of contamination, it is suggested that excessive access by cattle be restricted and the peripheral environment of all the intakes be protected by appropriate material.

4.3.3 Toxic Chemical Substances

High concentration of lead (0.361 mg/L) was detected in the sample of the Blahdia deep well which is 716m in depth, where levels exceed the limit set (<0.05 mg/L) in the drinking water draft guideline value. Therefore, quality of this water source was judged inadequate for potable use based on the draft guideline. Though the high concentration of copper (0.291 mg/L) and zinc (2.51 mg/L) were also recognized in sample, those contents were still acceptable. It is indicated that the water sample contains not only lead but also other minerals. It was also detected the high concentration of lead (0.329 mg/L) by reanalysis of spare sample to confirm the analysis result. Though the final decision on the realization of Blahdia subproject will be made by DGGR as responsible executing agency, the Study Team can not recommend in principle making use of water from such water sources especially regarding as for drinking purpose.

Toxic Chemical Substances were not detected in the rest samples of water sources in excess of the draft guideline values. However, considering effects of human health, it is suggested that the toxic chemical substance be included in the parameters of water quality monitoring to ensure.

4.3.4 Chemical Substances that Likely Induce Health Problems

(1) Fluoride

The draft guideline value for fluoride set different values for six different temperature regime. Due to lack of adequate data concerning temperature of the water sources, it was difficult to apply the national standard value of fluoride as the assessment basis, therefore, WHO's guideline value for fluoride of 1.5mg/L was employed to assess the quality. The following water sources failed to meet this value.

Therefore, quality of these water sources was judged inadequate for potable use based on the draft guideline.

Water sources with Fluoride Detected in Excess of the Draft Guideline Value

Governorate	Subproject	Water source	Concentration (mg/L)
Le Kef	Chaamba - O.EI Assel - Hmaidia	Tube Well	1.65
Gafsa	Khanguet Zammour	GR Extension	2.04
Kairouan	Zgainia	GR Extension	1.79
Sidi Bouzid	Mahrouga	Tube Well	2.10

Presence of fluoride at this level of concentrations may possibly lead to dental fluorosis which, in its moderate or severe forms, may result in a brown staining and/or pitting of the permanent teeth, though, at lower concentrations it can help reduce the incidence of tooth decay. Chronic intake of excessive fluoride can lead to the severe and permanent skeletal fluorosis.

Various fluoride treatment techniques for small communities may be adapted in the long run. They enable fluoride removal employing adsorption principle by activated alumina (Al_2O_3) and/or charred bone meal, and flocculation principle by Alum. Adaptability of the techniques should be examined with due consideration on the local circumstances such as availability of material, financial constraints and needs for capacity building for management of the system.

(2) Nitrate

The sample of the following water source exceeded the draft guideline value for nitrate set at 45mg/L. Therefore, quality of these water sources was judged inadequate for potable use based on the draft guideline

Water sources with Nitrate Detected in Excess of the Draft Guideline Value

Governorate	Subproject	Water source	Concentration (mg/L)
Kasserine	Daaysia	Tube Well	46
Le Kef	M'hafdhia – Ghraissia	Spring	75

Health concern associated with nitrate contamination of drinking water at this level is an increasing risk of methemoglobinaemia, which inhibits oxygen transport to tissue. It is brought about through oxidation of heamoglobin by nitrite to nitrate reduction. Potentially sensitive population includes the infant of 1 year of age or younger, particularly the bottle-fed infants of less than 3 months of age and pregnant women.

Increasing use of fertilizer and inappropriate management of human and animal excreta in the adjacent area to the source were supposed to be the major causes of the contamination.

Prospective beneficiaries should be warned of the risk of using the water for infant feeding. To this end, continued effort of sensitization program focussing on health effects of nitrate ingestion on the sensitive population is suggested for the project beneficiaries.

Preventive actions may provide realistic and effective means of control in the long run. It includes the control of fertilizer use, appropriate management of human and animal excreta in combination with the restriction of access to the water source and its catchment area. These measures can be realized by full understanding and cooperation of the population in the adjacent area to the water source with strong public support for educational programs regarding hygiene and good farming practices. Frequent monitoring of the parameter is also recommended to ensure the efficiency of these measures.

There is no cost-effective water treatment technique for reducing nitrate and nitrite level in water that can be adopted in water supply projects for small communities.

4.3.5 Acceptability Aspects and Other Considerations

Among 13 parameters, pH, sulfate, calcium, turbidity and iron of some samples did not meet the draft guideline value.

(1) pH

The draft guideline set pH values with a range between 6.5pH and 8.5pH values of the following subproject water source did not the draft guideline value. However, pH value at 8.6 does not instantly cause direct problematic event.

Water Sources with pH in Excess of the Draft Guideline Value

Governorate	Subproject	Water Source	pH
Jendouba	Chouaoula	GR extension	8.60

At the range of pH presented in the table, corrosion problem may not be induced. For effective disinfecting with chlorine, the pH should preferably be less than 8.

(2) Sulfate

The draft guideline value for sulfate is set at 600mg/L. The sulfate concentrations of the following subproject water sources in Governorates Sidi Bouzid and Gabes exceeded this draft value.

Water Sources with Sulfate in Excess of the Draft Guideline Value

Governorate	Subproject	Water Source	Concentration (mg/L)
Sidi Bouzid	Amairia	Tube Well	1,013
Sidi Bouzid	Mahrouga	Tube Well	1328
Gabes	Baten Trajma	Tube Well	1,296
Gabes	Ezzahra	GR Extension	777
Gafsa	Khanguet Zammour	GR Extension	891

Presence of sulfate in drinking water may generally cause noticeable taste at lower concentrations and gastrointestinal effect occasionally at higher concentrations (>600mg/L). Although no health-based guideline value has been derived in WHO's guidelines, this national standard value was adopted from health concern, including catharsis and gastrointestinal irritation.

However, there are very few scientific reports that address sulfate concentration in drinking water and the effects it may have on those individuals who are exposed. In addition, a recent study in the United

States (Health effect from exposure to high levels of sulfate in drinking water, Office of Drinking Water and Groundwater, U.S. Environmental Protection Agency, 1999) could not find a significant dose-response association between acute exposure to sodium sulfate (up to 1200mg/L) in water and reports of diarrhea.

As the contaminant may originate in geological sources of the area, most of the water sources in the subproject area was deemed affected by sulphate to various extents. Therefore, it was deemed difficult to exploit alternative water source free of sulfate. Considering the nature of the problems associated with consumption of drinking water with high concentrations, the concentrations determined in this study were considered to be at a tolerable level.

(3) Calcium

The draft guideline value of drinking water set calcium concentration at 300 mg/L from the viewpoint of scale formation. The samples of the following subprojects did not meet the draft guideline values.

Water Sources with Calcium in Excess of the Draft Guideline Value

Governorate	Subproject	Type of Water Source	Concentration (mg/L)
Sidi Bouzid	Mahrouga	Tube Well	355
Gabes	Ezzahra	GR Extension	364

In this context, it was recommended that the water supply network for the subprojects be regularly maintained with particular attention to scale deposition.

In some instances, a water hardness in excess of 500mg/L is tolerated by consumers. Depending on the interaction of other factors, such as pH and alkalinity, water with a hardness above approximately 200mg/L may cause scale deposition in the distribution system and result in excessive soap consumption and subsequent scum formation.

Although all the water samples did not exceed the draft guideline value for hardness of 1000mg/L, they exceeded the recommended guideline values of WHO. Therefore, it is anticipated that the distribution system may be deposited with scale and will result in excessive soap consumption and subsequent scum formation.

(4) Turbidity and Disinfecting Efficacy

Sample of Amairia subproject did not meet the draft guideline values for turbidity which was set at 25 NTU (Nepherometric Turbidity Unit), In addition, three samples exceeded the WHO's guideline value (5NTU).

Water Sources with Turbidity in Excess of the WHO's Guideline Value

Governorate	Subproject	Water Source	NTU
Sidi Bouzid	Amairia	Tube Well	29*
Sidi Bouzid	Blahdia	Tube Well	270*
Gabes	Baten Trajma	Tube Well	100*
Gafsa	Khanguet Zammour	Tube Well	8.26
Jendouba	Chouaoula	GR Extension	5.98
Jendouba	Ouled Dhifallah	Barbara Dam	6.00

*This value is in excess of the draft guideline value of the country.

In the tube well of Blahdia, stagnant water was sampled by manual sampler because of difficulty of pumping, so that re-sampling is required before construction work. In the tube well of Baten Trajma is under drilling, so that re-sampling is required after completed. Turbidity does not have any direct health effects, though, it has close relevance to disinfecting efficacy. There may be a risk of failure of disinfecting for the water sources with high turbidity and thereby high suspended solid on which microorganisms are aggregated or adsorbed.

It was strongly recommended that the treatment process preceding terminal disinfecting be always operated to produce water with a median turbidity not exceeding 1NTU and not exceeding 5NTU in any single sample.

In comparison between the samples taken form riverine and lacustrine zones of the reservoir, it appeared that the sample from riverine zone was more turbid and presented higher counts of micro-organisms.

Water Quality of Barbara Dam

	Turbidity	T.coliform	Faecal Streptcocci
Riverine Zone	16.0 NTU	70	38
Lacusrine zone	6.0 NTU	9	9

From this data, it was confirmed that the water quality in the lacustrine zone is more appropriate for drinking water sources. Although higher turbidity is likely to happen in the midst of rainy season, it can be controlled by filtration facility, which is to be installed for the subprojects whose water source is the Barbara Dam.

(5) Iron

The draft guideline for iron concentration in drinking water is set with a range from 0.5 to 1mg/L. The following water samples exceeded the upper range of the guideline value.

Water Sources with Iron in Excess of the Draft Guideline Value

Governorate	Subproject	Water Source	Concentration (mg/L)
Gabes	Baten Trajma	Tube Well	5.72
Sidi Bouzid	Blahdia	Tube Well	16.75
Sidi Bouzid	Bouchiha	Tube Well	1.61

In the tube well of Baten Trajma is under drilling, so that re-sampling is required after completed. In the tube well of Blahdia, stagnant water was sampled by manual sampler because of difficulty of pumping, so that re-sampling is required before construction work. Iron at this level of concentration does not have any health effects. The water containing iron does not instantly exhibit color when directly pumped from the well because iron is in colorless ferrous form under anaerobic condition. It turns into ferric iron with reddish-brown color upon exposure to the atmosphere. The discoloration is possibly objectionable to consumers in combination with stains clothes during laundering and give metallic taste.

6) Chloride

The draft guideline for chloride concentration in drinking water is set at 600mg/L. The following water samples exceeded the guideline value.

Water sources with chloride in excess of the draft national guideline

Governorate	Sub-project	Water Source	Concentration (mg/L)
Gabes	Baten Trajma	Tube Well	728

Chloride at this level of concentration can give rise to detectable taste, though, it does not have any health effects. Sensory threshold for chloride varies among nations and regions as consumers can become accustomed to the taste.

4.4 Quality Assessment of SONEDE Water Supply System

4.4.1 Introduction

The quality of the remaining 15 water sources, which is under jurisdiction of SONEDE, is being regularly monitored and controlled by SONEDE following the national draft guideline for drinking water. Ministry of Health also has responsibility for inspection of the water quality.

4.4.2 Water Quality Inspection

The draft guideline recommends the treated water be controlled at outlet of treatment facility for bacteriological quality and chemical quality. The record of quality control should be kept and subjected to inspection at least twice a year by an engineer and a hygienist.

(1) Bacteriological Analysis

The draft guideline recommends that untreated water entering a distribution network be subjected to bacteriological analysis under the following sampling frequency.

Sampling Frequency for Bacteriological Analysis 1

Population	Maximum sampling intervals
Up to 30,000	1month
30,001 to 50,000	2 weeks
50,001 to 100,000	4 days
Over 100,000	1 day

Whether the water is treated or not, water samples from distribution system should be taken for analysis as follows.

Sampling Frequency for Bacteriological Analysis 2

Population	Sampling Intervals	Sampling frequency
20,000	One month	1 sample/month/5,000 heads
20,001 to 50,000	2 weeks	1 sample/month/5,000 heads
50,001 to 100,000	4 days	1 sample/month/3,000 heads
Over 100,000	1 day	1 sample/month/10,000 heads

(2) Physico-chemical Parameters

For distribution systems covering 50,000 heads or over, the standard requires to undertake analysis four times a year. While, for the distribution system covering less than 50,000, sampling frequency should be once every 6 months. If an incidence of contamination is observed, sampling frequency should be increased.

4.4.3 Assessment

An interview was conducted with responsible personnel at SONEDE which is planned to cover Jimla subproject in Zaghouan to confirm sampling frequency and parameters analysed in the monitoring activity. The past monitoring data for the latest one year of physico-chemical parameters and for one month of bacteriological parameters were collected for review and assessment.

Reviewing the past monitoring data of other SONEDE water supply systems, it was concluded that the water quality of SONEDE connection is generally well controlled and appropriate as drinking water source.

CHAPTER 5 ALLOWABLE AND DESIGN INTAKE FOR WATER SUPPLY

The allowable and design intakes of 43 subprojects are listed in Table B.5.1. The proposed design intake is decided based on the maximum daily demand of year 2017. However, design intake is sometimes restricted by allowable yield of each water source that is decided by potential of each water sources as mentioned in Chapter 3 in this Appendix.

The allowable intake of surface water and spring for each subproject is authorized by related local water resources office based on the agreement between AGR and local water resources office. The design intake of tube well should be considered with allocated an allowable intake of each well, because some tube wells use for irrigation and co-operative use with other communities. The allowable intake of each well is recommended by DGRE. The design intake of GR Extension and SONEDE connection are also restricted by the allowable intake which are provided from existing water supply systems.

CHAPTER 6 RECOMMENDATIONS

It is prospected that groundwater resources will be continued to develop for irrigation and water supply water sources in the rural area of Tunisia. Meanwhile, it is concerned that the groundwater level would decline in the long term. Therefore, groundwater development is managed by Directorate General of Water Resources, Ministry of Agriculture (DGRE) in Tunisia to secure the groundwater resource in the long term. Actually, the allowable intake of each deep well is recommended by DGRE. Therefore, DGGR make a water intake plan following the recommendation of DGRE to secure the groundwater resource for rural water supply in the long term.

Since securing quality water is a principal element for successful water supply project, regular monitoring of water quality is of great importance to improve welfare of beneficiaries.

Quality of several water sources included in the Project did not meet the national draft guideline for drinking water. Though the final decision on the realization of each subproject will be made by DGGR as the responsible executing agency, the Study Team advises DGGR to pay attention the health effects regarding lead (Pb), fluoride (F) and nitrate (NO_3^-) considering the particular conditions on the scarcity of water sources of each subproject area. However, the Study Team can not recommend in principle making use of water from such water sources especially regarding lead (pb) for drinking purpose.

Periodical monitoring of residual chlorine at service points is a prerequisite for all the subprojects to maintain the biological quality for drinking.