MINISTRY OF AGRICULTURE, WATER RESOURCES AND FISHERIES

SOCIETE NATIONALE D'EXPLOITATION ET DE DISTRIBUTION DES EAUX（SONEDE）

THE PREPARATORY SURVEY ON SFAX SEA WATER DESALINATION PLANT CONSTRUCTION PROJECT IN THE REPUBLIC OF TUNISIA

FINAL REPORT

VOL. 1 : MAIN

AUGUST 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.
INGEROSEC CORPORATION
JAPAN TECHNO CO., LTD.

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The cost estimates is based on the price level and exchange rates as of May 2015.

Exchange Rates: TND 1.000 = JPY 61.02

USD 1.00 = JPY 119.6

TND: Tunisian Dinar

JPY: Japanese Yen

USD: United States Dollars

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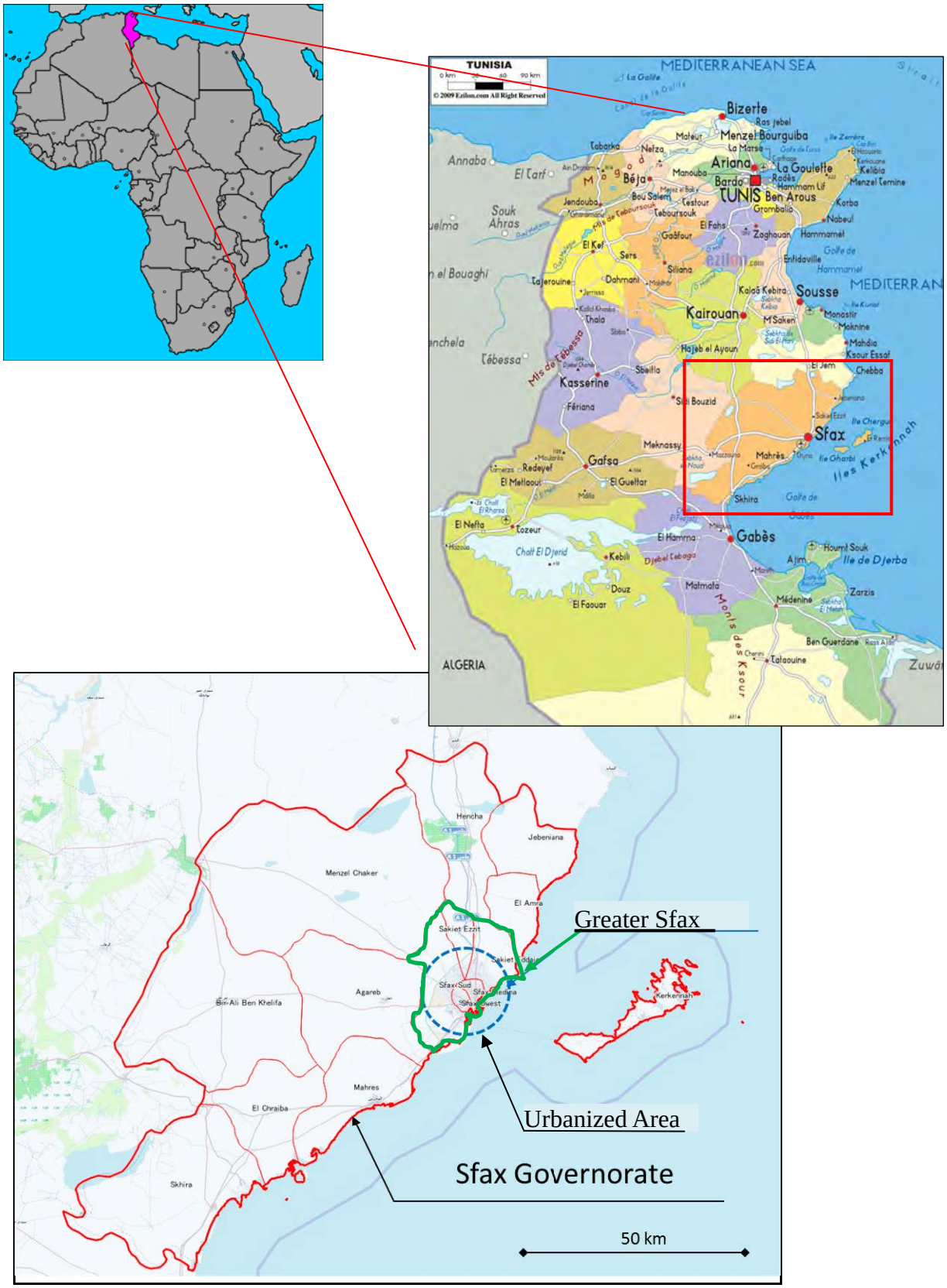

Location Map

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ABBREVIATIONS AND ACRONYMS

AFD	France Development Agency (Agence Française de Developpement)
AfDB	African Development Bank
ANPE	National Agency for Environmental Protection (Agence Nationale de Protection de l'Environnement)
APAL	Coastline Protection and Planning Agency (Agence de Protection et d'Aménagement du Littoral)
C/P	Counter Part
COD	Chemical Oxygen Demand
CPI	Consumer Price Index
CRDA	Agricultural Development Regional Commission (Commisariats Régionaux du Développement Agricole)
DCIP	Ductile Cast Iron Pipe
DGBGTH	General Directorate of Dams and Large Hydraulic Works (Direction Générale du Génie Rurale et de l'Exploitation des Eaux)
DGGREE	General Directorate of Rural Engineering and Water Exploitation (Direction Générale du Génie Rurale et de l'Exploitation des Eaux)
DGRE	General Directorate of Water Resources (Direction Générale de Ressources en Eau)
EC	European Commission
EIA	Environmental Impact Assessment
EIB	European Investment Bank
F/S	Feasibility Study
FADES	Arabic Fund for Social Economic Development (Le Fonds arabe de développement économique et social)
GDA	Agricultural Development Groups (Groupments de Développement Agricole)
GDP	Gross National Products
GNI	Gross National Income
HDPE	High Density Polyethylene
ICT	Information and Communication Technology
IME	Mechanical and Electrical Industry
IT/R	Interim Report
ITH	Garments and Apparel Industry
JICA	Japan International Cooperation Agency
lpcd	Litres per Capita per Day
KfW	German Reconstruction Loan Banking Group (Kreditanstalt für Wiederaufbau)
MDICI	Ministry of Development, Investment and International Cooperation (Ministère du Développement, de l'Investissement et de la Coopération Internationale)

MOA	Ministry of Agriculture, Water Resources and Fisheries (Ministère de l'Agriculture, des Ressources Hydrauliques et de la Pêche)
ND	not detected
NT09.14	Tunisian Drinking Water Quality Standard (NT09.14:1983 or 2013)
NTU	Unit of Turbidity (Nephelometric Turbidity Unit)
ONAS	National Office of Sanitation (Office National de l'Assainissement)
PC	Cluster (Pôle de Compétitivité)
RO	Reverse Osmosis
SEDCI	State Secretary of Development and International Cooperation, Ministry of Economy and Finance (Secrétaire d'Etat au Développement et à la Coopération internationale, former Ministry of Development and International Cooperation (MDCI))
SECADENORD	National Corporation for Development of North Canal and Conveyors (Société d'exploitation du canal et des adductions des eaux du nord)
SONEDE	National Water Distribution Utility (Société Nationale d'Exploitation et de Distribution des Eaux)
STEG	Tunisian Company of Electricity and Gas (Société Tunisienne de l'Electricité et du Gaz)
TDS	Total Dissolved Solid
TOR	Term of Reference
TND	Tunisian Dinar (Tunisian currency unit)
WHO	World Health Organization

SUMMARY

CHAPTER 1 PURPOSE AND CONTENTS OF THE SURVEY

1.1 Purpose of the Survey

This survey is conducted for the formation of the project suitable for the Japanese ODA loan to the Tunisian government, with the Ministry of Foreign Affairs, the Ministry of Development, Investment and International Cooperation, and the Ministry of Finance as borrower, and the National Water Distribution UtilityWater (French: Société Nationale d'Exploitation et de Distribution des Eaux, hereinafter referred to as "SONEDE") as the executing agency. The purpose of the survey is to contribute to the implementation of the Project as the Japanese ODA loan project by conducting feasibility study for Sfax Seawater Desalination Plant.

Accordingly, the accomplishment of the survey will be the reference for loan assessment by JICA and the scope of work planned in the survey will be the basis for the Project under the Yen loan.

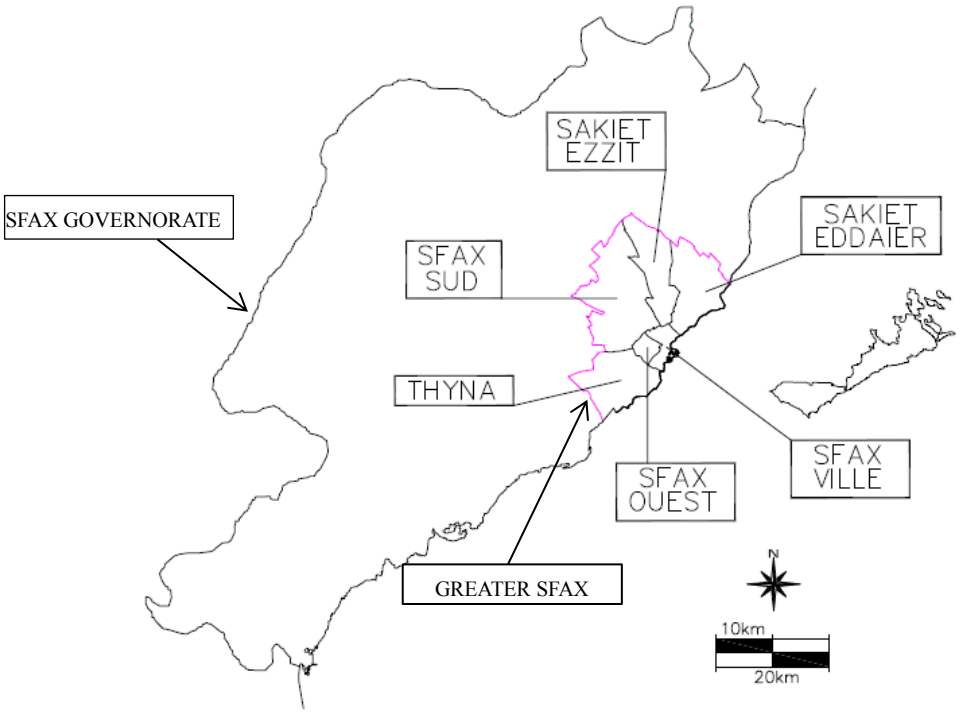
1.2 Scope of the Project

Scope of the Project is for a seawater desalination plant with a production capacity of 200,000 m^3/day. However, 100,000 m^3/day is the subject capacity for the Japanese ODA loan including intake and discharge facilities, transmission pipeline, distribution reservoir, and related pumping facilities.

1.3 Survey Area

The area of the survey is the Greater Sfax and its surrounding area. Sfax is a city, located 270 km southeast of Tunis, and is the capital of the Sfax Governorate. The city expansion is explained with the development as a harbour city, and of the road system to inland in multi-direction from the port. Recently, a circular road was developed and urbanization extends along the road.

The Greater Sfax consists of Sfax Ville and five (5) delegations i.e. Sfax Ouest (West), Sfax Sud (South), Thyna, Sakiet Ezzit and Sakiet Eddaier. Each delegation consists of several sectors. There are 43 sectors in total in the Greater Sfax.



Source: JICA Survey Team

Figure 1-1 Administrative Map of the Greater Sfax

1.4 Relevant Authorities

Authorities relevant to the survey are as follows:

- Counterpart: National Water Distribution Utility (SONEDE)
- Related Authorities：
  1) Ministry of Development, Investment and International Cooperation (MDICI, Window for the Japanese ODA loan)
  2) Ministry of Finance (Borrowing and repayment of the Japanese ODA loan)
  3) Ministry of Agriculture, Water Resources and Fisheries (Regulatory authority of SONEDE)
  4) Ministry of Foreign Affairs (International relation, Agreement with Foreign Countries)
  5) Ministry of Environment and Sustainable Development
     Environmental Protection Agency (ANPE, Appraisal of Environmental Impact Assessment)
     Coastal Protection and Development Agency (APAL, Approval of Development in Coast)

1.5 Schedule of the Survey

The survey was conducted in two phases as follows:

(1) Phase 1 (September to December 2013): Confirmation of Necessity and Viability of Seawater Desalination Plant

The Phase 1 survey was started from 13 September 2013, and the Field Work was conducted from 28

September to 23 November, 2013 after the preparatory work. After the fieldwork, the work was conducted in Japan up to the beginning of January 2014.

(2) Phase 2 (January 2014 to August 2015): Feasibility Study

The feasibility study was conducted from January 2014 to August 2015.

The second fieldwork was conducted from the middle of January to the beginning of March 2014. After the succeeding work in Japan, the accomplishments were compiled as the Interim Report 2.

The third fieldwork was started from the middle of April 2014 and was conducted up to the middle of June, after which the Draft Preparatory Survey Report was made in Japan from June to September 2014.

Explanation and discussion on the draft report were carried out on 29 September 2014. The Final Report, which included the revisions on the draft report reflects comments from Tunisian side, and was prepared and submitted in August 2015[1].

This report was prepared based on the information obtained up to June 2015.

CHAPTER 2 REVIEW OF EXISTING INFORMATION AND EXPLORATION

2.1 Natural Condition

The Greater Sfax is located in the middle area of semi-arid climate of the Republic of Tunisia. It has an area of 163,610 km^2, but is characterised by mild climate with relatively high humidity because it face the Mediterranean Sea.

2.1.1 Meteorological Information

(1) Temperature

The average annual temperature in the past 21 years (1992-2012) is 18 ^oC. The climate is divided into cold season from December to February and hot summer season from July to September. The climates in spring and autumn are pleasant.

(2) Humidity

Due to the influence of the Mediterranean Sea, the humidity is around 50% to 70% through the year. Figure 2.1-2 shows the humidity ranges during 2010-2013.

[1] After explanation of the draft report, revision of water balance between demand and supply, water source allocation plan were conducted to reflect SONEDE's comments, and revision of facility development plan was conducted to cope with the change of distribution flow as well. Further, review of the project cost, and financial and economic analysis were also conducted.

(3) Wind

Wind blows 300 days in a year with varying directions by season. In winter, the land breeze blows from the direction ranging between North and Southwest. In summer, the sea breeze blows from the direction ranging between east and southeast. Figure 2.1-3 shows changes in wind blow directions from 2010 to 2013.

(4) Precipitation

Annual average precipitation in Greater Sfax in past 20years (1991-2010) is 228.5mm (464.5mm in Tunis). Rainfall averages about 25mm per month during the period of September to April, and then decreases from the beginning of May. There is scarce precipitation in the period from June to August.

2.1.2 Topography and Geography

Greater Sfax area is the urban area spreading like a fan from the harbour. It has a little monotonous undulating terrain, gently sloping towards the sea.

2.1.3 Marine Context

(1) Tidal data

The tidal data at Sfax Port is as shown in the table below.

Table 2-1 Tidal Data

	Average tidal	Maximum tidal	Minimum tidal
Above sea level (m)	+1.16	+2.15	+0.00

Source：RAPPORT DU CENTRE HYDROGRAPHIQUE ET OCEANOGRAPHIQUE DE LA MARINE NATIONALE DE LA TUNISIE

(2) Sea Current

The sea current in the Mediterranean is generally very weak, flowing towards the east Mediterranean from the west Mediterranean. It is characterized as an arid region of high temperature and high amount of evaporation region. Offshore of Sfax sees the current flows move slowly along the coast from Sousse to Gabes. The cyclic tidal current flows along the coast of the Greater Sfax corresponding to the rise and fall of the tide.

(3) Bathymetric Survey

The coast of the Greater Sfax slopes gently away from the water's edge. The offshore seabed from La Cheba to Sfax through Kerkennah continues with less than 5 m in depth. The seabed with less than 10m depth spreads to 5km offshore along Gabes Bay, south of Sfax. A 60 m wide channel to the Sfax seaport has been dredged to 11m depth to offshore of about 4.5 km.

2.2 Social and Economic Situation

Tunisia is positioned as a more developed country using the income classification by the World Bank. In

2013, Tunisian GDP was US$46.99 Billion and GDP growth rate was 2.5%. GNP per capita was US$4,317 although growth has slowed down. Overall unemployment rate for the second quarter of 2013 was 13.3% and the unemployment rate of young people was particularly high and has remained at high levels over a long period.

2.3 Population

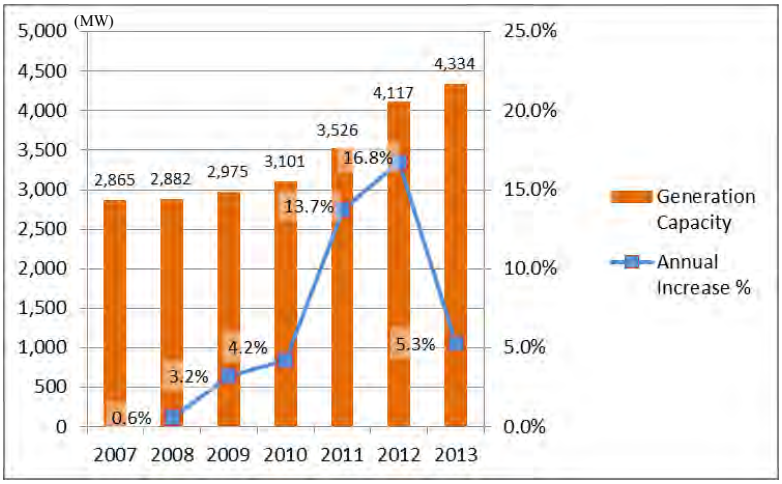
The population of Tunisia was 10.89 million in 2013. Urban population stood at 66%, and 34% of the population live in rural area. Working-age population was 43% and young working-age population was high at 33%.

The Greater Sfax, whose main area is inside the Route 11 bypass, is the second biggest city in Tunisia. It is a commercial hub where 620 thousand people out of 970 thousand of the entire Sfax region live as of July 2013. Many students, reaching almost 50,000, live in this area, but they come from other regions. During the summer holidays, the student population decreases. Many tourists stay in Tunisia during the summer holiday season, but most of them go to the resort areas such as Djerba and Sousse. Tourists do not generally stay in Sfax.

For the period between 2003 and 2013, the average population increase rate of Tunisia was 1.02%/year. For the Tunis Governorate, it was 0.21 %/year, while it ws 1.37%/year for the Sfax Governorate exceeding that of Tunis.

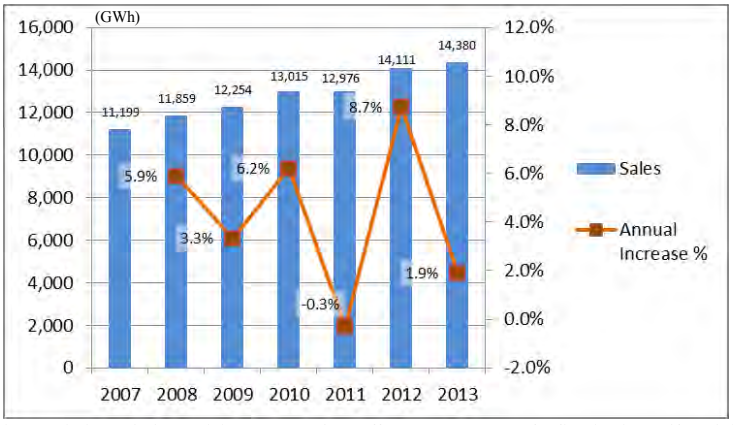
2.4 Situation of Power Supply

STEG is a main power supplier in Tunisia. The status of its power generation and power sales are as shown in Figures 2-1 and 2-2.



Source: Annuaire Statistique de la Tunisie 2007-11, https://www.steg.com.tn/en/institutionnel/produire.html (2012-13)

Figure 2-1 STEG Power Generation Capacity



Source: Annuaire Statistique de la Tunisie 2007-11, https://www.steg.com.tn/en/institutionnel/produire.html (2012-13)

Figure 2-2 STEG Power Sales

The power generation of STEG has been continuously increasing since 2008 at a relatively high rate. It was 3,526 MW in 2011 with an annual increase rate of 13.7%, 4,117MW with 16.8% increase in 2012, and 4,334 MW with 5.3% increase in 2013. Total power sales has also generally shown increasing tendency. It in 2011, however, showed slight decrease of 0.3% over the previous year at 12,976 GWh. It could be caused by the stagnation of industrial activities due to the Jasmine Revolution. However, it increased to 14,111 GWh in 2012 and 14,380 GWh in 2013.

Power Sales in 2007 was 44.6% (= (11,199 x 10^9) / (2,865 x 10^6 x 24 x 365)) of Generation Capacity. It was decreased to 37.9% (= (14,380 x 10^9) / 4,334 x 10^6 x 24 x 365)). This fact shows the improvement of balance between power supply and demand. STEG has been exerting effort to improve the situation.

CHAPTER 3 PRESENT STATUS OF WATER SUPPLY SERVICE IN TUNISIA

3.1 Relevant Organization and Legal Framework of Water Sector

3.1.1 Outline of Relevant Organization

The Ministry of Agriculture, Water Resources and Fisheries (hereinafter referred to as "MOA") develops the policy framework of the water sector in Tunisia, based on the Water Act of 1975. The MOA, the governing authority of SONEDE develops policy and plans for the water sector as well as constructs, operates and maintains large scale hydraulic structures. SONEDE, on the other hand, supplies drinking and industrial water to urban and large-scale rural communities aligned with the policy and developed plan using the hydraulic structures managed by the MOA.

3.1.2 National Water Distribution Utility (SONEDE)

SONEDE was established in 1968 as a financially autonomous public company under the control of the MOA. It is in charge of supplying drinking water nationwide, and conducts research and planning on the intake, transfer, treatment, transmission and distribution of water, as well as uses, renews, operates and

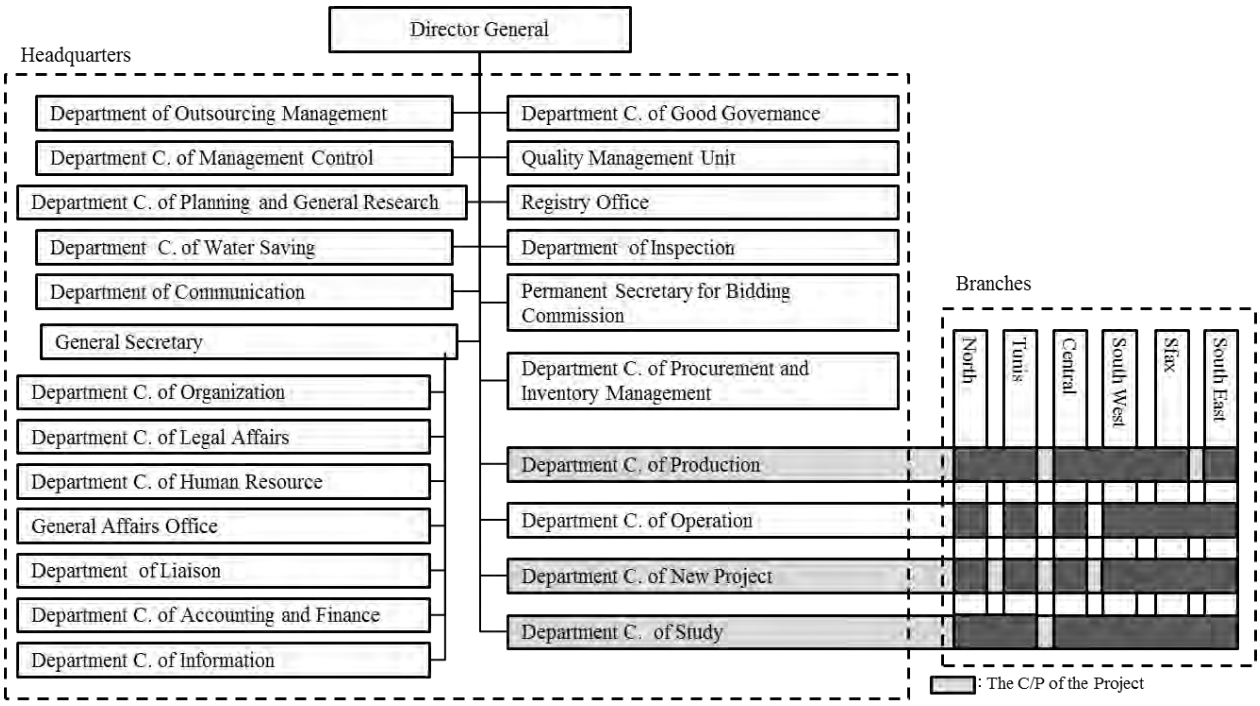
maintains constructed hydraulic works. The outline of organization and its activities as of 2013 are shown in Table 3-1.

Table 3-1 Outline of Organization and Activities of SONEDE (2013)

Item	Description	Remarks
Number connections	2,550,318 connections	Number of employees per 1,000 connections: 6,818 employees /2,550,318 connections /1000 =2.67
Served Population	9.11 million	
Annual Volume of Production	609.4 million m^3	Details of production: - Surface water: 347.2 million m^3 - Groundwater: 234.4 million m^3 - Desalinated water: 19.7 million m^3 - Deferrizated water: 6.2 million m^3
Annual Volume of Distribution	555.5 million m^3	
Annual Volume of Revenue Water	449.9 million m^3	
Length of Pipelines	49,500 km	Details: - Intake and Conveyance: 9,400 km - Transmission and Distribution:40,100 km
Personnel	Total 6,818 Permanent Employee 6,039 Temporary Employee 779	Breakdown of Permanent Employee - Technical: 4,505 - Administrative: 1,534

Source: SONEDE and JICA Survey Team

The organogram of SONEDE is shown in Figure 3-1.



Source: SONEDE and JICA Survey Team

Figure 3-1 Organogram of SONEDE (as of October 2014)

3.2 Water Balance in Tunisia

As shown in Table 3-2 and Table 3-4, among the available water resources of below 3000mg/L TDS, 100% of the surface water and almost the entire groundwater have been utilized, and only water sources of more

than 3000mg/L are available. The utilization of the remaining water is limited due to salinity. For example, in accordance with the water norm for agricultural use, TDS is permissible up to 2000mg/L, but actually, the remaining water meetin this criterion is very limited. For olive cultivation the permissible TDS is about 3000mg/L; however, in the long run, the salinity accumulates in the ground and exceeds the permissible value.

Table 3-2 Water Resources and Water Availability for Use in Tunisia (2013)

unit: Million m^3/year

	Water Resources	Water Availability for Use*			
		TDS <1500mg/L	1500<TDS <3000mg/L	3000mg/L <TDS	Total
Surface Water	2,700	1,200	400	100	1,700
Groundwater	2,100	300	800	500	1,600
Total	4,800	1,500	1,200	600	3,300

Remarks* : MOA plans to take measures to increase the water availability for use.
Source: MOA Documents

Table 3-3 Water Demand and Resources in Tunisia (2013)

unit: million m^3/year

Usage	Demand	Surface Water			Groundwater		
		TDS <1500mg/L	1500<TDS <3000mg/L	3000mg/L <TDS	TDS <1500mg/L	1500<TDS <3000mg/L	3000mg/L <TDS
Irrigation	2,160	970	370	0	250	570	0
Drinking	380	160	0	0	40	110	70
Industries	130	60	20	0	10	40	0
Tourism	30	10	10	0	0	10	0
Total	2,700	1,200	400	0	300	730	70
Utilized rate		100%	100%	0%	100%	91%	14%

Source: MOA Documents, SONEDE Documents

Table 3-4 Water Balance between Demand and Resources in Tunisia (2013)

unit: million m^3/year

	Demand			Water Available to Use			Utilized rate		
Usage	Surface Water	Ground water	Total	Surface Water	Ground water	Total	Surface Water	Ground water	Total
Irrigation	1,340	820	2,160						
Drinking	160	220	380						
Industries	80	50	130						
Tourism	20	10	30						
Total	1,600	1,100	2,700	1,700	1,600	3,300	94%	69%	82%

Source: MOA Documents, SONEDE Documents

3.3 Future Plan of Water Sector

The Tunisian Government released the 12th Five Year Plan (2010 – 2014), before the revolution in 2011. This national plan, which includes water service rate of 100% in urban area and an installation of seawater

desalination plants for the drinking water quality improvement, was cancelled because of the revolution. SONEDE, however, works based on the national plan.

This Project is to construct a seawater desalination plant contributing the improvement of drinking water quality while sustaining 100 % service rate in the urban area. Therefore, this Project meets the policy of the water sector in Tunisia. Presently, the Tunisian Government is preparing to implement its new social economic development plan from 2016 to 2020, which aims 7% annual increase of GDP.

CHAPTER 4 WATER SUPPLY PLAN FOR GREATER SFAX

4.1 Current Status and Future Plan of Water Sector

4.1.1 Current Status of Water Sector

SONEDE is in charge of water supply in urban areas and large rural centres in the Sfax Governorate, while the General Directorate of Rural Engineering and Water Exploitation (DGGREE, French; La Direction Générale du Génie Rural et de l'Exploitation des Eaux) is in charge of medium and small water supply systems. The population and the population served data in the Sfax Governorate from 2006 to 2012 are shown in Table 4-1.

Table 4-1 Administrative and Served Populations in Sfax Governorate

unit: 1,000m^3/year

Item \ Year		2006	2007	2008	2009	2010	2011	2012
Total Population		887.9	900.0	911.3	923.8	936.7	938.7	963.1
Urban	Population	570.0	578.9	586.5	595.6	605.0	613.8	624.2
	SONEDE Covered Pop.	570.0	578.9	586.5	595.6	605.0	613.8	624.2
	Covered Rate	100%	100%	100%	100%	100%	100%	100%
Rural	Population	317.9	321.1	324.8	328.2	331.7	334.9	338.9
	SONEDE Covered Pop.	179.2	183.8	188.6	192.3	194.4	197.6	199.9
	DGGR Covered Pop.	131.6	134.4	134.6	118.0	119.4	119.1	120.6
	Covered Rate	97.8%	99.1%	99.5%	94.5%	94.6%	94.6%	94.6%
Covered Rate in Sfax Governorate		99.2%	99.7%	99.8%	98.1%	98.1%	98.1%	98.1%

Source: SONEDE Annual Report

The annual water supplies (consumption) in the Sfax Governorate from SONEDE are shown in Table 4-2.

Table 4-2 Annual Water Supply in Sfax Governorate (Consumption)

unit: 1,000m^3/year

Item \ Year		2006	2007	2008	2009	2010	2011	2012
House Hold Water	Connection Supply	23,037	24,064	26,164	26,388	28,093	29,138	31,440
	Communal Tap	1,364	1,560	2,116	1,965	3,072	2.396	2,862
	Total	24,401	25,624	28,280	28,353	31,165	31,534	34,302
Public Office & Commercial		3,186	3,278	3,257	3,307	3,428	3.464	3,648
Industrial		2,784	2,817	2,921	2,786	2,963	2,826	3,441
Tourism		191	199	209	205	189	173	182
Others		229	246	188	136	138	177	97
Total		30,791	32,164	34,855	34,787	37,883	38,174	41,670

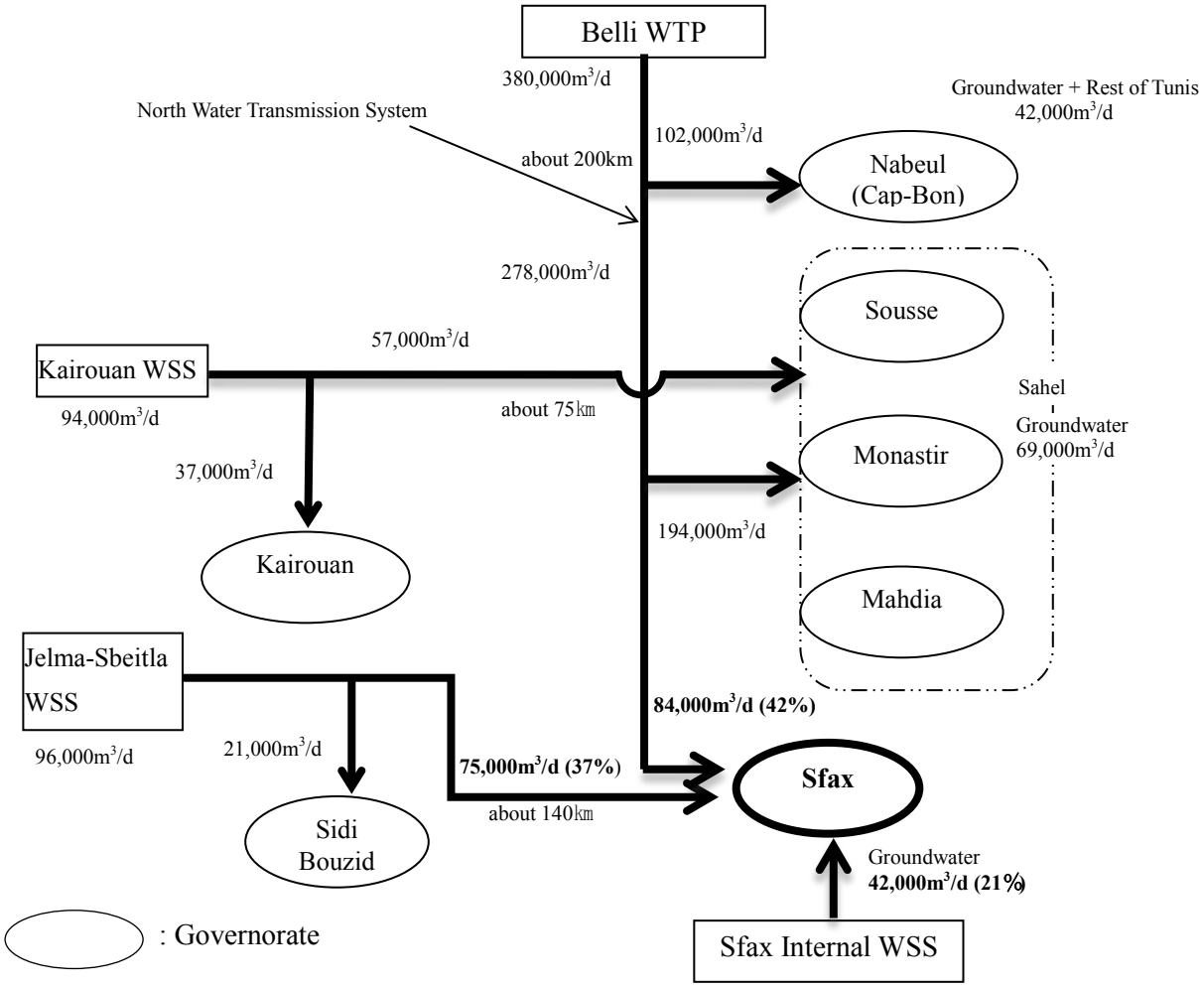
Source: SONEDE Annual Report

The usage-wise rates of SONEDE water supply in 2012 are as follows; Household; 82.3%, Administration and Commercial; 8.8%, Industrial; 8.3%, Tourism; 0.4%, Others; 0.2%. Regarding the water supply for industries, the figures are only from SONEDE's subscribers and relatively large-scale consumers such as factories which have their own private wells and to obtain required water supply. With the growth of population and industrial expansion, the water demand is also increasing. SONEDE's responsibility is to ensure continuous water supply services to their growing customer bases.

4.1.2 Water Resources for Water Supply in Sfax

(1) Outline of Water Resources

Water resources for the water supply in the Sfax Governorate are from the North Water Transmission System, the Jelma-Sbeitla Groundwater Transmission System from Sidi Bouzid Governorate and Sfax's own groundwater supply. Figure 4.1-2 shows a schematic diagram of the water resources for the water supply in the Sfax Governorate. Total available water supply volume at peak period in 2013 was 201,000 m^3/day and ratios by each water source are 42%, 37%, and 21% respectively.



Source: JICA Survey Team
Note: Water flow rate is estimated at the peak in 2013.

Figure 4-1 Schematic Diagram of the Water Resources for Sfax Governorate

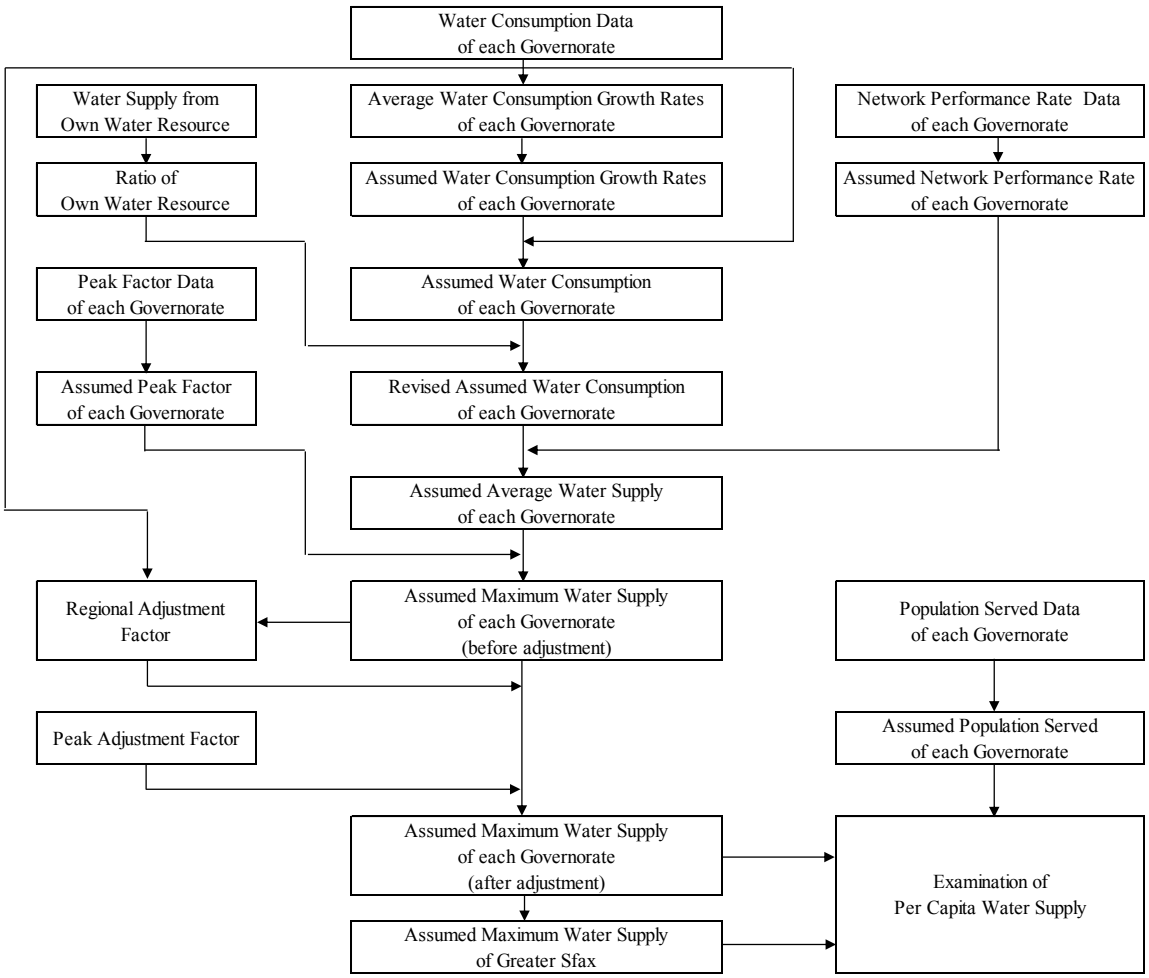
4.2 Water Demand and Supply in North Water Transmission System

4.2.1 Water Demand in North Water Transmission System

SONEDE formulated the "Feasibility Study on the Mid-South Area Water Supply Scheme" in 2005, target year being on 2030. As the countermeasure against severe water shortage which occurred in 2012, the "Strategic Study" was formulated in 2013. The Strategic Study, however, was prepared within spending several months only because the Feasibility Study had been already formulated, and the formulated plan was requested to be implemented urgently. The future water demand was estimated by a statistical analysis on the past water supply data in seven Governorates such as Cap-Bon (Nabeul Governorate), Sahel (Sousse, Monastir and Mahdia), Kairouan, Sfax, and Sidi Bouzid, based on the following detailed assumptions:

In this survey, water demand was reviewed based on the method applied in the Strategic Study with revision by following adjustment parameters. Then, appropriateness of results was examined by

considering the calculated per capita consumption. The flow diagram of projection of the survey stated above is as shown in Figure 4-2.



Source：JICA Survey Team

Figure 4-2 Flow Diagram of Water Demand Projection of the Survey

The maximum water demand by governorate is shown in Table 4-3.

Table 4-3 Maximum Water Demand by Governorate

Unit: m^3/day

Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
2011	134,247	124,110	102,740	71,233	173,425	35,068	19,452	660,274
2012	138,904	127,945	106,027	74,795	179,178	35,616	20,000	682,466
2013	144,384	131,507	109,863	78,630	185,479	36,986	21,096	707,945
2014	149,589	135,616	113,151	82,466	191,507	38,082	21,644	732,055
2015	154,795	139,726	116,438	86,575	198,356	39,178	22,740	757,808
2016	160,274	144,110	120,274	90,685	205,479	39,726	23,562	784,110
2017	166,301	148,493	123,562	95,342	211,781	40,548	24,658	810,685
2018	171,781	153,151	127,397	100,000	219,452	41,370	25,479	838,630
2019	178,082	156,986	131,233	104,932	226,575	41,918	26,301	866,027
2020	184,384	161,918	135,616	110,137	234,521	42,740	27,397	896,712
2021	190,959	166,849	140,000	115,616	242,466	44,110	27,945	927,945
2022	197,808	172,055	144,384	121,644	251,233	45,205	29,589	961,918
2023	205,205	177,260	148,767	127,397	259,452	46,301	30,137	994,521
2024	212,603	182,740	153,425	134,247	268,219	47,945	31,781	1,030,959
2025	219,726	187,945	158,082	141,096	277,260	48,767	32,877	1,065,753
2026	227,671	193,425	163,562	147,671	287,123	49,863	33,425	1,102,740
2027	236,164	199,452	167,945	155,068	296,986	50,959	35,342	1,141,918
2028	244,658	205,753	173,699	163,288	307,123	52,055	36,986	1,183,562
2029	253,425	211,507	179,178	171,507	317,808	53,151	38,082	1,224,658
2030	262,740	217,808	184,658	180,274	328,493	54,247	39,178	1,267,397
2031	272,329	224,384	190,137	189,315	340,822	56,438	41,370	1,314,795
2032	281,918	231,233	196,164	198,904	353,699	57,534	42,466	1,361,918
2033	292,603	238,082	201,918	209,315	366,301	59,726	44,658	1,412,603
2034	303,014	244,932	208,493	219,726	379,726	60,822	46,301	1,463,014
2035	313,699	252,055	214,521	230,685	393,425	63,014	48,219	1,515,616

4.2.2 Water Supply Plan in North Water Transmission System

In the Strategic Study, the scenario for the water supply to meet the demand until 2030 was studied. In the Survey, the JICA Survey Team confirmed from SONEDE about the implementation of the treatment plants planned in the Strategic Study. As a result of discussion, SONEDE indicated the one-year delayed schedule of the project for Saida reservoir and Kalaa Kebira reservoir and the water treatment plant as shown in Table 4-4. SONEDE also intends to expedite the project for Sfax Seawater Desalination Plant as soon as possible.

Table 4-4 Water Treatment Plant and Seawater Treatment Plant formulated in the Strategic Study

Name	Year	Production capacity	Supply to Greater Sfax
Saida reservoir & Kalaa Kebira reservoir / water treatment plant	2020	1,500 L/s (129,600 m^3/d)	-*
	2024	3,000 L/s (259,200 m^3/d)	-*
	2029	4,000 L/s (345,600 m^3/d)	-*
Sfax sea water desalination plant	2020	1,157 L/s (100,000 m^3/d)	1,157 L/s (100,000 m^3/d)
	2026	2,325 L/s (200,000 m^3/d)	2,325 L/s (200,000 m^3/d)

*: As a part of the North Water Transmission System, supplied water is mixed with the water supplied by existing water sources.
Source: SONEDE, 2014

In this survey, the schedule presented by SONEDE is applied for the project for Saida reservoir and Kalaa Kebira reservoir and the water treatment plant. The Sfax Seawater Desalination Plant, however, is scheduled taking into consideration the required period and procedures for the Japanese ODA loan for the Project. After examining the schedule, (which is discussed in detail in Chapter 10), the commissioning of the plant is expected by 2022. The period for the Phase 1 is therefore considered as the period when the capacity of the Phase 1 facilities, 100,000 m^3/day, which is a half of final capacity, can meet the demand. After that, the Phase 2 period will be started.

Even though new water resources stated above are developed, the upstream areas of the North water transmission system will experience water shortage by 2021 caused by increased water demand. Because of this reason, an additional water source with a capacity of 250,000 m^3/day will have to be developed at the place close to large water demand areas like Souse Governorate to avoid transmission of big volume of water.

4.2.3 Review on Demand and Supply Plan in the Strategic Study

Water demand and supply were reviewed under the conditions stipulated in Sections 4.2.1 and 4.2.2. The results are presented in Tables 4-5 to 4-7, and Figures 4-3. In addition, calculation table showing demand and supply analysis in seven governorates is presented in Table 4-8.

Table 4-5 Water Demand in Seven Governorates in North Water Transmission System

	2015	2020	2025	2030	2035
Population	4,469,600	4,731,500	4,993,700	5,255,700	5,517,800
Population Served	3,732,100	4,014,100	4,296,200	4,578,100	4,860,200
Per Capita Consumption (L/person/day)	103	114	127	143	161
Non Domestic Rate (%)	22	22	22	22	22
Average Non-Revenue Water (%)	23.7	23.0	22.4	21.8	22.0
Daily Average Demand (m^3/day)	581,400	687,700	816,700	971,000	1,161,100
Peak Factor (Daily Max/Daily Average)	1.303	1.291	1.305	1.305	1.305
Daily Maximum Demand (m^3/day)	757,800	887,500	1,065,700	1,267,400	1,515,600

*: Daily Max/Daily Average of seven governorates x adjusting coefficient (0.944)
Source: JICA Survey Team

Table 4-6 Water Balance in Seven Governorates in North Water Transmission System (existing facilities only)

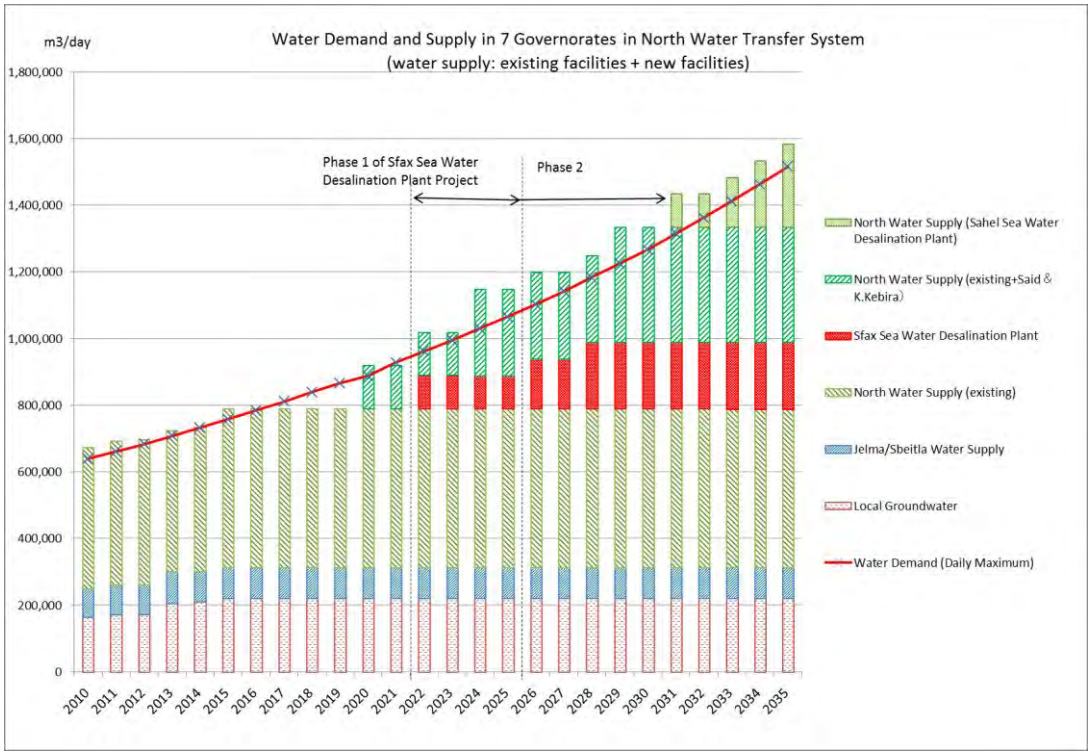
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	North Water Transmission	476,800	477,600	477,500	477,200	476,800	476,300
	Jelma-Sbeitla GW Transmission	91,600	91,600	91,600	91,600	91,600	91,600
	Local Groundwater	221,400	221,400	221,400	221,400	221,400	221,400
	Total	789,800	790,600	790,400	790,100	789,700	789,300
Daily Maximum Water Demand		757,800	887,500	961,800	1,065,700	1,267,400	1,515,600
Balance		31,900	▲97,000	▲171,400	▲275,600	▲477,700	▲726,400

Source: JICA Survey Team (Note: Due to rounding, (available volume-demand) is not equal to Balance.)

Table 4-7 Water Balance in Seven Governorates in North Water Transmission System (existing facilities + new facilities)

(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	Sahel Desalination Plant	0	0	0	0	0	250,000
	Saida/Kalaa Kebira WTP	0	129,600	129,600	259,200	345,600	345,600
	Sfax Desalination Plant	0	0	100,000	100,000	200,000	200,000
	North Water Transmission	476,800	477,600	477,500	477,200	476,800	476,300
	Jelma-Sbeitla Groundwater Transmission	91,600	91,600	91,600	91,600	91,600	91,600
	Local Groundwater	221,400	221,400	221,400	221,400	221,400	221,400
	Total	789,700	920,200	1,020,000	1,149,300	1,335,300	1,584,900
Daily Maximum Water Demand		757,800	887,500	961,800	1,065,700	1,267,400	1,515,600
Balance		31,900	32,600	58,200	83,600	67,900	69,200

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4-3 Water Demand and Supply in Seven Governorates in North Water Transmission System (water supply: exiting facilities + new facilities)

Table 4-8 Water Demand and Supply in Seven Governorates in North Water Transmission System

(unit: L/sec.)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Nabeul																										
Belli Treatment Plant	4,268	4,398	4,398	4,398	4,398	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798
Local Resources +Tunis Unit	634	611	646	489	596	720	737	735	733	731	730	729	728	727	726	725	724	723	722	721	720	719	718	717	716	715
Total resources in Nabeul	4,902	5,009	5,044	4,887	4,994	5,518	5,535	5,533	5,531	5,529	5,528	5,527	5,526	5,525	5,524	5,523	5,522	5,521	5,520	5,519	5,518	5,517	5,516	5,515	5,514	5,513
Qpj	1,503	1,554	1,608	1,671	1,731	1,792	1,855	1,925	1,988	2,061	2,027	2,210	2,289	2,375	2,461	2,543	2,635	2,733	2,832	2,933	3,041	3,152	3,263	3,387	3,507	3,631
Balance of Nabeul	3,399	3,455	3,436	3,216	3,263	3,726	3,680	3,608	3,543	3,468	3,501	3,317	3,237	3,150	3,063	2,980	2,887	2,788	2,688	2,586	2,477	2,365	2,253	2,128	2,007	1,882
Kairouan																										
Local resources in Kairouan	1,085	1,085	1,085	1,091	1,091	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119
Qpj	396	406	412	428	441	453	460	469	479	485	495	511	523	536	555	564	577	590	602	615	628	653	666	691	704	729
Balance of Kairouan	689	679	673	663	650	666	659	650	640	634	624	608	596	583	564	555	542	529	517	504	491	466	453	428	415	390
Sahel (Sousse+Monastir+Mahdia)																										
Local Resources of Sahel	528	614	614	794	866	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952
Saida/K.Kebira Reservoirs+WTP （1500L/s + 1500L/s + 1000L/s）											1,500	1,500	1,500	1,500	3,000	3,000	3,000	3,000	3,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sahel Desalination Plant （100,000 m3/d+50,000m3/d+50,000m3/d+50,000m3/d）																						1,157	1,157	1,736	2,315	2,894
Arrival from Kairouan	689	679	673	663	650	666	659	650	640	634	624	608	596	583	564	555	542	529	517	504	491	466	453	428	415	390
Arrival from Northern Water	3,399	3,455	3,436	3,216	3,263	3,726	3,680	3,608	3,543	3,468	3,501	3,317	3,237	3,150	3,063	2,980	2,887	2,788	2,688	2,586	2,477	2,365	2,253	2,128	2,007	1,882
Total resources	4,616	4,748	4,723	4,673	4,779	5,344	5,291	5,210	5,135	5,054	6,577	6,377	6,285	6,185	7,579	7,487	7,381	7,269	7,157	8,042	7,920	8,940	8,815	9,244	9,689	10,118
Qpj in Sousse	1,398	1,436	1,481	1,522	1,570	1,617	1,668	1,719	1,773	1,817	1,874	1,931	1,991	2,052	2,115	2,175	2,239	2,308	2,381	2,448	2,521	2,597	2,676	2,756	2,835	2,917
Qpj in Monastir	1,161	1,189	1,227	1,272	1,310	1,348	1,392	1,430	1,475	1,519	1,570	1,620	1,671	1,722	1,776	1,830	1,893	1,944	2,010	2,074	2,137	2,201	2,270	2,337	2,413	2,483
Qpj in Mahdia	786	824	866	910	954	1,002	1,050	1,104	1,157	1,214	1,275	1,338	1,408	1,475	1,554	1,633	1,709	1,795	1,890	1,985	2,087	2,191	2,302	2,423	2,543	2,670
Total Qpj in Sahel	3,345	3,449	3,574	3,704	3,834	3,967	4,110	4,253	4,405	4,550	4,719	4,889	5,070	5,249	5,445	5,638	5,841	6,047	6,281	6,507	6,745	6,989	7,248	7,516	7,791	8,070
Balance of Sahel	1,271	1,299	1,149	969	945	1,377	1,181	957	730	504	1,858	1,488	1,215	936	2,134	1,849	1,540	1,222	876	1,535	1,175	1,951	1,567	1,728	1,898	2,048
Sidi Bouzid																										
Local resources in Sidi Bouzid	977	1,019	1,019	1,115	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
Qpj	219	225	231	244	251	263	273	285	295	304	317	323	342	349	368	381	387	409	428	441	453	479	492	517	536	558
Balance of Sidi Bouzid	758	794	788	871	809	797	787	775	765	756	743	737	718	711	692	679	673	651	632	619	607	581	568	543	524	502
Sfax																										
Local Resources of Sfax	301	301	301	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491
Sfax Desalination Plant Ph1/2 (100,000+100,000 m3/d)													1,157	1,157	1,157	1,157	1,736	1,736	2,315	2,315	2,315	2,315	2,315	2,315	2,315	2,315
Arrival from Northern Water	1,271	1,299	1,149	969	945	1,377	1,181	957	730	504	1,858	1,488	1,215	936	2,134	1,849	1,540	1,222	876	1,535	1,175	1,951	1,567	1,728	1,898	2,048
Arrival from Sbeitla-Jelma	758	794	788	871	809	797	787	775	765	756	743	737	718	711	692	679	673	651	632	619	607	581	568	543	524	502
Total resources in Sfax	2,330	2,394	2,238	2,331	2,245	2,665	2,459	2,223	1,986	1,751	3,092	2,716	3,581	3,295	4,474	4,176	4,440	4,100	4,314	4,960	4,588	5,338	4,941	5,077	5,228	5,355
Qpj	1,937	2,007	2,074	2,147	2,217	2,296	2,378	2,451	2,540	2,622	2,714	2,806	2,908	3,003	3,104	3,209	3,323	3,437	3,555	3,678	3,802	3,945	4,094	4,240	4,395	4,554
Balance of Sfax	393	387	164	184	28	369	81	-228	-554	-871	378	-90	673	292	1,370	967	1,117	663	759	1,282	786	1,393	847	837	833	801
Total																										
Existing Resources	7,793	8,028	8,063	8,378	8,502	9,140	9,157	9,155	9,153	9,151	9,150	9,149	9,148	9,147	9,146	9,145	9,144	9,143	9,142	9,141	9,140	9,139	9,138	9,137	9,136	9,135
Saida/K.Kebira Reservoirs+WTP	0	0	0	0	0	0	0	0	0	0	1,500	1,500	1,500	1,500	3,000	3,000	3,000	3,000	3,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Desalination (Sfax+Sahel)	0	0	0	0	0	0	0	0	0	0	0	0	1,157	1,157	1,157	1,157	1,736	1,736	2,315	2,315	2,315	3,472	3,472	4,051	4,630	5,208
Total Resources	7,793	8,028	8,063	8,378	8,502	9,140	9,157	9,155	9,153	9,151	10,650	10,649	11,805	11,804	13,303	13,302	13,880	13,879	14,457	15,456	15,455	16,611	16,610	17,188	17,766	18,343
Total Qpj	7,400	7,641	7,899	8,194	8,474	8,771	9,076	9,383	9,707	10,022	10,272	10,739	11,132	11,512	11,933	12,335	12,763	13,216	13,698	14,174	14,669	15,218	15,763	16,351	16,933	17,542
Global Balance	393	387	164	184	28	369	81	-228	-554	-871	378	-90	673	292	1,370	967	1,117	663	759	1,282	786	1,393	847	837	833	801

Qpj: Daily Maximum Water Demand

Source: JICA Survey Team

4.3 Water Demand and Supply in Sfax Governorate

A large amount of water is conveyed to the Sfax Governorate by the North Water Transmission System and the Jelma-Sbeitla Groundwater Transmission System. However, it is projected that there will be increased consumption in the regions upstream of the Sfax Governorate. As a result, the amount of water supplied to the Sfax Governorate is projected to decrease furthermore. It is also expected that no water, presently being conveyed by the North Water Transmission System, may reach the Sfax Governorate during summer, the peak consumption period due to increased water demand in the upstream areas.

Water demand and supply were reviewed under the conditions stipulated. In this calculation, the peak adjustment factor which was applied for water demand projection for whole seven governorates is not applied to the Sfax Governorate. The results are presented in Tables 4-9 to 4-11, and Figure 4-4.

Table 4-9 Water Demand in Sfax Governorate

	2015	2020	2025	2030	2035
Population	999,500	1,062,000	1,124,600	1,187,100	1,249,600
Population Served	862,600	925,600	988,600	1,051,600	1,114,700
Per Capita Consumption (L/person/day)	126	140	156	176	199
Non Domestic Rate (%)	18	18	18	18	18
Average Non-Revenue Water (%)	23	22	21	20	20
Daily Average Demand (m^3/day)	158,100	186,800	220,800	261,600	313,400
Peak Factor (Daily Max/Daily Average)*	1.321	1.321	1.322	1.322	1.322
Daily Maximum Demand (m^3/day)	208,800	246,800	291,900	345,800	414,200

*: peak factor (1.4) x adjusting coefficient
Source: JICA Survey Team

Table 4-10 Water Balance in Sfax Governorate (existing facilities only)

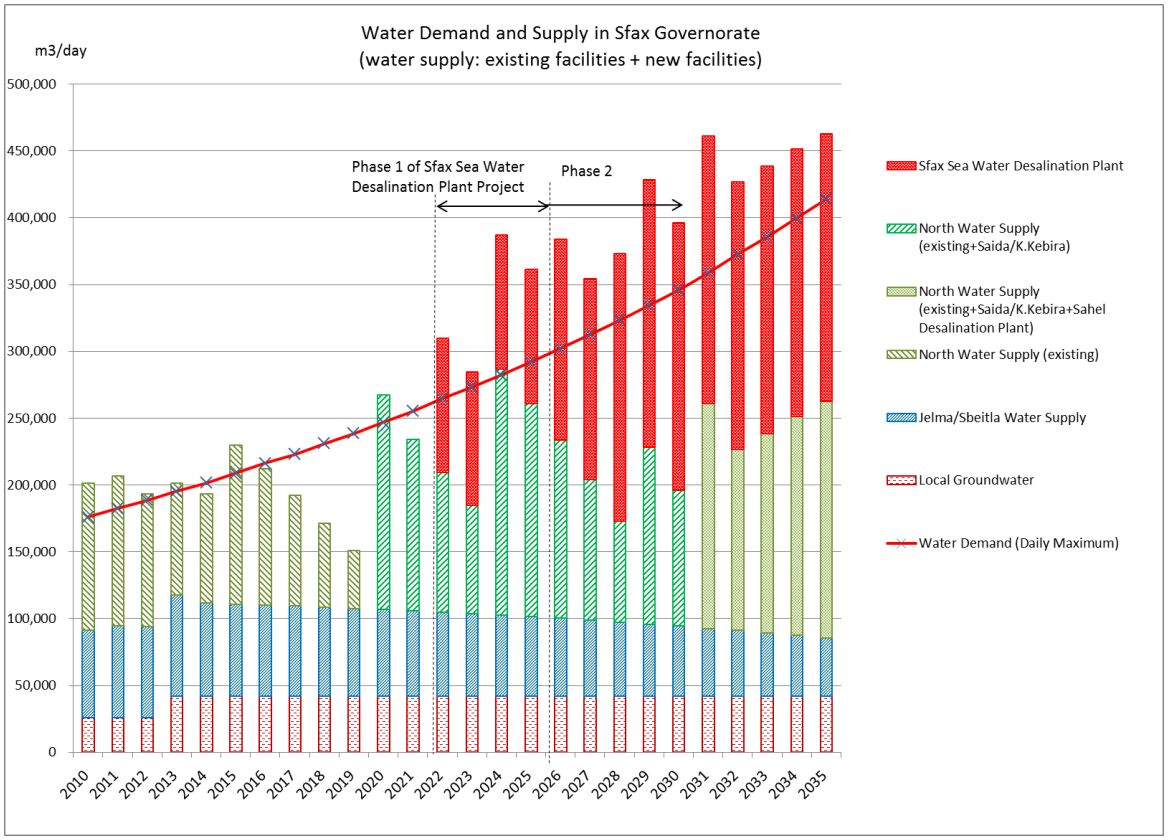
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	North Water Transmission	119,000	30,900	0	0	0	0
	Jelma-Sbeitla GW Transmission	68,900	64,200	62,000	58,700	52,400	43,400
	Local Groundwater	42,400	42,400	42,400	42,400	42,400	42,400
	Total	230,300	137,500	104,500	101,100	94,900	85,800
Daily Maximum Water Demand		208,800	246,800	264,500	291,900	345,800	414,200
Balance		21,400	▲109,300	▲160,000	▲190,800	▲250,900	▲328,400

Note: Due to rounding, (available volume - demand) is not equal to Balance.
Source: JICA Survey Team

Table 4-11 Water Balance in Sfax Governorate (existing facilities + new facilities)

(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	Sfax Desalination Plant	0	0	100,000	100,000	200,000	200,000
	North Water Transmission	119,000	160,500	105,000	159,800	101,500	176,900
	Jelma-Sbeitla GW Transmission	68,900	64,200	62,000	58,700	52,400	43,400
	Local Groundwater	42,400	42,400	42,400	42,400	42,400	42,400
	Total	230,300	267,100	309,400	360,800	396,400	462,700
Daily Maximum Water Demand		208,800	246,800	264,500	291,900	345,800	414,200
Balance		21,400	20,300	45,000	69,000	50,600	48,500

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4-4 Water Demand and Supply in Sfax Governorate (water supply: existing facilities + new facilities)

4.4 Water Demand and Supply in Greater Sfax

Water demand in the Greater Sfax is estimated as the population ratio between the Sfax Governorate and the Greater Sfax. Because the distribution data was not obtained, the demand was estimated from data between 2010 and 2012.

The Greater Sfax, where 2/3 of population in the Sfax Governorate lives, is the main urbanized area in the Sfax Governorate. In the future, the population in the Governorate is expected to increase. There are some special conditions in the Greater Sfax to be noted as follows.

1) On the way to the Greater Sfax, some amount of water from North Water Transmission System is distributed north of the Sfax Governorate. The remaining water is conveyed to the Greater Sfax.
2) On the way to the Greater Sfax, some amount of water from Jelma-Sbeitla Groundwater Transmission System in Sidi Bouzid Governorate, the west of the Sfax Governorate is distributed to the western part of the Sfax Governorate. The remaining water is conveyed to the Greater Sfax.
3) The Greater Sfax is the main urbanized area. However, the water is not supplied to the Greater Sfax with the highest priority. The concept on the equal treatment to the residents is applied.

Water demand and supply were reviewed with the conditions mentioned above. The results are presented in Tables 4-12 to 4-14, and Figures 4-5 and 4-6.

Table 4-12 Outline of Water Supply Plan in Greater Sfax

	Present (2012)	Yr 2025	Yr 2030	Yr 2035
1) Service Area	3,069 ha	3,069 ha	3,069 ha	3,069 ha
2) Population Served	631,900	737,900	782,100	826,300
3) Maximum Daily Water Supply	117,200 m^3/d 1,356 L/s	187,900 m^3/d 2,175 L/s	224,400 m^3/d 2,597 L/s	270,900 m^3/d 3,135 L/s
4) Average Daily Supply	83,700 m^3/d 969 L/s	134,200 m^3/d 1,553 L/s	160,300 m^3/d 1,855 L/s	193,500 m^3/d 2,240 L/s
5) Average Per Capita Supply	132 L/d/person	182 L/d/person	205 L/d/person	234 L/d/person
6) Non-domestic use (%)	18	18	18	18
7) Non-revenue Water (%)	24	22	21	20
8) Per Capita Consumption	91 L/d/person	126 L/d/person	144 L/d/person	165 L/d/person

Source: JICA Survey Team

Table 4-13 Water Balance in Greater Sfax (existing facilities only)

(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	North Water Transmission	95,200	24,700	0	0	0	0
	Jelma-Sbeitla GW Transmission	31,000	28,900	21,700	20,600	18,300	15,200
	Local Groundwater	25,100	26,100	26,100	26,100	26,100	26,100
	Total	151,400	78,700	46,800	45,700	43,500	40,300
Daily Maximum Water Demand		133,700	157,900	169,500	187,900	224,400	270,900
Balance		17,700	▲79,200	▲112,700	▲142,200	▲180,900	▲230,500

Source: JICA Survey Team

Table 4-14 Water Balance in Greater Sfax (existing facilities + new facilities)

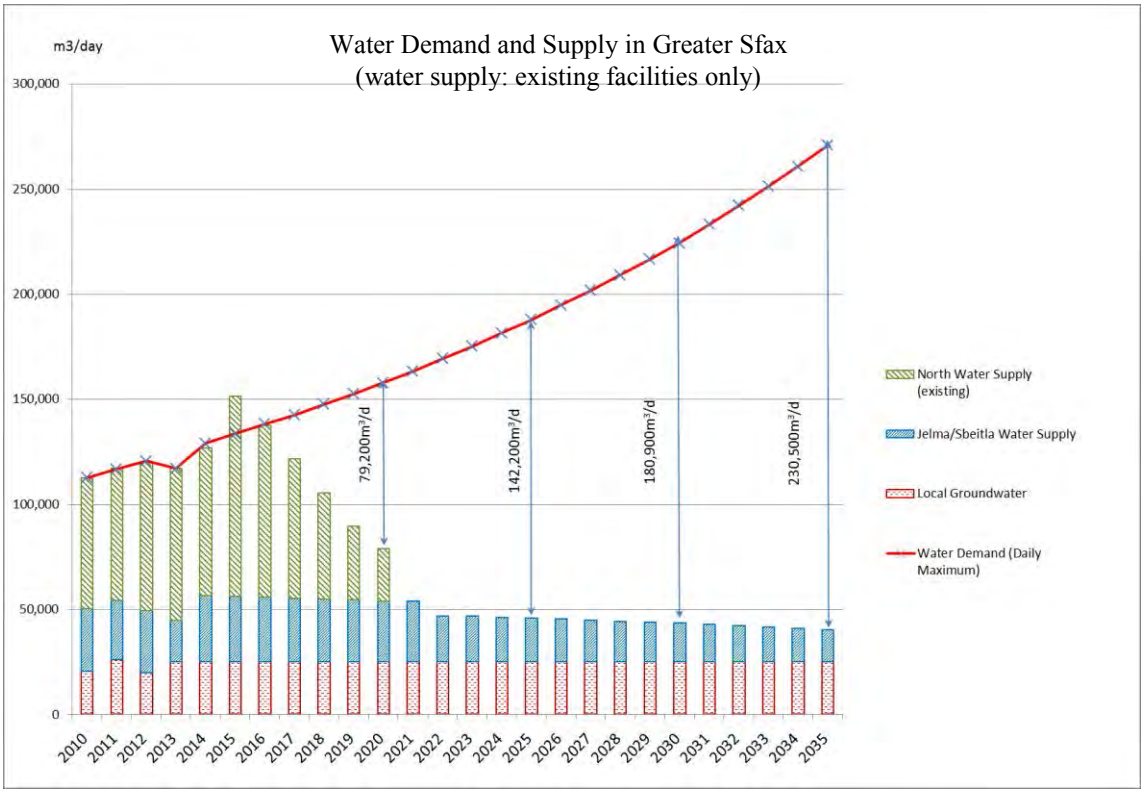
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	Sfax Desalination Plant	0	0	100,000	100,000	200,000	200,000
	North Water Transmission	95,200	128,400	65,100	75,100	29,500	67,200
	Jelma-Sbeitla GW Transmission	31,000	28,900	21,700	20,600	18,300	15,200
	Local Groundwater	25,100	26,100	26,100	26,100	26,100	26,100
	Total	151,400	182,400	211,900	220,800	272,900	307,600
Daily Maximum Water Demand		133,700	157,900	169,500	187,900	224,400	270,900
Balance		17,700	24,500	42,400	32,900	48,500	36,700

Source: JICA Survey Team

Figure 4-5 indicates water balance of demand and the supply in the Greater Sfax in case the new facilities or the development of new water sources formulated by the Strategic Study are not implemented. Water supply for the existing facilities is estimated under the maximum conveyance condition. Under this condition, a large amount of water shortage is confirmed. The shortage will be at an amount of 79,200 m^3/d in 2020, 142,200 m^3/d in 2025, 180,900 m^3/d in 2030, and 230,500 m^3/d in 2035, respectively.

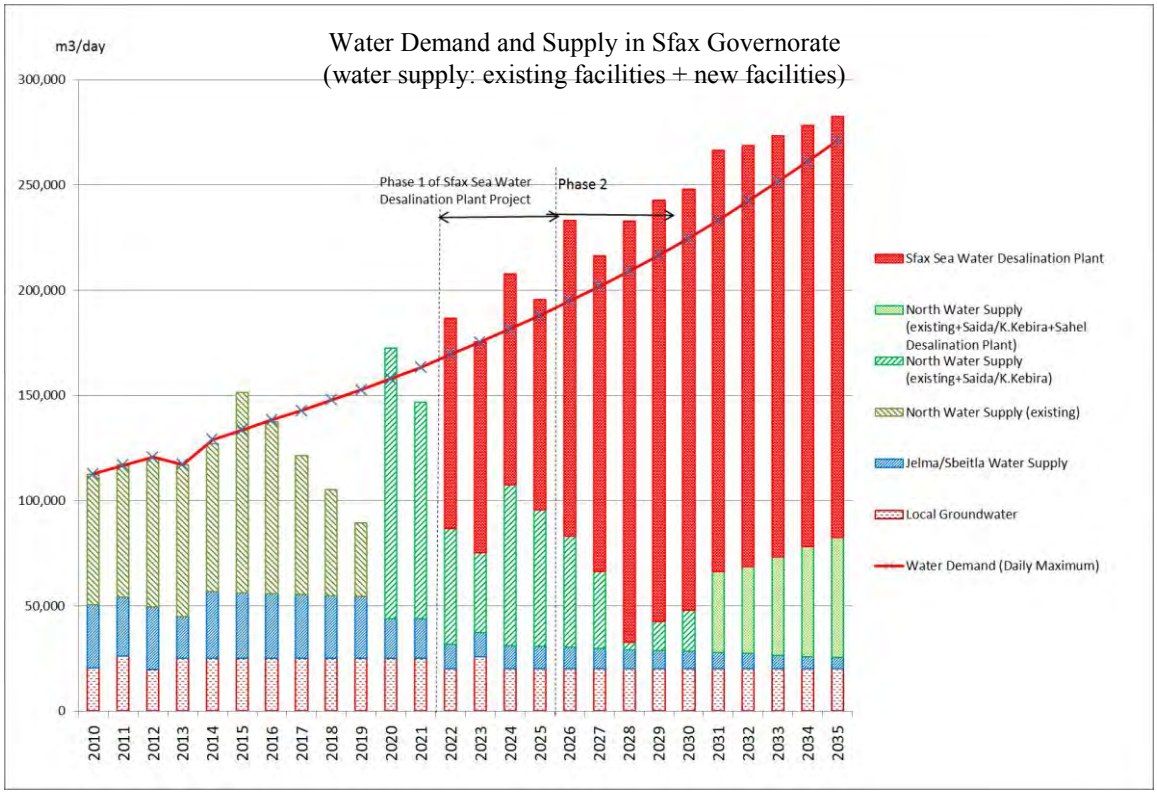
Figure 4-6 indicates the balance in case the new water sources developments formulated by the Strategic Study are implemented. The water supply volume shown in Figure 4-6 was assumed with the conditions that water volume equivalent to half of pumpage in the Greater Sfax is reduced from water supply of the North water transmission system and the same from the Jelma-Sbeitla groundwater transmission system,

As a result, water supply amount by the new facilities satisfies the demand. As mentioned before, however, shortage will still occur from 2017 to 2019.



Source: JICA Survey Team

Figure 4-5 Water Demand and Supply in Greater Sfax (water supply: existing facilities only)



Source: JICA Survey Team

Figure 4-6 Water Demand and Supply in Greater Sfax (water supply: existing facilities + new facilities)

CHAPTER 5 STUDY ON SEAWATER DESALINATION PLANT

Non-disclosure Information

CHAPTER 6 PLAN OF WATER SUPPLY FACILITIES

Non-disclosure Information

CHAPTER 7 ELECTRIC FACILITY PLAN

Non-disclosure Information

CHAPTER 8 SOCIO-ENVIRONMENTAL CONSIDERATIONS

8.1 Project Category

JICA classifies this Project as falling into the B category of its following four categories:

8.2 Terms of Reference of the EIA

Based on the results of the scoping exercise, the JICA Survey Team prepared and submitted a draft of the Terms of Reference (TOR) for the EIA to be conducted by local consultant. Based on this draft, SONEDE discussed the matter with APAL and ANPE and agreed with them to finalize the TOR. The JICA Survey Team then finalized the TOR and submitted it to SONEDE, and the latter sought the concurrence ANPE and APAL. Having received the concurrence, SONEDE held a bidding and contracted the EIA to a local consultant. Work was on-going as of June 2015. The summary of the EIA's TOR was developed based on the scoping study given in the following table:

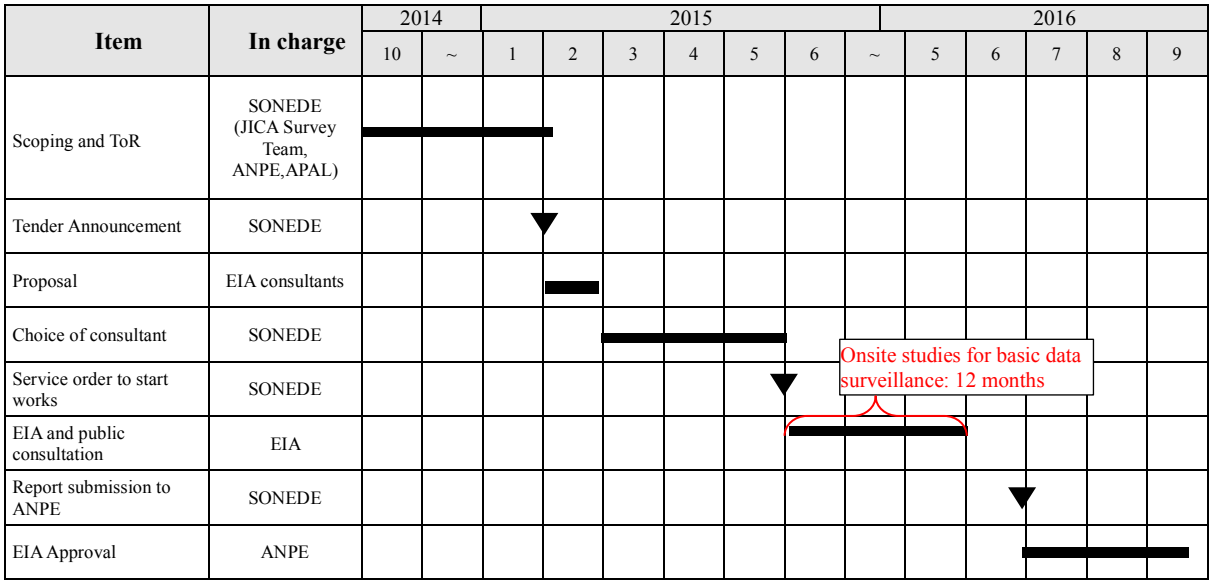
Table 8-1 Summary of the EIA's Main Terms of Reference

Objective	Point to study	Study Method
Approach and framework of EIA study	1. Legal and institutional framework of EIA 2. EIA methodology, approach, planning, and personnel	1-Refer to EIA scoping report 2-Refer to EIA Terms of reference
Define the baseline of the natural and social	1. Description of the receiving environment : Project area, land	1-Collect and summarize available data and reports

Objective	Point to study	Study Method
environment	and marine physical and biological natural environment 2. Description of the society: population, healthcare, gender effects.	2-Additional studies on site of the marine environment: ➢ Water quality (including plankton) ➢ Description of marine grasses ➢ Description of the ecosystem ➢ 4 sampling points. 2 points at the level of the Project (A and B on the figure) and 2 points on pilot areas (C and D). ➢ Sampling in summer and in winter 
Project description	1. Description of the Project's components 2. Project's materials inventory (input/output) 3. Construction and operation methods	1- Refer to the report of the Project's preparatory study (This report)
Evaluation of the Project's variants and the Project site	1. Project variants 2. Project site options	1- Refer to the report of the Project's preparatory study (This report) 2-Conduct site visits
Evaluation of impacts on the natural and social environments	1. Evaluate impacts with regard to the Project's components (during construction and during operation) 2. Areas impacted by the discharge of brine and impact on the marine environment	1-Consult reference documents, check each item. 2- Calculate the area affected by the brine discharge 3-Consult documents concerning the relation between salinity and toxicity in the marine environment
Mitigation measures and compensation of related costs	1. Suggest appropriate mitigation and compensation measures for each impact 2. Evaluate costs and suggest an organization for the implementation of measures	1-Based on the evaluation of site conditions and impact characteristics, elaborate appropriate mitigation measures. 2-Design compensation measures complying with the relevant laws and regulations in force. 3-Jointly with SONEDE, define costs and organization to implement and enforce compensation measures.
Monitoring plan	1. Design of a monitoring plan: items to monitor, applicable standards, concerned institutions, costs, implementation organization	1-Definition of supervision modes for each item to monitor 2- Jointly with SONEDE, design a monitoring plan
Consultation with stakeholders and with the population	1. Consultation with stakeholders reflecting the results of the Project 2. Information of the local populations	1- Hold meetings with stakeholders in Sfax in order to explain the characteristics and the impacts of the Project. Refer to the stakeholders meeting already held during the preparatory study. Evaluate different proposals and reflect them in the Project implementation. 2- Hold information meetings with the local population in order to explain the Project characteristics and

Objective	Point to study	Study Method
		impacts.

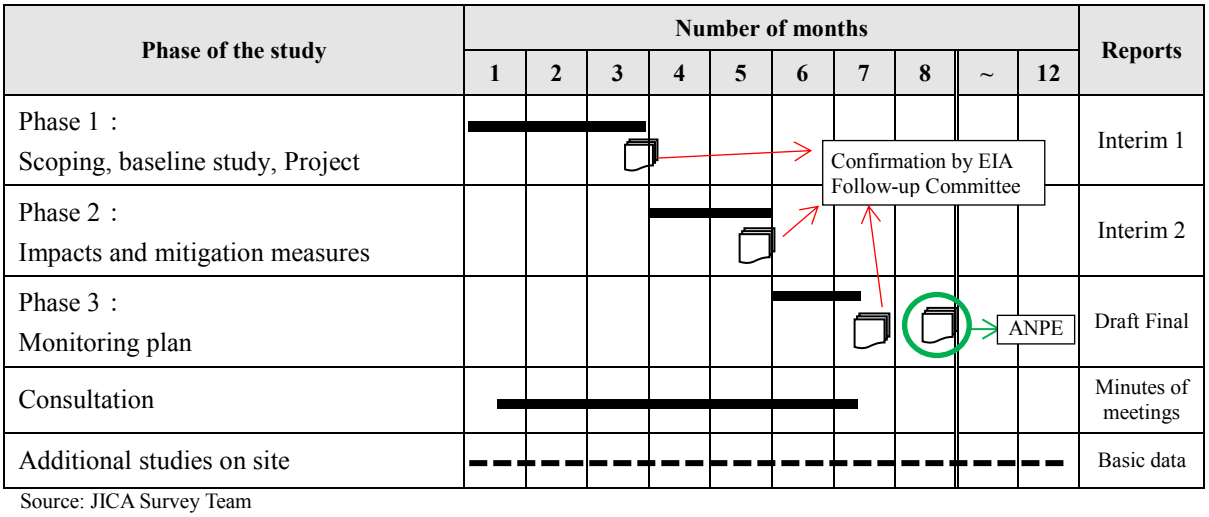
The provisional schedule for the execution of the scoping study, preparation of the terms of reference and the EIA is shown in Figures 8-1.



Source: JICA Survey Team

Figure 8–1 Provisional Schedule for Scoping, TOR and EIA

The execution of EIA is detailed in Figure 8-2.



Source: JICA Survey Team

Figure 8–2 EIA Execution Plan (proposal)

Since every phase and intermediate report will be checked by the EIA Follow-up Committee, we may expect that the final approval by ANPE will only raise a few additional comments or little reservations.

8.3 Results of Socio-Environmental Investigations

Further to the scoping results, characterizing impacts related to brine discharge was subject to a simulation exercise. Data related to marine grass, *Posidonia oceanica,* in the Project's surrounding areas have also been collected and analysed.

A social survey was conducted in order to assess the satisfaction rate in terms of drinking water service and impacts on society. Finally, a meeting with representatives of the British Gas company (hereafter referred to as BG) was organized in order to identify possible impacts of this Project on fishing activities. Results are collected in Table 8-2.

Table 8-2 Results of Socio-Environmental Investigations

Criteria	Investigations Results
Water pollution	**Simulation of brine dispersion** In order to assess the impact of brine discharge into the natural environment, amounting to about 73,000 mg/L TDS at the level of the discharge head, the JICA Survey Team studied the dispersion of brine in surrounding sea water. To do this, a two-layer model was utilised: 1. First a gravitational jet model at the level of the nearby field (ten meters around the discharge tower): this model takes into consideration the immediate dilution at the level of the circulating jet mixed with surrounding water. It gives information about the form of the jet, the falling point and the evolution of concentration in the jet. It also takes into consideration the form, the inclination of the nozzle, the number of nozzles and the speed of discharge. 2. Then a model for dissemination in remote areas at 2 dimensions following the equation developed by Joseph Sendner : the model is based on the concentration of the jet at the level of the falling point calculated by the nearby field model, and calculates the progressive dilution of salinity through dispersion throughout a plane area. It takes in consideration the total quantity of water discharged as well as the water height and the shape of the dispersion area. This type of simulation is largely used at the level of the pre-project preparatory studies for conventional or nuclear thermal power plants (floating jet), and for desalination stations (falling jet), and is based on several references. The model was also applied by research laboratories, and suitability and accuracy of it was confirmed. <u>Calculation conditions for this Project</u> Simulation was based on unfavourable conditions in the summer period (highest salinity of the environment) as shown in Table 8.8-2. Discharge quantity : 244 ;400 m^3/day (maximal capacity, Phase 2) Discharge speed : 3m/s Number of nozzles : 4 Diameter of the nozzle : 0.55m Angle of the nozzle from horizontal line : 45deg Height of discharge from the ground (nozzle centre) : 1.3m Current velocity : 0.01m/s (*1) *(*1) in the absence of more accurate data, we used the pejorative hypothesis of minimal current.* Discharge angle : 180deg (*2) *(*2) Since discharge is slightly heavier than sea water, it tends to flow on the highest slope. Based on this phenomenon, a discharge tower of 180deg. is adopted.*

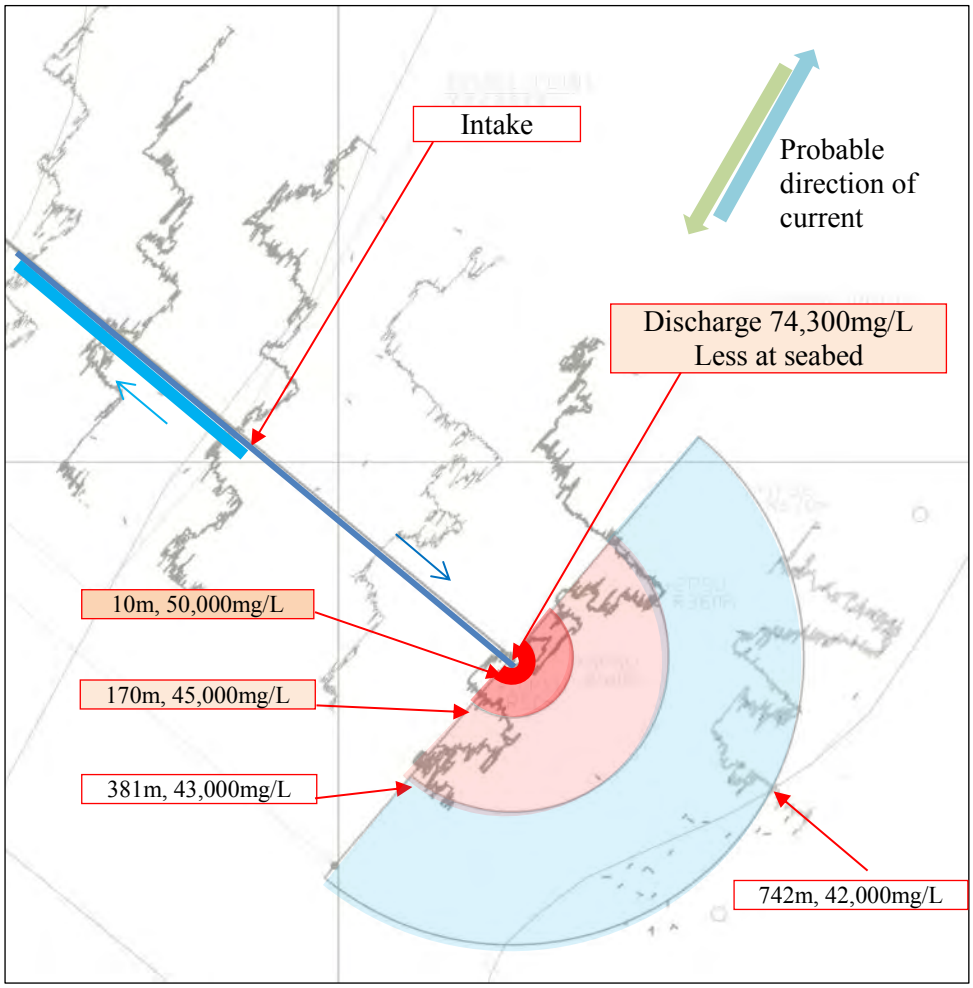
Criteria	Investigations Results

Table 8-3 Temperature and Salinity

Month		Jan - Mar	April - June	July August	Sep.-Nov.	December
		Winter	Spring	Summer	Fall	Winter
Sea water temper.	C	15	25	30	25	15
Discharge temper	C	15	25	30	25	15
Sea water salinity	mg/L	39,000	40,000	41,000	40,000	39,000
Discharge salinity	mg/L	70,800	72,500	74,300	72,500	70,800
Difference	psu	31.8	32.5	33.3	32.5	31.8

Source: JICA Survey Team

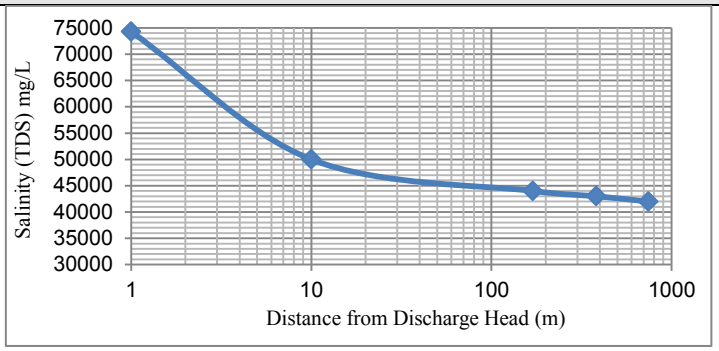
Results are shown in figure below in the following figures:



Source: JICA Survey Team

Figure 8–3 Results of the Brine Dispersion Simulation

Salinity according to distance from the discharge tower is shown in the graph below:

Criteria	Investigations Results
	 Source: JICA Survey Team **Figure8–4 Salinity according to Distance to the Discharge Head**
Natural habitats	**Baseline of *Posidonia oceanica*** Data concerning the state of *Posidonia oceanica* and *Cymodoc*ae in the Governorate of Sfax were provided by INSTM (L. Ben Mustapha) based on a 2008 World Bank Study. The SIG Analysis of these data shows the following facts: In the Governorate of Sfax, the current conditions of *Posidonia oceanica* is as follows : ▪ Coverage area : about 130,000 ha (green area above, including surveyed areas) ▪ Average coverage rate (low hypothesis) : 40% => sea grass area = 0.4x130,000 = 52 000 ha ▪ Average coverage rate (high hypothesis) : 60% => sea grass area = 0.6x130,000 = 78,000 ha **Relation between the salinity rate and *Posidonia oceanica* survival** The relationship between the salinity rate and the survival of *Posidonia oceanica* was studied in Fernandez-Torquemada, Y., Sanchez-Lizaso "Effects of salinity on leaf growth and survival of the Mediterranean sea-grass *Posidonia oceanica*", 2005. According to this source, survival of this sea grass is not possible when salinity exceeds 50000 mg/L in TDS. However, we may consider that as of 45000 mg/L in TDS, the environment would have long term damage. This shows the impact of the Project on sea grasses, *Posidonia oceanica*: ▪ Impact due to the construction of the intake and discharge pipes: 34 m (width of excavation) x 4000 m (average length of pipeline) x 80% (sea grass coverage rate at the level of the pipeline) = 11.2 ha (note: partial recovery is possible above the pipeline in coming years) ▪ Impact due to the discharge of salinity: salinity (TDS)< 45000mg/L => radius > 200m => impacted area : $3.1416 \times 200^2 / 2 \times 80\% = 5$ha (the choice of the coverage rate at 80% is pejorative for this calculation as it increases the impacted area) <u>Desalination effects in the Gulf of Gabes</u> In the Gulf of Gabes, 4 sea water desalination projects are in progress : ▪ Sfax (this Project) : 200,000m^3/day at the end of the project ▪ Djerba : 75,000m^3/day at the end of the project ▪ Zarat : 100,000m^3/day at the end of the project ▪ Kerkennah : 6,000m^3/day at the end of the project This represents therefore a total of 381,000m^3/day at the level of the Gulf of Gabes by horizon year 2030. If we consider that the Gulf of Gabes covers a total area of about 12,000km² and if we also consider an average annual evaporation of 1788m/year (ref. National Meteorology Institute), then the daily evaporated water volume would be 12,000,000,000m² x 1.788m / 365 day = 58,800,000m^3/day. Water desalination would then represent at the end of projects 381,000 / 58,800,000 = 0.6% of the evaporation all over the Gulf of Gabes (by deliberately not calculating additional inputs of soft water discharged by purification stations). Therefore, except the influences at discharge point, its influence on ecology system in the Gulf of Gabes is quite small. The nearest seawater desalination plant planned is the Kerkennah plant 40km from the Sfax plant, Therefore, discharge water from both plants will not merge and their combined influence on ecology system is negligible because of sufficient dilution effects.
Subsidence means, poverty,	**Coastal fishing activities in the vicinity of the desalination station's site** In 2004, fishing in the Governorate of Sfax represented 47% of the national overall activity, while the port of Sfax represents the largest fishing port in Tunisia (with an annual production of about 15,000 tons).

<table>
<tr><th>Criteria</th><th>Investigations Results</th></tr>
<tr><td>vulnerability</td><td>Fishing methods used in Sfax are shown in the following table:

Table 8-4 Fishing Methods in the Sfax Region
<table>
<tr><th>Method</th><th>Boats</th><th>Target</th><th>Area</th><th>Status</th></tr>
<tr><td>Coastal shell collection</td><td>-</td><td>Crustaceans, molluscks</td><td>Beach, littoral</td><td>Authorized</td></tr>
<tr><td>Line fishing</td><td>Sail boats or with engines (1 to 2 fishermen)</td><td>cuttlefish, sea bream</td><td rowspan="5">Posidonia oceanica (depth 2 to 10m)

Sfax-Kerkennah Channel (depth +10m)</td><td>Authorized</td></tr>
<tr><td>Net fishing (static)</td><td>Sail boats or with engines (2 to 5 fishermen)</td><td>Octopus, cuttlefish, shrimps, sea bream, flounder</td><td>Authorized</td></tr>
<tr><td>Trapping</td><td>Sail boats or with engines (1 to 2 fishermen)</td><td>Octopus, mullet</td><td>Authorized</td></tr>
<tr><td>Fishing with turning seine</td><td>Motor boats (6 to 8 fishermen)</td><td>Tuna, sardine</td><td>Authorized (depth.+20m)</td></tr>
<tr><td>Mini-trawl fishing (« kiss »)</td><td>Sail boats or with engines (1 to 6 fishermen)</td><td>Octopus, cuttlefish, shrimps, sea bream, flounder</td><td>forbidden</td></tr>
</table>
Source : SMAPIII report, City of Sfax (Impact study : report on marine environment)

Impact of the construction of intake and discharge pipes on fishing activities, the example of British Gas (referred to as BG)
The gas plant of British Gas is located in the vicinity of the project site.
The following observations can be made about gas pipelines linking offshore extraction platforms to the plant:
1) According to the pipelines' coordinates, they neither cross the desalination station's proposed site nor sea pipelines:
2) When laying a new pipeline in 2008, the following problems emerged:
1. Since the orientation of sail boats is conditioned by the wind, the limit set for the construction of the pipeline will no longer allow access to a certain fishing areas;
2. Collection of shells is practiced in the project area by local women. As turbidity increased during excavation works offshore, the quality of the shells dramatically dropped reducing sales;
3) In order to act on these issues, BG set up a compensation system summarized as follows:
1. During the construction phase of the initial 5 kilometres of the pipeline, payment of a monthly compensation to populations affected by the Project;
2. For boats or vessels: NDI TND for the captain and NDI TND for crew members;
3. About NDI TND for women shell collectors.
4) Four staff members of BG devoted 30% of their time for 6 months to settle these issues.

We expect similar works for the construction of intake and discharge pipes. In order to prevent these issues, it is necessary to consult with fishermen and with the local population, explain the construction method and define an appropriate compensation programme.</td></tr>
<tr><td>Historical and cultural heritage</td><td>The nearest archaeological ruins No. 115.052 is 290m from the site.
The law related to conservation of ruins is No. 94-35 (24.2.1994). Clause 69 of the law enables stopping construction work for six months in case new ruins are discovered to enable survey of any newly discovered archaeological ruins.</td></tr>
</table>

Source: JICA Study Team

8.4 Evaluation of Impacts

Based on results of Section 8.3 above, the different impacts of the Project were evaluated for each evaluation component as described in Table 8-5.

Table 8-5 Evaluation of Impacts : Seawater Desalination Plant

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
Pollution	1	Air pollution / dust	C	D	D	D	**During construction:** - Large scale earth works and pavement works are not being planned, and areas surrounding the plant site are mainly farmlands, road and beach. Since only dust will be produced, no significant specific impact is therefore expected.
	2	Water pollution	C-	C-	D	D	**During construction :** - Turbidity will temporarily increase due to offshore excavation works, however since turbidity is generated by existing sediments, there is no additional pollution of sea water (impacts on fishing activities are described below) **During operation:** - Since discharges are diluted, salinity drops to +1000mg/L（or +2%）of the natural salinity at about 750m from the discharge head, the situation is therefore not dangerous for human activities. (Concentrations of Na and Cl in Tunisian Standards for Water discharge to Sea, NT106-002, shown in Table 8.11-1, are "No Limit"). (Impacts on natural habitats are described below). - Taking in consideration the nominal capacity of the 4 sea water desalination stations planned in the Gulf of Gabes, the accumulated water intake volume will be 0.6% of water losses through evaporation at the level of the Gulf. There is therefore no significant impact at this level.
Natural environment and natural risks	10	Natural habitats	B-	C-	B-	B-	**During construction :** - Due to excavation works in the sea, 11.2 ha of *Posidonia oceanica* will be lost, which will have an impact on the marine environment. However, when compared with the 52,000 ha of sea grasses living along the Sfax coast, this impact is rather limited and partial recovery will be possible in the long term above the pipelines. - The coverage rate of sea grasses in the pipelines area ranges between 60% and 80%. The deposit of excavated materials in the area may generate additional loss of sea grasses. This is why the impact depends on the choice of the deposit site for the 101,600 m^3 excess excavated material. **During operation :** - The final impact area of discharged water is estimated at about 5.0 ha, however, compared to the 52,000 ha of sea grasses living along the coast of Sfax, the impact is relatively limited.
	11	Hydrology	C-	D	D	D	**During construction :** - After excavation, pipes will be taken to the site by floating them and then they

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
							will be laid at the bottom of the sea trench and buried, so there will be no impact on marine currents.
Human and social environment	14	Means of subsidence, poverty, vulnerability	C-	D	B-	D	**During construction :** - Based on the British Gas experience, it is possible that the construction of pipelines impacts fishing activities.
	16	Local economy/Employment	B+	B+	B+	B+	**During construction :** - Local employment will increase; - Possibility for sub-contracting services with local providers **During operation :** - Possibility for operators' positions at the plant - Possibility for sub-contracting services with local providers
	18	Water resources	D	B+/C+	D	B+/D	**During operation :** - No impact on health by change of water supply system because no relationship between the water supply and diseases has definitely been proved.
	19	Public infrastructures and public services	D	B+	D	B+	**During operation :** - The Project will improve the quantities and quality of drinking water
	22	Local conflicts of interest	D	B+	D	B+	**During operation:** - The Project facility will be located in the Greater Sfax area. The subject area of the Project is the whole Greater Sfax. - As this seawater desalination Project will ease the water supply situation in the central area of Tunisia, it will have a positive effect on any impacts of any local conflicts.
	23	Historical and cultural heritage	C-	D	D	D	**During construction :** - As shown on Figure 8.8-9, there are currently no archaeological ruins at the desalination plant site. The route for the transmission pipeline was once excavated for road construction, and therefore, the possibility of discovery of new archaeological ruins is very low. Areas for foundation works of power transmission towers are small, i.e. four piles which are 0.8m in diameter. In addition, it is possible to change the route to avoid any archaeological ruins if they exist. - As results of geotechnical drilling works have shown no hard stratum in the Project area, the probability of archaeological ruins is very limited.
	25	Gender	D	C+	D	D	**During operation :** - Though the increase of water supply volume by the Project will allow create the possibility of an extension of the water supply area; as the rate of connection to drinking water supply in Sfax is already very high, the improvement of the water supply service may have only little positive impacts on

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
							existing women's conditions.
	28	Professional health /safety on the worksite	D	C-	D	D	**During operation :** - SONEDE's operating stations already use similar chemical products, so the staffs have good and appropriate experience in managing any leaks and related hazards.
Others	30	Trans-border effects and climatic changes	D	C-	D	D	**During operation :** - Power consumption in Tunisia for the year 2013 was 14,379 GWh (https://www.steg.com.tn), the power consumption by the station: 143 GWh will therefore represent 1% or less of the national consumption figures, the increase of CO_2 emissions will then be very limited at the national level.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 8-6 Evaluation of Impacts : Transmission Pipeline

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct . phase	Operation phase	
Pollution	1	Air pollution/dust	C	D	D	D	**During construction:** -Large scale earth works and pavement works are not being planned, and the pipeline route is mainly surrounded by farmland and roads. Since only dust will be produced, no significant specific impacts therefore are expected.
Natural environment and natural risks	12	Morphology and geology	C-	D	D	D	**During construction :** - The construction and laying of transmission pipes will generate 60,000m^3 of excess excavated material. However a large part can be reused on the site of the desalination station, which requires backfilling. On the other hand, several deposit sites nearby Sfax are also available; there will therefore be no big impact on existing soils.
Human environment and society	16	Local economy / Employment	B+	B+	B+	B+	**During construction :** - Local employment will increase; - Possibility for sub-contracting services with local providers **During operation :** - Possibility for sub-contracting services with local providers
	17	Use of soils and local resources	C-	D	B-	D	**During construction :** - In general, pipes will be laid in the right of way areas of existing roads. However, some land acquisition will be necessary in several areas and for surge tank areas.
	19	Public infrastructures and social services	D	B+	D	B+	**During operation :** - The Project will improve the quantities and quality of drinking water

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct . phase	Operation phase	
	21	Repair of benefits, social equity	B+	B+	B+	B+	**During construction, and During operation:** - The Project facility will be located in the Greater Sfax area. The subject area of the Project is the whole Greater Sfax.
	22	Local conflicts of interest	D	B+	D	B+	**During operation:** - The Project facility will be located in the Greater Sfax area. The subject area of the Project is the whole Greater Sfax. - As this seawater desalination Project will ease the water supply situation in the central area of Tunisia, it will only positively affect the impacts of any local conflicts.

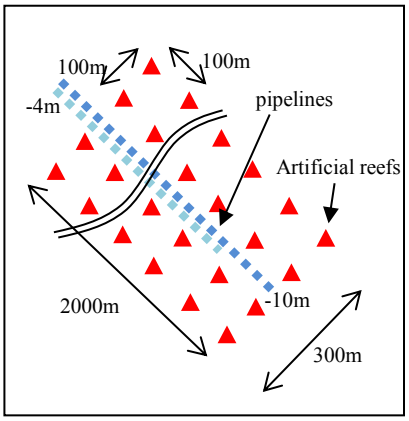
Table 8-7 Evaluation of Impacts : Power Transmission Line

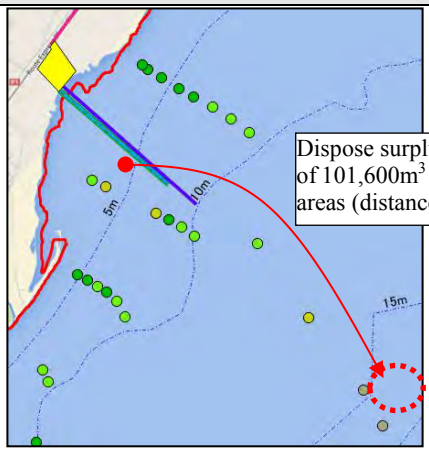
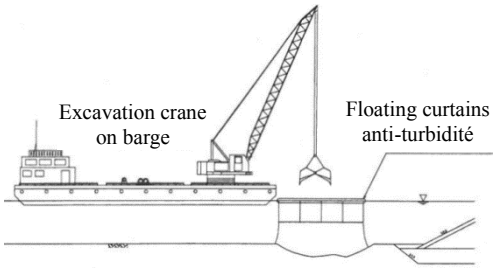
Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
Pollution	1	Air pollution/dust	C-	D	D	D	**During construction:** - Approximately 40 power transmission towers will be constructed. The work requires an excavator crane and a transportation vehicle only. Large scale earth works are not being planned, and sites are mainly surrounded by farmland. Since only dust will be produced, no significant specific impacts are therefore expected.
Human and social environment	14	Subsidence means, poverty, vulnerability	C-	D	B-	D	**During construction:** - Land acquisition of 10 m x 10m each for power transmission pylons. Including additional space for construction work, there is a high possibility of impacts on farmlands. Cutting-off of olive trees will be needed.
	17	Use of soils and local resources	C-	D	B-	D	**During construction:** - Land acquisition of 10 m x 10m each for power transmission towers. Including construction work space, there is a high possibility of impacts on farmlands.
	24	Landscape	D	C-	D	D	**During operation:** - The seawater desalination plant site is 10km from the Thyna archaeological park, and also far from the Medina located in Sfax city. Therefore, no impact is expected on landscape of tourist spots. It is expected that the power transmission route will be located in areas surrounded by farmland, and therefore no serious impact on landscape is expected.

8.5 Mitigation Measures and Implementation Costs

For each impact identified and evaluated in Section 8.4 above, the following mitigation measures are suggested:

Table 8-8 Suggestion of Mitigation Measures

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
During construction					
1	Loss of sea grass during excavation of intake and discharge pipes (~12ha)	In order to efficiently protect sea grasses and related ecosystems, it is possible to lay down artificial reefs all over the Project area. Reefs will also protect against mini-trawl fishing. This technique to valorise resources is already implemented by the DGPA in the Gulf of Gabes. An example of the installation of reefs along pipelines in this Project is suggested below :  Source : JICA Survey Team **Figure 8-5 Artificial Reefs Installation Plan (example)** Therefore, there will be 4x21=84 reefs, each reef will be made up of eight concrete blocks each weighing one ton. Hence a total of 84×8ton＝672ton or 280m^3 of concrete. Reinforcement bar weighs about 100kg/m^3 or 28ton. The cost of 1m^3 of concrete is NDI USD and installed reinforcement bar costs NDI USD/ton. The total estimated cost is about 280x NDI + 28x NDI = NDI USD for a protected area of 60ha. **Examination results :** Mitigation measures against the negative influences to sea grasses meadows are; 1) artificial planting, and 2) artificial reef installation. Based on the experience in Gabes Bay Artificial Reefs Project, implementation of 2) is judged to be practical, thus it was selected as the mitigation measure of choice against negative influences on sea grass meadows by the Project.	Construction company	SONEDE / INSTM / ANPE	Non-disclosure Information
2	Impact of the deposit of excess excavated materials (~50,000m^3)	Excavated material in excess should be deposited in areas with no sea grasses growing as shown on the map below.	Construction company	SONEDE / INSTM / ANPE	Non-disclosure Information

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
		 Source : JICA Survey Team **Figure 8-6 Sea Deposit Plan (example)** Transportation and depositing costs will be about NDI USD/m^3, total costs will then amount to 101,600m^3 NDI USD/m^3 = NDI USD. Note : A detailed study about sea weed coverage in the area may suggest further reducing this distance.			
3	Impact of the construction of pipelines works on fishing activities	After explaining in detail the construction methods of pipelines to the local fishermen, anti-turbidity measures may be implemented and where required a suitable financial compensation plan put in place. An example of an anti-turbidity protection system is shown below. Considering unitary costs practiced in Japan, a protection along the pipeline would amount to about JPY NDI million.  Source : Equipe d'enquête JICA **Figure 8-7 Anti-Turbidity Protection (example)** The closest fishing port to the project area is Mahres at about 10 km to the Project's south-west (photo below). We consider that 20 boats and 100 women collectors are impacted by fishing activities in the pipeline area, and that the period required for excavations in the coastal area would be about six months, and about one year for the laying of pipes. Based on the BG example, the following estimates can be made for compensations: 12 months × 20 boats × (NDI TND + 2 × NDI TND) + 6 months × 100 individuals × NDI TND = NDI TND.	Explanations of anti-turbidity methods and measures: Construction company Compen-sation : SONEDE		Non-disclosure Information

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
4	Land acquisitions for transmission pipeline and power transmission line	The acquisition of lands and compensations will be made according to Tunisian Law n. 2003-26.	Legal and acquisitions department at SONEDE and STEG	SONEDE / MOA	See Chapter 9
During operation					
5	Permanent impact of discharge on sea grass	The impact on sea grass meadows is not avoidable around the discharge head. As an off-set measure, it is recommended to apply mitigation measures at a place different from the discharge head location. The measures are; 1) artificial plantation of sea grass, and 2) installation of artificial reefs. Due to the same reasons as those stated above, installation of artificial reefs is recommended. The installation plan is shown in Figure 8-5. Required cost is USD NDI . In addition, due to the permanent character of impacts, it is necessary to regularly monitor sea grasses. A monitoring plan is suggested in Section 8.6.	-	-	Included in No.1

Source : JICA Survey Team

Mitigation measures suggested above represent an investment of about JPY NDI million excluding land acquisitions as shown in Table 8-9. This cost is considered as a part of the project cost. Assuming that the total project cost is JPY NDI billion, the said mitigation cost will be equivalent to 0.6% of the total cost.

Table 8-9 Cost for Mitigation Measures

Mitigation Measures	Cost	Cost (equivalent Yen) (USD1=JPY119.6) (TND1=JPY61.02)	Item
Artificial Reef	Non-disclosure Information		Construction Cost
Deposit of Surplus Material			Construction Cost
Turbidity Prevention			Construction Cost
Compensation to Fisheries			Compensation

8.6 Monitoring Plan

This Project mainly impacts the marine environment, it is therefore necessary to monitor the state of sea grass and sea water quality. In Tunisia, standard NT106-002 regulates discharges within the natural environment.

Monitoring water quality during the construction of pipelines will be based on the monthly measurement of turbidity (as well as pH, temperature and electric conductivity) along the pipelines (one location) and at the level of the beach (one location). Once operation starts, water quality will be measured at the level of the discharge site to check items of the standard cited above (twice a year for the first year and once a year in the two following years at one location).

Table 8-10 Monitoring Plan

Environmental aspect	Criteria	Site	Frequency	Entity in charge
Construction phase				
Water quality	Turbidity, pH, Temperature, electric conductivity	Along the pipeline and along the coast Total 2 locations	Every month	SONEDE
Natural habitats (*Posidonia* oceanica)	Criteria of Table 8-11	2 sites near the pipeline and 1 site near deposit area Total 3 locations	Twice a year	SONEDE (+INSTM)
Operation phase				
Water quality	NT106-002 Water Quality Standard concerning Discharges to Sea	Near discharge tower 1 location	Twice in the first year, once a year in the two following years	SONEDE
Natural habitats (*Posidonia oceanica*)	Criteria of Table 8-11	Artificial Reef, Water discharge point, 200m from discharge, 1000m from discharge Total 4 locations	Four times in the first year, and twice a year in the two following years	SONEDE (+INSTM)

Source : JICA Survey Team

Table 8-11 Monitoring Parameters of Posidonia oceanica

Parameter	Observation
Sea grass pressure (Grass)	L: % of leafs with herbivores
Coverage by invasive algae	T: % cover of algae such as *C. racemosa* on 3 transects along 20 m
Sea grass covering (Cover)	T: % spots of live sea grass over 3
Dead mat cover	T: % dead mats on 3 transects over 20 m
Density of transect beams	T: Number of live beams per quadrant of 40x40 cm taken randomly
Plagiotrope rhizomes (Pl rhi)	T: % per quadrant (3) of 40x40 cm taken randomly
Beam biomass	Dry weight of leaves without epiphytes (gr/beams)
Surface of leafs by beam (Shoot FS)	L: (LAI) surface area of leaves (cm^2 shoot21)
Length and width of leafs (Leaf L)	L: average per type of leaves and by beam (cm)
Others	

Source : INSTM, Ben Mustapha

In order to efficiently submit monitoring results, the Monitoring Form may be used.

8.7 Stakeholders Meeting

While Tunisian legislation does not formally state the need and obligation of consultations with stakeholders in the execution of projects, this practice is already common and it is also recommended in the JICA Guidelines. In order to take into consideration the opinions of all parties concerned by the Project, a meeting with stakeholders was suggested by the Project's steering committee.

This meeting was held once the Project components were defined. The purpose was to explain the Project's outlines as well as the scoping works related to the EIA. Participants represented concerned organizations (ANPE, APAL, ONAS, ANGED, etc.), local authorities (the City of Sfax, the Governorate,

Fisheries related groups, Farming related group) as well as nongovernmental organizations. The policy regarding land acquisition and compensation was also explained verbally. An advance announcement was previously carried out by posting a printed poster on the notice boards of SONEDE, the universities, and governorate offices.

The following comments are reflected in the Project as follows:

- Several institutions are already involved in the EIA preparation (ANPE, APAL, INSTM, etc.), but during the EIA implementation phase, the Sfax University and the local branches of ANPE, APAL and INSTM may be involved.
- The BG experience implies the launch during construction of collaboration channels with local fishermen and UTAP to explain construction methods and eventually define a compensation plan.
- The Project development is supported by measures to improve the present system while evaluating it in a global and integrated way.

During the EIA implementation phase (in 2015), meetings with stakeholders will be held and meetings to inform the general population will also be held in different communities affected by the Project. It is appropriate to hold the explanatory meetings at the places where land acquisition will be conducted or construction affected area, i.e. Mahres (on place), Agareb (two places), and Sfax South (two places). At the explanatory meetings, it is required to explain and discuss about contents of the Project including power transmission line, implementation schedule, land acquisition procedure, compensation plan, and cut-off-date regarding compensation.

CHAPTER 9 LAND ACQUISITION AND RESETTLEMENT

9.1 Needs for Land Acquisition and Resettlement

The need for land acquisition and resettlement for this Project are summarized in Table 9-1. This Project will not require the displacement of people and will not require large scale land acquisition.

Table 9-1 Needs for Land Acquisition and Resettlement

Component	Use	Land acquisition and procedure requirements	Resettlement requirements
Intake pipe Discharge pipe Desalination plant (RO Process)	Maritime public domain (public land)	The use of the maritime public domain is conditioned by a special authorization	None
Transmission pipeline	Generally in the right of way areas of existing roads (public lands) with the possibility to acquire some private lands (underground)	Normal procedure with the permission of the authority in charge of road networks or the road operators. Possibility of having to acquire lands in some areas	This Project was designed so as to avoid the resettlement of people by adjustment of the outline of pipes and the location of structures if necessary.
Pumping station	Within the desalination plant area or in current reservoirs sites (public or SONEDE's lands)	None	

Component	Use	Land acquisition and procedure requirements	Resettlement requirements
Water hammer/surge tank	According to the final choice of sites, possibility of having to acquire private land	Possibility of having to acquire lands	
Distribution reservoirs	Within sites of existing reservoirs	None	
Power transmission line	Farmland (Private)	Possibility of having to acquire lands. SONEDE will possess the lands.	

Source: JICA Study Team

In this study, land parcels to acquire and the impacted agricultural patrimony (olive trees) are estimated as shown in Table 9-2:

Table 9-2 Property and Patrimony Damage related to Water Transmission Pipelines

Real estate property						
Item	**Community**	**Type**	**Area**			**Total (m^2)**
			Length (m)	**Width(m)**	**Area (m^2)**	
No.1	Mahres	Industry	275	8	2,200	2,200
No.2	Agareb	Farming	1,320	8	10,560	10,560
No.3	Sfax South	Industry	155	8	1,240	17,294
No.4		Industry	100	8	800	
No.5		Farming	970	8	7,760	
No.6		Industry	205	8	1,640	
,No.7		Farming	31	17	527	
No.8		Farming	31	17	527	
B12		Farming	600	8	4,800	

Structures				
Item	**Community**	**Type**	**Length (m)**	**Total (m)**
Table 9.3.1,No.1	Mahres	Wall	275	275
Table 9.3.1,No.2	Agareb	Wall	150	150
Table 9.3.1,No.3	Sfax South	Wall	155	810
Table 9.3.1,No.4		Wall	100	
Table 9.3.1,No.5		Wall	350	
Table 9.3.1,No.6		Wall	205	

Farming Patrimony							
Item	**Community**	**Type**	**length(m)**	**Width(m)**	**Area(m^2)**	**Number**	**Total**
Table 9.3.1,No.2	Agareb	Olive trees (25/ha)	1,320	15	19,800	50	50
Table 9.3.1,No.5	Sfax South		970	15	14,550	37	61
Table 9.3.1,No.7			31	17	527	2	
Table 9.3.1,No.8			31	17	527	2	
Figure 9.3.3 (B12)			600	13	7,800	20	

Source: JICA Survey team

The required land for 40 power transmission towers is about 4,000 m^2. For construction work to be carried out, however, an area of 20m x 20m is required on a temporary basis. Therefore, compensation shall cover the area of 10m × 10m + 20m × 20m ＝500 m^2 for each transmission tower. For total of 40 towers, 40 towers × 500 m^2/tower = 20,000 m^2, and therefore, 2ha × 25 tree/ha = 50 olive trees logged will be the subject of compensation. Regarding compensation for the land under the power line, its subject area will be 10m x 15km = 15ha, and 375 olive trees. Compensation for it will be quite small because farming activities can be continued. As stated previously, the cost for land acquisition and compensation will be shouldered by SONEDE.

All in all, the land acquisition area is 3.41ha at maximum including those for power transmission line, and compensation is necessary for the fence of 1,235metres, and 536 olive trees as shown in Table 9-3.

Table 9-3 Summary of Land Acquisition and Compensation for Water and Power Transmission Facilities

Subject	Water Transmission Pipeline			Power Line	Total
	Mahres	Agareb	Sfax South		
Land (m^2)	2,200	10,560	17,294	4,000	**34,054**
Structures (wall, m)	275	150	810	-	**1,235**
Olive Trees (tree)	-	50	61	50+375	**536**

Source: JICA Survey team

9.2 Costs and Funding

(1) Costs related to acquisitions

Costs related to acquisitions are evaluated based on Table 9-2. Unit costs for olive trees and other fruit trees are estimated at NDI TND/tree based on another expropriation file submitted by the Juridical and Real Estate Affairs Department of SONEDE. Wall is estimated at NDI TND/m. Land price is estimated based in the data provided by the Juridical Section of SONEDE Sfax Branch.

The square meter costs of lands along the transmission pipeline were provided by SONEDE's General Department in Sfax.

Table 9-4 Land Acquisition and Compensation Costs for Transmission Facilities

Land						
Item	**Community**	**Type**	**Area (m^2)**	**U. Price[1)] (TND)**	**Total (TND)**	**Total (TND)**
Table 9.3.1,No.1	Mahres	Industry	2,200	Non-disclosure Information		
Table 9.3.1,No.2	Agareb	Farming	10,560			
Table 9.3.1,No.3	Sfax South	Industry	1,240			
Table 9.3.1,No.4		Industry	800			
Table 9.3.1,No.5		Farming	7,760			
Table 9.3.1,No.6		Industry	1,640			
Table 9.3.1,No.7		Farming	527			
Table 9.3.1,No.8		Farming	527			
Figure 9.3.3 (B12)		Farming	4,800			
Power Transmission Tower	Based on STEG's Plan[2)]	Farming	4,000			
Structures						
Item	**Community**	**Type**	**Length(m)**	**Price**	**Total**	**Total**
Table 9.3.1,No.1	Mahres	Wall	275	Non-disclosure Information		
Table 9.3.1,No.2	Agareb	Wall	150			
Table 9.3.1,No.3	Sfax South	Wall	155			
Table 9.3.1,No.4		Wall	100			
Table 9.3.1,No.5		Wall	350			
Table 9.3.1,No.6		Wall	205			
Agricultural assets						
Item	**Community**	**Type**	**Number**	**Price**	**Total**	**Total**
Table 9.3.1,No.2	Agareb	Olive trees (25/ha)	50	Non-disclosure information		
Table 9.3.1,No.5	Sfax South		37			
Table 9.3.1,No.7			2			

Table 9.3.1,No.8			2	Non-disclosure Information
Figure 9.3.3 (B12)			20	
Power Transmission Tower	Based on STEG's Plan		425	

Note 1): price in 2014
Note 2): Mahres, Agareb, Sfax South
Source: JICA Survey team

For each community, the total costs amount to NDI TND in Mahres, NDI TND in Agareb, NDI TND in Sfax South, with a combined total of NDI TND. The above includes the costs for land asset, structure and crops assets, based on market prices in the region, and can be considered as full replacement costs.

SONEDE will also shoulder the following costs for land acquisition and compensation for power transmission line; TND NDI (land acquisition) + TND NDI (olive) = TND NDI .

(2) Compensations to fishing activities

As described in Table 8.10-2, the compensation cost for fishing activities amounts to TND NDI .

(3) Budget and funding for social considerations

The total budget necessary for compensations to expropriation and to fishing activities amounts to NDI + NDI + NDI = TND NDI . Since this Project is being implemented by SONEDE, funding will be provided by SONEDE and may be charged for the budget of the Juridical and Real Estate Affairs Department.

9.3 Monitoring Implementation Follow-up Form

The Project's overall schedule depends on the enforcement of social considerations including land acquisition and compensation relating to power transmission line, therefore follow up must be conducted by PIU using the follow up form.

9.4 Explanation to Residents about Power Transmission Line

In addition to the support for the stakeholders meeting, the JICA Survey Team also supported SONEDE to explain and collect the opinions of residents about power transmission line for the desalination plant. Collection of residents' opinions was carried out by distribution of explanation papers and questionnaire survey.

Contents of the distributed papers are; general map, questionnaire, outlines of the Project, and policies of land acquisition and compensation relating to construction of the power transmission line.

Since the Sfax Governorate office is the sole responsible authority for administrative issue in the Sfax Governorate under Ministry of Interior of Tunisia, SONEDE could not contact each region, but did so through the governorate office. SONEDE sent the questionnaire to the governorate office and requested

the office to deliver the questionnaire to representatives of each region. The answer was that there had been no objection from Sfax Ville, West Sfax, and Thyna, and the governor also had no objection about the Project. It may be considered that no objection to construction work of the power transmission line at present.

Social survey will be conducted by SONEDE at the time of detailed design of the power transmission line by STEG. Subject area and residents will be identified through the survey, and then, the land required to be acquired and amount of compensation will be identified. Further, SONEDE will hold explanation meeting with residents in the subject areas to explain about policies for land acquisition and compensation and to confirm that there is no opposition to the Project.

CHAPTER 10 IMPLEMENTATION PLAN

Non-disclosure Information

CHAPTER 11 CONFIRMATION OF VIABILITY AND RISK ANALYSIS

The necessity for installing a seawater desalination plant installation was examined in Chapter 4. In constructing the plant, there are some issues on finance, environment, and power supply. This chapter discusses these issues as well as mitigation of risks associated with the issues presented.

11.1 Concern about Financial Aspect

The initial costs in the construction of seawater desalination plant will be shouldered by the government of Tunisia. SONEDE is not required to consider the payment of the initial cost from its account, but the operation and maintenance cost shall be borne by SONEDE from its own revenue. The O&M cost of the desalination plant is higher compared with the common water treatment process. Without implementing measures to increase revenue, SONEDE will not able to shoulder the increased expenditure for operation and maintenance of the desalination plant.

SONEDE has applied the uniform water tariff rate to all users in the nation. If all the customers of SONEDE cover the increased cost brought by this Project, the required water tariff is NDI TND/m^3. The required increase will be approximately NDI TND/m^3 or NDI % of present tariff. The percentage of the water tariff against the disposable income is 0.67% after the increase.

11.2 Concern about Social and Environmental Aspect

There are two categories of environmental issues caused by implementation of the Project, i.e. concerns under the sea and on ground.

Since intake and discharge pipelines will be installed under the seabed, the pipe installation will directly impact the aquatic environment. Seagrasses are observed to grow by the seafront of the proposed site for the desalination plant, which means that other marine creatures inhabit the area. In the field investigation, no other remarkable sea creatures were observed except for the presence of seagrasses.

In the interview survey, the environmental authority responded there would be no particular concern, but the issue will still be clarified when the EIA will be implemented. Since the intake and the discharge pipelines will be installed under the seabed, the seagrasses habitat will temporary be disturbed during the construction period. It is necessary to reduce the impacts during the construction work, and if required, transplanting of the seagrasses from the construction site will be done. After construction, the area will be restored to its original state.

The sea water desalination plant is to be installed at non-utilized open space facing the coast, so a big impact to the environment will not be expected. However, there will be construction vehicles plying the roads. The transmission pipelines are to be installed along main roads covering a long distance, thus pipeline construction work is seen to seriously affect traffic. Efforts shall be made to minimize the effect on traffic.

With the identification of impacts of the Project and measures by EIA, appropriate mitigation measures will be undertaken to lessen its adverse impacts.

11.3 Concern about Power Supply Aspect

Power demand of the proposed sea water desalination plant is assumed at 40MW in the final stage of the Project. SONEDE inquired STEG of the availability of 40MW power supply, which requires the payment of a new power distribution system including a substation.

11.4 Concern about Delay of the Project

If the implementation schedule of the Project is delayed, water shortage in the Greater Sfax, which is anticipated to occur from 2017 will continue until the completion of the Project.

There will be various causes of delay of the schedule. There are many procedures to be followed for implementation of the Project, and any small delay of each procedure will become a big delay in the end. Approval or permission for implementation by related authorities for construction work such as permission for pipe installation work under roads are usually delayed. In the Project, it is expected that the PIU to be established in SONEDE will take strong leadership and approach to related authorities together with cooperation with related sections of SONEDE.

On the Saida Seawater Desalination Plant Construction Project, the first phase of the Project of Saida Reservoir and Kalaa Kebira Reservoir & Water Treatment Plant is expected to be completed by 2020, and completion of the second phase by 2024. If that project is delayed, water shortage in the Greater Sfax will be in more serious because water to be supplied by the said project will be much more than that supplied from the Sfax Seawater Desalination Plant.

11.5 Risks and Mitigation Measures

Table 11-1 Financial Risks and Mitigation Measures

Financial Risks	Cause of Risks	Mitigation Measures
Initial cost of sea water desalination facility	• Increase in construction cost	• Increase the burden of the government • Review of construction work
Operation and maintenance cost of sea water desalination facility	• Increase the amount of water supply due to the high unit cost production process	• Consideration of tariff increase • Review of the supplies and personnel expenses • Reduction of operating expenses, including the use of outsourcing • Decrease in the utilization rate of the high unit cost production process with water-saving[2]
Opposition of residents to the tariff increase	• Rapid rate increase	• Explanation to residents and public relations on a review on water tariff • Information to residents about the benefits of the seawater desalination plant • Information to residents about water-saving measures
Socio-Environmental Risks	Cause of Risks	Mitigation Measures
Social impact • Impact on life of residents during construction • Legal action if the residents do not agree with the construction of the desalination plant	• Lack of social awareness for water supply development plan • Lack of public relations • Failure of negotiation • Impact on economic activities (For instance: impact of intake/discharge pipes to fishery activities, noise at pump station, traffic congestion caused by construction)	• Verification of the necessity of the Project • Explanation to residents and public relations • Installation of transmission pipes or pump stations along roads, or public land avoiding residential areas, and technical and economic applicability • Securing sufficient budget for land acquisition
Impact on the natural environment • Non-approval of the EIA • Impact on the economic activities	• Impact of intake and discharge pipes on marine environment (change in salinity, change in current, excavation for pipe installation, etc.) • An increase in sewage by an increase in water supply, and pollution expansion at public waters	• Selection of the site with less or insignificant impact to marine environment • Optimization of design by simulating intake/discharge pipe operation • Verification of impact on economic activities with change in the natural environment • Promotion of sewerage development plan
Power Supply Risks	Cause of Risks	Mitigation Measures
Power failure	• Lack of emergency generators • Accidents	• To intensify generating facilities (below: measures at the plant) • Two-line power receiving system • To receive power from high voltage line • To secure large capacity of production water tanks • To install standby generators for transmission

[2] The operation rate of the Chatan Sea Water Desalination Plant in Okinawa, Japan with a capacity of 40,000 m^3/day was 25% on average for 10 years from when it started operation in 1997 to 2006. In 2011 it was 12.3%. The reasons of its low operation rate are; high power consumption at 6.17 kWh/m^3, and other water resource development after its completion.
Umi-no-nakamichi Nata Sea Water Desalination Plant in Fukuoka, Japan with a capacity of 50,000 m^3/day was 78% in 2011 due to drought of surface water and water shortage caused by other works. However, not only that year but also other years, the plant had high operation rate of 60% to 83%/ since the start of its operation in 2005. Though the high power consumption at 5.87 kWh/m^3,is much higher than that of the nearby Ushikubi Water Treatment Plant at 0.18 kWh/m^3, this plant keeps high operation rate because of lack of water supply capacity originated from surface water.

		pumps.
Implementation Delay Risks	Cause of Risks	Mitigation Measures
Delay in the implementation of the Project	• Delay in the establishment of PIU • Delay in making Loan Agreement • Delay in the preparation of Tender Documents • Delay in the approval in various procedures by HAICOP • Delay in Tender evaluations • Rupture of Tender • Delay in concurrence in various procedures by JICA • Delay in land acquisition • Delay in the approval for implementation of works by related authorities • Delay in marine works due to bad weather.	• Strong leadership and approach to related authorities by PIU. • Secure sufficient number of PIU staff • Hiring consultants • Preparation of appropriate and easily understandable tender documents. • Preparation of flexible construction plan.

CHAPTER 1

PURPOSE AND CONTENTS OF THE SURVEY

CHAPTER 1 PURPOSE AND CONTENTS OF THE SURVEY

1.1 Background

Half of the Republic of Tunisia, hereinafter referred to as "Tunisia", belongs to semi-arid climate. Precipitation is a little less than 500 mm in average in unis. Consequently groundwater contributes to about 40 % of water usage.

Water supply system in Tunisia has been developed in accordance with continuous economic growth[1], covering 97.8 % of the entire country, i.e. 100% of urban area, 93.4% of rural area (SONEDE, 2012). In Tunisia, Ministry of Agriculture, Water Resources and Fisheries (French: Ministère de l'Agriculture, des Ressources Hydrauliques et de la Pêche, hereinafter referred to as "MOA") establishes policies for water sector. The provision of water supply to rural areas by communal faucet method is under jurisdiction of MOA. It is the National Water Distribution Utility (French: Société Nationale d'Exploitation et de Distribution des Eaux, hereinafter referred to as "SONEDE") that is responsible for supplying water to the urban areas and a part of rural areas by individual water supply system including water supply for domestic use and development and maintenance of conveyance and transmission system.

The Greater Sfax is the second largest city in Tunisia with a population of about 621,000[2] (Jan. 2013) located in the Sfax Governorate (about 963,000 population[2], Jan. 2013). Water supply volume is about 190,000m^3/day for SONEDE's coverage area with a served population of about 810,000 in 2012 according to SONEDE. Because of rapid increase of population of the governorate with an average increase rate of 1.37% per annum in past 10 years, from 2003 to 2013, it is projected that serious water shortage will occur in 2018, and development of new water sources is requested. For its water supply, the Sfax Governorate relies on surface water transmitted from the northern region of Tunisia, groundwater in the central-western region, and its own groundwater. The water sources for the Sfax Governorate were shown that 42% from the North Water Transmission System, 37 % from the central western region by Jelma-Sbeitla Groundwater Transmission System, and 21 % from groundwater in Sfax Governorate. It is projected, however, that the water supplies to the Greater Sfax from other governorates will decrease because of the increase of demand in upstream governorates. In order to cope with this situation, it has been requested to develop water resources and related infrastructure only for the Greater Sfax, and SONEDE conducted "the Feasibility Study on the Mid-South Area Water Supply Scheme (hereinafter referred to as "the Feasibility Study") in 2005. In the Feasibility Study, the regional water supply plan including the Sfax Governorate was formulated to satisfy water demand in the central and the south regions. Many projects proposed in the study, however, have not been implemented due to scarcity of budget.

In such circumstance, the Sfax Governorate, especially the Greater Sfax suffered serious water shortage

[1] About 4% of average GDP annual growth rate in during past 15 years including 2011 when the revolution broke out with economy recession of -1.94%.
[2] http://www.ins.nat.tn/en/serie_annuelle.php?Code_indicateur=0201060

during the peak demand in the summer in 2012 due to temporary decrease of water transmitted by the North Water Transmission System. This water shortage was an opportunity to confirm the appropriateness of the regional water supply plan planned in the Feasibility Study. For solving the issue, SONEDE conducted the Strategic Study in April 2013 for enhancement of water supply capacity and improvement of water quality by 2030. In the study, a top priority was given for enhancement of water source of the Greater Sfax, and augmentation of water supply capacity by introduction of desalination of seawater was planned as a practical and immediate effective measure in the situation of shortage of water resources.

Under the background stated above, implementation of the project for seawater desalination plant in suburbs of Sfax (hereisafter referred to as "the Project") was planned based on the plan in the Strategic Study. In response to the request of Tunisian government, JICA discussed with SONEDE about Terms of Reference (TOR) for this preparatory survey for the Project, and this survey started based on the TOR.

1.2 Outline of the Survey

1.2.1 Purpose of the Survey

This survey is conducted for the formation of the project suitable for the Japanese ODA loan with Tunisian government, represented by the Ministry of Foreign Affairs, the Ministry of Development, Investment and International Cooperation, and the Ministry of Finance as borrower, and SONEDE as executing agency. The purpose of the survey is to contribute to the implementation of the project as Japanese ODA loan project by conducting feasibility study for Sfax Seawater Desalination Plant under this survey.

Accordingly, the accomplishment of the survey will be the reference for loan assessment by JICA and the scope of work planned in the survey will be the basis for the project under the Japanese ODA loan.

1.2.2 Scope of the Project

Scope of the Project is for a seawater desalination plant with a production capacity of 200,000 m^3/day. However, 100,000 m^3/day is the subject capacity for the Japanese ODA loan including intake and discharge facilities, transmission pipeline, distribution reservoir, and related pumping facilities.

1.2.3 Survey Area

The area of the survey is the Greater Sfax and its surrounding area. Sfax is a city, located 270 km southeast of Tunis, and the capital of the Sfax Governorate. The city expansion is explained with the development as a harbour city, and of the road system to inland in multi-direction from the port. Recently, a circular road was developed and the urbanization is extending to along the road.

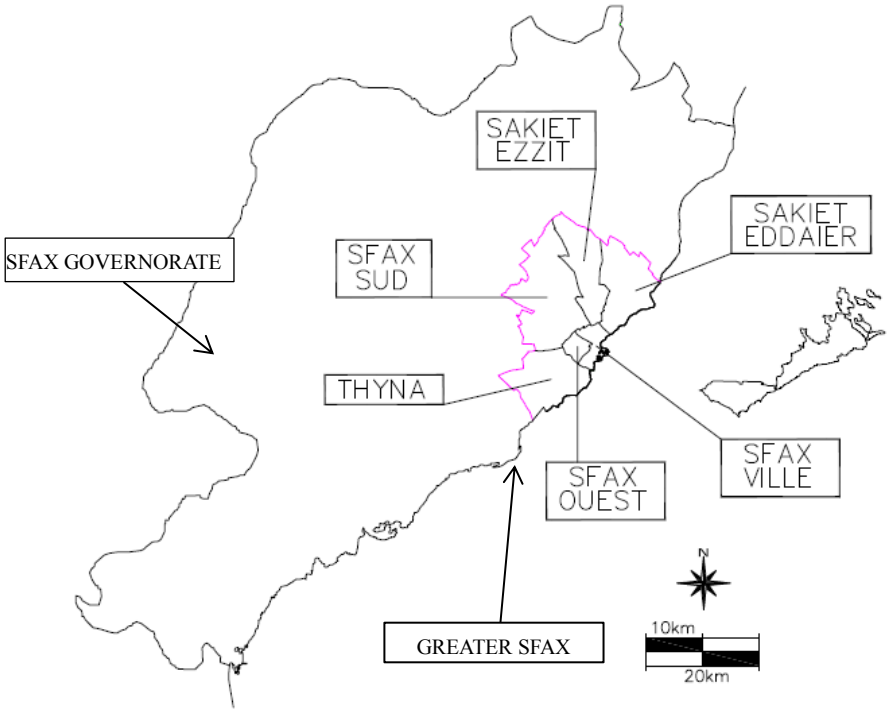
The Greater Sfax consists of Sfax Ville and five (5) delegations i.e. Sfax Ouest (West), Sfax Sud (South), Thyna, Sakiet Ezzit and Sakiet Eddaier. Each delegation consists of its sectors. There are 43 sectors in total

in the Greater Sfax.

Table 1.2-1 Delegations and Sectors in the Greater Sfax

Delegation	Sector	Delegation	Sector
Sfax Ville	Sfax Medina	Sfax Sud	Bouzaien
	15-Novembre		El Afrane Nord
	Ain Cheikhrouhou		El Ain
	Bab B'har		El Aouabed
	Bassatine		El Khazzanet
	Cite Attaouidhi		Gremda
	Cite Khiri		Ouyoun El Mayel
	Merkez Bacha	Thyna	El Hajeb
	Merkez Gaddour		Sidi Abid
	Mohamed Ali		Tyna
	Rbat	Sakiet Ezzit	Bouacida
	Sidi Abbes		Cedra
Sfax Ouest	El Alia		Chihia
	El Hadi		Sakiet Ezzit
	Hay El Bahri		Sidi Salah
	Hay El Habib		Teniour
	Merkez Chaker	Sakiet Eddaier	Bderna
	Oued Ermal		Cite Bourguiba
	Sokra		El Khairia
			Merkez Kaaniche
			Merkez Sebii
			Sakiet Eddaier
			Seltania
			Sidi Mansour

Source: delegation; L'Institut National de la Statistique: INS, Sector: JICA Survey Team



Source: JICA Survey Team

Figure 1.2-1 Administrative Map of the Greater Sfax

1.2.4 Relevant Authorities

Authorities relevant to the survey are as follows:

- Counterpart: National Water Distribution Utility (SONEDE)
- Related Authorities：
  1) Ministry of Development, Investment and International Cooperation (MDICI, Window for the Japanese ODA loan)
  2) Ministry of Finance (Borrowing and repayment of the Japanese ODA loan)
  3) Ministry of Agriculture, Water Resources and Fisheries (Regulatory authority of SONEDE)
  4) Ministry of Foreign Affairs (International relation, Agreement with Foreign Countries)
  5) Ministry of Environment and Sustainable Development
     Environmental Protection Agency (ANPE, Appraisal of Environmental Impact Assessment)
     Coastline Protection and Planning Agency (APAL, Approval of Development in Coast)

1.2.5 JICA Survey Team

The JICA Survey Team was composed of following persons;

(1)	Mr. Takafumi Kiguchi	Team Leader / Water Supply Planning
(2)	Mr. Junichi Kamimura	Seawater Desalination Facility Designing
(3)	Mr. Tadao Funamoto	Transmission and Distribution Facilities Designing
(4)	Mr. Tetsuji Niwano	Water Resources Study
(5)	Mr. Yoshinari Fujiwara	Mechanical Facility Design 1
(6)	Mr. Ryuta Kudo	Mechanical Facility Design 2
(7)	Mr. Toru Watanabe	Electrical Facility Design 1
(8)	Mr. Akira Miura	Electrical Facility Design 2
(9)	Mr. Takashi Nakagawa	Natural Condition Survey
(10)	Mr. Daisuke Yashiro	Procurement and Cost Estimates
(11)	Mr. Yasuo Nakada	Economic and Financial Analysis
(12)	Mr. Sebastien Arnaud	Environmental and Social Consideration
(13)	Mr. Toshihiko Tamama	Institution and organization
(14)	Mr. Ryosuke Ohta	Coordination / Seawater Desalination Facility Designing Assist.

1.2.6 Schedule of the Survey

The survey was conducted in two phases as follows:

(1) Phase 1 (September to December 2013): Confirmation of Necessity and Viability of Seawater Desalination Plant

The Phase 1 survey was started from 13 September 2013, and the Field Work was conducted from 28 September to 23 November, 2013 after the preparatory work. After the fieldwork, the work were conducted Japan up to the beginning of January 2014.

(2) Phase 2 (January 2014 to August 2015): Feasibility Study

The feasibility study was conducted from January 2014 to August 2015.

The second fieldwork was conducted from the middle of January to the beginning of March 2014. After the succeeding work in Japan, the accomplishments were compiled as the Interim Report 2.

The third fieldwork was started from the middle of April 2014 and was conducted up to the middle of June, and then, the Draft Preparatory Survey Report was made in Japan from June to September 2014.

Explanation and discussion on the draft report were carried out on 29 September 2014. The Final Report, which included the revision on the draft report to reflect comments from Tunisian side, was prepared and submitted in August 2015[3].

This report was prepared based on the information obtained up to June 2015.

1.3 Scope of Work of the Survey

1.3.1 Scope of Work in Phase 1

In Phase 1, review of existing information, execution of fieldwork, and collection and analysis of information was conducted to confirm necessity and viability of the seawater desalination plant construction project. In addition, the appropriate capacity of the plant and the suitable site were recommended after reviewing the target year and the future water demand. Major survey items are as follows:

(1) Review and survey on existing information
   1) Natural Condition Survey (meteorology, topography, terrain, hydrology, hydrogeology, etc.)
   2) Social Condition Survey (Socio Economic Situation and Population, Commerce and Industry, Land Use, Infrastructure, rend of economy)
   3) Environmental Condition Survey (legislation and regulation relating to environment, public sanitation, etc.)

(2) Collection and analysis of basic information for planning of the Project
   1) Water Demand and Water Supply Volume in the Greater Sfax
   2) Available Water Volume in the Greater Sfax
   3) Water Supply Facility in the Greater Sfax
   4) Other Water Supply Projects in the Greater Sfax
   5) Candidates Sites for Seawater Desalination Plant in the Greater Sfax
   6) Existing Water Supply Facility in the Greater Sfax
   7) Existing Desalination Plants
   8) Organization Structure for Water Sector

[3] After explanation of the draft report, revision of water balance between demand and supply, water source allocation planning were conducted to reflect SONEDE's comments, and revision of facility development plan was conducted to cope with the change of distribution flow as well. Further, review of the project cost, and financial and economic analysis were also conducted.

9) Water Tariff
10) Financial Status of SONEDE
11) Available Power Supply
12) ”Djerba Island Seawater Desalination Plant Construction Project” Tender Document

(3) Necessity of the Project and confirmation of risks
1) Present Status and Problems of Water Sector including Domestic, Agricultural, and Industrial Uses
2) Policy and Future Plan of Water Sector including Domestic, Agricultural, and Industrial Uses
3) Required Capacity for Water Supply for Domestic, Agricultural, and Industrial Uses
4) Water Resource Development Plan of SONEDE to increase Water Supply Volume
5) Present Status and Construction Plan of Existing Distribution Facility
6) Status of Support by Other Donors
7) Water Supply Facility Development Plan by SONEDE (including Seawater Desalination Plant)
8) Comparison between Seawater Desalination Plant and Alternative Water Resource and Confirmation of Risks
9) Examination of Impact on Water Tariff by Introduction of Seawater Desalination Plant
10) Positioning in Policy of Tunisia
11) Examination and Recommendation of Mitigation Measures Against risks

(4) Preparation and Discussion about Interim Report 1 (IT/R1)

1.3.2 Scope of Work in Phase 2

Selection of optimum site from candidate sites identified in Phase 1 and preparation of the project plan was reported in the Interim Report 2. Upon confirmation of the contents of the Interim Report 2 with SONEDE and JICA, preliminary design and rough cost estimates were prepared, and then the Preparatory Survey Report was compiled as a feasibility study report inclusive of the project implementation plan and evaluation of the Project.

Major survey items are as follows:

(1) Planning of the Project
1) Water Supply Plan in the Greater Sfax
2) Required Water Production Volume by Seawater Desalination Plant
3) Selection of Seawater Desalination Plant Construction Site
4) Comparison of Seawater Desalination Method (RO Membrane, Multi-stage Flush Evaporation)
5) Decision of Seawater Intake Method
6) Decision of Discharge Method for Condensed Wastewater
7) Site Selection for Pumping Facility
8) Site Selection for Reservoirs
9) System Operation Plan
10) Calculation of required area for the Project

11) Confirmation of legislation and procedure for land acquisition

(2) Preparation and Discussion about Interim Report 2 (IT/R2)

(3) Preliminary Design of the Project
1) Identification of Scope of the Project
2) Preliminary Design of Seawater Intake Facility, Seawater Desalination Plat, Concentrated Seawater Discharge Facility, Pumping Facility, Transmission Pipeline, and Reservoir
3) Confirmation of Required Official Procedures and Legislation, Land Acquisition Procedure

(4) Assessment of and Evaluation of Major Environmental and Social Impact Item, Preparation of Mitigation Measures, and Monitoring Plan

(5) Rough Cost Estimates

(6) Preparation of Project Implementation Plan
1) Financial Plan
2) Execution Scheme
3) Project Implementation Schedule
4) Procurement Plan
5) Organization for Project Implementation
6) Operation and Maintenance Plan
7) Preparation of TOR for Consultants
8) Economic and Financial Analysis
9) Other Considerations

(7) Project Evaluation

(8) Recommendation of Operation and Performance Indicators

(9) Recommendations

(10) Preparation of Preparatory Survey Report (Draft)

(11) Explanation and Discussion on Preparatory Survey Report (Draft)

(12) Preparation and submission of Final Report

1.4 Past Projects in Water Supply Sector under Japanese ODA Loan

Projects in water supply sector under the Japanese ODA loan in Tunisia are listed on Table 1.4-1.

In addition, the Japanese government granted the fund for the Project for Desalination of Groundwater at Ben Guerdane in Medenine Governorate, in which groundwater desalination plant with a capacity of 1,800m^3/day was constructed. Operation of the plant started in June 2013.

Table 1.4-1 Projects in Water Supply Sector under Japanese ODA Loan

Year	ODA Loan Outlines	Project Outlines	Status
1994	L/A No.: TS－P6 Project Name: Southern Area Water Supply and Sewerage Improvement Project L/A signing: 1995.03.31 Loan Amount (M yen): 7,577	● Provision of water supply and sewerage facilities in tourist resorts in south Tunisia, i.e. Djerba, Zarzis and others. ● Sites for water supply project are Djerba, Zarzis, Ben Guerdane, Medenine and Tatawin, and the site for sewerage project is the tourist spot at east area of Djerba. ● Scope of the water supply project includes; Groundwater desalination plant (15,000m^3/day x 2 plants), 15 deep wells, 5 distribution reservoirs, 169km long conveyance pipeline, 91km long distribution pipeline, and others. Completed in February 2003.	DC.
1999	L/A No.: TS－P19 Project Name: Rural Water Supply Project L/A signing: 2000.03.23 Loan Amount (M yen): 3,352	● In rural areas of 17 governorates, small-scale water supply infrastructures, consulting services and procurement of equipment materials and construction work.	DC.
2002	L/A No.: TS－P24 Project Name: Rural Water Supply Project (II) L/A signing: 2003.03.31 Loan Amount (M yen): 4,495	● Lending required fund for construction and improvement of water supply facilities, procurement of related equipment (pumps and pipes), and consulting services for about hundred poor districts based on the 10th Rural Water Supply Scheme planned by Tunisian government.	DC.
2006	L/A No.: TS－P28 Project Name: Jendouba Rural Water Supply Project L/A signing: 2006.05.23 Loan Amount (M yen): 5,412	● In rural areas of Jendouba Governorate and a part of Beja in north-west region, transmission and distribution pipelines, 1 water treatment plant, 12 distribution reservoirs, 9 pumping facilities, 1 pressure reduction facility	OG.
2011	L/A No.: TS－P36 Project Name: Local Cities Water Supply Network Improvement Project L/A signing: 2012.02.17 Loan Amount (M yen): 6,094	● Rehabilitation and extension of existing water supply facilities including civil works, procurement of ductile cast iron pipes, other materials and equipment in 19 governorates. Distribution facilities in Sfax are also subjects of the project.	OG.

Status: DC.; Disburse Completed, OG.; On-going
Source: JICA Study Team, as of December 2014

1.5 Other Donor's Programs for Water Supply Sector

SONEDE is conducting and planning the following programs with assistances of other international donors.

Table 1.5-1 Projects in Water Supply Sector Assisted by Other International Donors

Donors / Project		Project Outlines	Status
KfW Bankengruppe			
	South Tunisia Desalination Plants Construction Project	● Assistance for the project to construct desalination plants in the southern area of Tunisia. ● In the Phase 1 project (PNAQ1), the study was conducted in 2003, and, the construction of ten desalination plants will be completed in October 2015. ● For the Phase 2 project (PNAQ2), the study has started since 2011 by grant aid support. Presently the EIA report and the final report of the study are being finalized. Six desalination plants are planned to be constructed from 2015.	OG.

Donors / Project	Project Outlines	Status
Djerba Desalination Plant in Medenine	● In Djerba in Medenine governorate, a 50,000m^3/day seawater desalination plant had been planned in the study funded by EU grant aid. SONEDE has modified the plan to enable the increase of the capacity to 75,000m^3/day. ● Financial support of KfW and French Development Agency (AFD) is expected. The contract for the construction work was signed on 8th September 2014 by SONEDE as a borrower.	OG.
Zarat Desalination Plant in Gabes	● A study for 100,000m^3/day desalination plant in Zarat in Gabes governorate was started in September 2012 with the technical support from Fund for African Private Sector Assistance (FAPA） of African Development Bank (AfDB). ● As for the implementation of the project, SONEDE intends to start the project by the end of 2014 with financial support of KfW, it has not been arranged yet as of November 2014.	NF.
Kerkennah Desalination Plant in Sfax	● SONEDE have a plan to start a study for 6,000m^3/day desalination plant in Kerkennah in the Sfax Governorate in 2013. For this study, KfW's support is expected.	NF.
French Development Agency (AFD)		
Rural Water Supply Project III 2009-2016	● Agreed in 2009 about a program for rural water supply. ● Program provides drinking water supply in 49 new groups of a population of 52 536 spread over 14 governorates by: - extension of existing networks, civil works and installation of equipment. - acquisition of 80 000 meters pipeline material - implementation of energy mastering program. - implementation of the program of geographic information system ● Project cost : 21 M EUR	OG
Program securing production capacity and water supply of SONEDE: 2012-2016	● Programs to improve the capacity of SONEDE for water production and distribution. ● The implementation period of the program is from 2011 to 2016 and the programs are carrying out in 13 locations in Tunisia including connection works from Djerba desalination plant to existing distribution reservoirs in Medenine governorate. ● Project cost : 52.95M EUR	OG.
Rural water supply program : 2013 – 2017	● Agreed in July 2013 about a program for rural water supply. ● It includes the creation of sixty networks, the creation of 3 wells, 39 reservoirs, 31 pumping stations and iron removal station. ● Project cost : 23.85M EUR	OG.
World Bank Group		
Urban Water Supply Project - Additional	● For urban water supply project of SONEDE, agreed and effective on 17 November 2014. Additional financing project for the project with same name agreed in December 2005 and expected to be completed in 2012. ● The project objectives are i) to ensure the continuity of water service (twenty four (24) hours per day, seven (7) days a week) to the population in Greater Tunis and other targeted cities; and (ii) improve the financial viability of SONEDE ● Project Cost: 26.2M USD	OG
Construction of the transmission pipeline from Saida reservoir, the transmission pipeline from Kalaa Kebira reservoir, and the water treatment plant.	● For the North Water Transfer System, which supplies water to Sfax, SONEDE expect to obtain financial support for construction of the transmission pipeline from Saida reservoir, the transmission pipeline from Kalaa Kebira reservoir, and the water treatment plant. ● According to the person in charge in Tunisia, the World Bank has planned to support rehabilitation project of those transmission facilities from reservoirs. The specific contents and timing is still under consideration.	NF.

Donors / Project		Project Outlines	Status
Arab Fund for Economic and Social Development (FADES)			
	Construction of Saida reservoir and Kalaa Kebira reservoir	● Among the components of the North Water Transfer System, which supplies water to Sfax, expect to obtain financial assistance for construction of Saida reservoir and Kalaa Kebira reservoir, MOA will implement the project. FADES agreed with MOA and SONEDE in principle to provide loan for the project finance. ● Donors of Arab showed funds made their interest to fund the remaining components (transfer, treatment, reservoirs, pumping, etc.); Saudi Arabia, Kuwait, and Abu Dhabi	NF.

Status: OG.; On-going, N.F; Financial arrangement has not been finalized.
Source: JICA Study Team, as of March 2015

On-going and expected desalination projects supported by KfW Bankengruppe are as shown in Table 1.5-2 and Figure 1.5-1.

Table 1.5-2 Desalination Plant Construction Projects in Tunisia supported by KfW

No.	Location		Raw Water	Capacity (m^3/day)	Project*	Status
1	Tozeur	Tozeur	Brackish	6,000	a, PNAQ1	Completion expected in Oct. 2015
2		Nafta	Brackish	4,000	a, PNAQ1	Completion expected in Oct. 2015
3		Hezoua	Brackish	800	a, PNAQ1	Completion expected in Oct. 2015
4	Kebili	Kebili	Brackish	6,000	a, PNAQ1	Completion expected in Oct. 2015
5		Douz	Brackish	4,000	a, PNAQ1	Completion expected in Oct. 2015
6		Souk Lahad	Brackish	4,000	a, PNAQ1	Completion expected in Oct. 2015
7	Gabes	Matmata	Brackish	4,000	a, PNAQ1	Completion expected in Oct. 2015
8		Mareth	Brackish	5,000	a, PNAQ1	Completion expected in Oct. 2015
9	Medenine	Beni Khedache	Brackish	800	a, PNAQ1	Completion expected in Oct. 2015
10	Gafsa	Belkhir	Brackish	1,600	a, PNAQ1	Completion expected in Oct. 2015
11	Tozeur	Degueche	Brackish	2,000	a, PNAQ2	Construction to be started in 2015
12	Sidi Bouzid	Mazouna, etc.	Brackish	3,000	a, PNAQ2	Construction to be started in 2015
13	Medenine	Ben Guerdane	Brackish	9,000	a, PNAQ2	Construction to be started in 2015
14	Gafsa	Gafsa Est	Brackish	9,000	a, PNAQ2	Construction to be started in 2015
15		Gafsa Ouest	Brackish	6,000	a, PNAQ2	Construction to be started in 2015
16	Kebili	Bechlli, etc.	Brackish	2,000	a, PNAQ2	Construction to be started in 2015
17	Medenine	Djerba	Seawater	75,000*[2]	b	Contracted in Sept. 2014
18	Gabes	Zarat	Seawater	100,000	c	Requesting for finance
19	Sfax	Kerkennah	Seawater	6,000	d	Under planning

Brackish: Brackish Groundwater

*:Project :

a: South Tunisia Desalination Plants Construction Project, Phase 1 (PNAQ1), Phase 2 (PNAQ2)

b: Djerba Desalination Plant in Medenine

c: Zarat Desalination Plant in Gabes

d: Kerkennah Desalination Plant in Sfax

*[2]: Initial capacity is 50,000 m^3/day, but expandable to 75,000 m^3/day in the future.

Source: SONEDE Conseil D'Administration du 06/08/2013, confirmed and updated by SONEDE (March 2015)

List of KfW assisted Desalination

No.	Location		Capacity (m^3/day)
1	Tozeur	Tozeur	6,000
2		Nafta	4,000
3		Hezoua	800
4	Kebili	Kebili	6,000
5		Douz	4,000
6		Souk Lahad	4,000
7	Gabes	Matmata	4,000
8		Mareth	5,000
9	Medenine	Beni Khedache	800
10	Gafsa	Belkhir	1,600
11	Tozeur	Degueche	2,000
12	Sidi Bouzid	Mazouna, etc.	3,000
13	Medenine	Ben Guerdane	9,000
14	Gafsa	Gafsa Est	9,000
15		Gafsa Ouest	6,000
16	Kebili	Bechlli, etc.	2,000
17	Medenine	Djerba	75,000
18	Gabes	Zarat	100,000
19	Sfax	Kerkennah	6,000

Figure 1.5-1 On-going and Expected Desalination Projects supported by KfW Bankengruppe

CHAPTER 2

REVIEW OF EXISTING INFORMATION AND EXPLORATION

CHAPTER 2 REVIEW OF EXISTING INFORMATION AND EXPLORATION

2.1 Natural Condition

The Greater Sfax is located in the middle area of semi-arid climate of the Republic of Tunisia. It has an area of 163,610 km^2, but is characterised by mild climate with relatively high humidity because of facing the Mediterranean Sea.

2.1.1 Meteorological Information

(1) Temperature

The average annual temperature in the past 21 years (1992-2012) is 18 ^oC. The climate is divided into cold season from December to February and hot summer season from July to September. The climates in spring and autumn are pleasant.

Table 2.1-1 Average Temperature in Greater Sfax

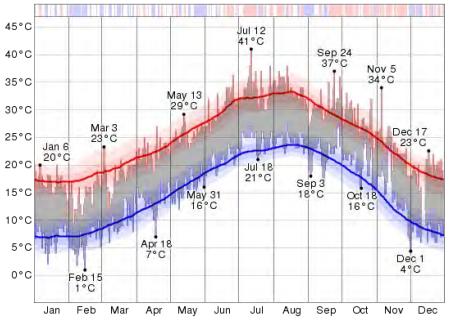
Month	1	2	3	4	5	6	7	8	9	10	11	12	Ave
High average temperature ^oC	16	17	18	21	24	28	31	31	29	25	20	17	23
Average temperature ^oC	11	12	14	16	20	23	26	27	25	21	16	12	18
Low average temperature ^oC	6	7	9	11	15	19	21	22	21	17	11	7	14

Source：Weatherbase

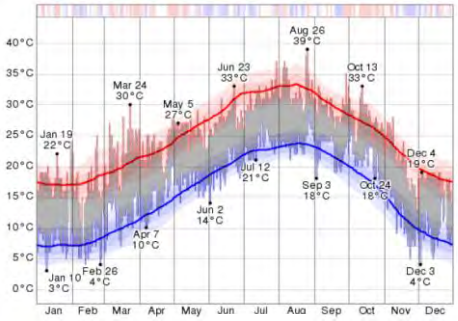
Figure 2.1-1 shows the maximum and minimum temperature ranges during 2010-2013. Monthly average lowest temperature is 6 ^oC in January. On 10 January 2012, the lowest temperature at 1 ^oC was recorded. Monthly average highest temperature is 31 ^oC in August. On 12 July 2010, the highest temperature at 41 ^oC was recorded.

(2) Humidity

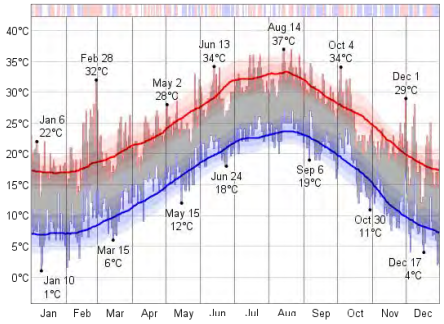
Due to the influence of the Mediterranean Sea, the humidity is around 50% to 70% through the year. Figure 2.1-2 shows the humidity ranges during 2010-2013.



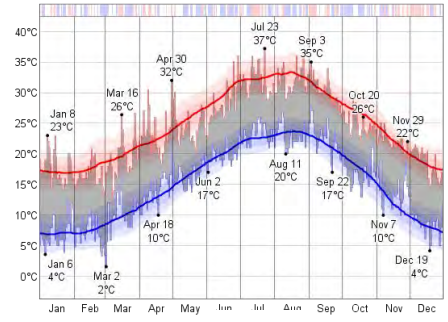
2010



2011



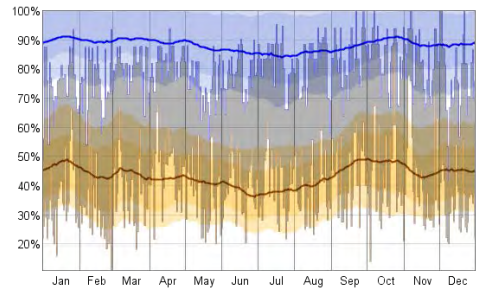
2012



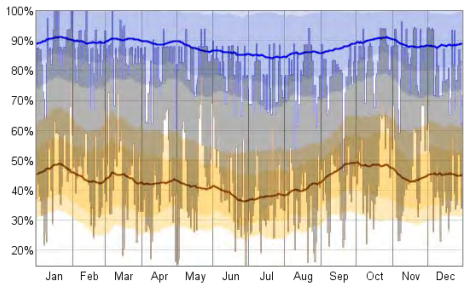
2013

Red line: Average line of maximum temperature, Blue line: Average line of minimum temperature
Source: Weather Spark

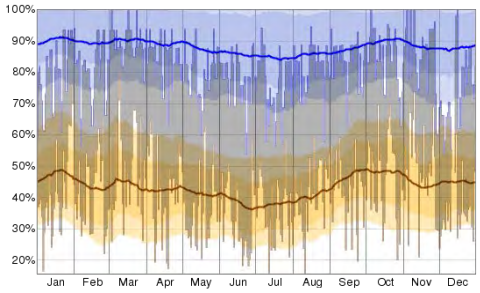
Figure 2.1-1 Temperature Range from 2010 to 2013



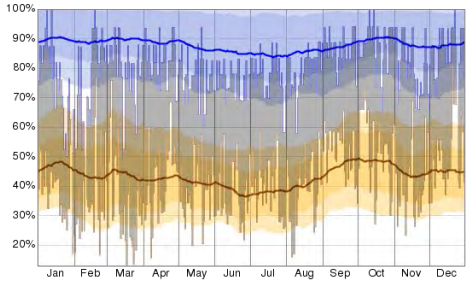
2010



2011



2012



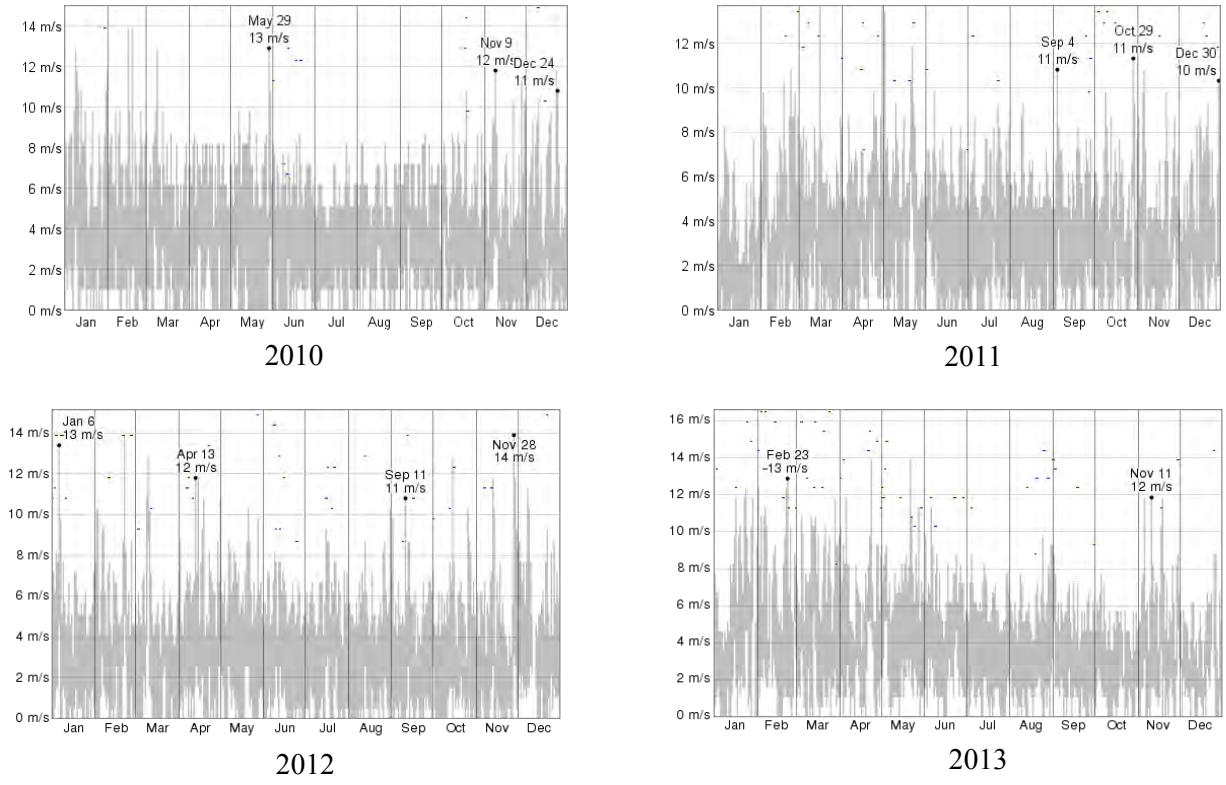
2013

Blue line: Average line of maximum humidity, Brown line: Average line of minimum humidity
Source: Weather Spark

Figure 2.1-2 Humidity Range from 2010 to 2013

(3) Wind

Wind blows 300 days in a year with vary direction by season. In winter, the land breeze blows from direction ranging between North and Southwest. In summer, the sea breeze blows from direction ranging between east and southeast. Figure 2.1-3 shows changes in wind blow from 2010 to 2013.



Gray line: Changes in wind blow speed on every day, Blue point: Maximum wind speed of the day
Source: Weather Spark

Figure 2.1-3 Changes in Wind Blow from 2010 to 2013

The strongest windy month is May with an average wind speed of 5 m/s. The weakest windy month is October with an average wind speed of 3 m/s. The highest wind gust speed was recorded on 22 May 2013 at 22 m/s.

(4) Precipitation

Annual average precipitation in Greater Sfax in past 20years (1991-2010) is 228.5mm (464.5mm in Tunis). Rainfall averages about 25mm per month during the period of September to April, and then decreases from the beginning of May. There is scarce precipitation in the period from June to August.

Table 2.1-2 Average Precipitation in Greater Sfax

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	Month. Ave.
Average precipitation mm	32.3	14.1	25.7	20.6	17.4	4.6	0.3	3.1	33.0	25.0	23.7	28.6	228.5	19.0

Source：National Office of Mines

2.1.2 Topography and Geography

Greater Sfax area is the urban area spreading like a fan from the harbour. It has a little monotonous undulating terrain, gently sloping towards the sea.

2.1.3 Marine Context

(1) Tidal data

The tidal data at Sfax Port is as shown in the table below.

Table 2.1-3 Tidal Data

	Average tidal	Maximum tidal	Minimum tidal
Above sea level (m)	+1.16	+2.15	+0.00

Source：RAPPORT DU CENTRE HYDROGRAPHIQUE ET OCEANOGRAPHIQUE DE LA MARINE NATIONALE DE LA TUNISIE

Maximum tide level changes monthly in the past three years are as shown in Table 2.1-4. The highest tide was 2.0m and the lowest tide was 0.1m in the last 3 years.

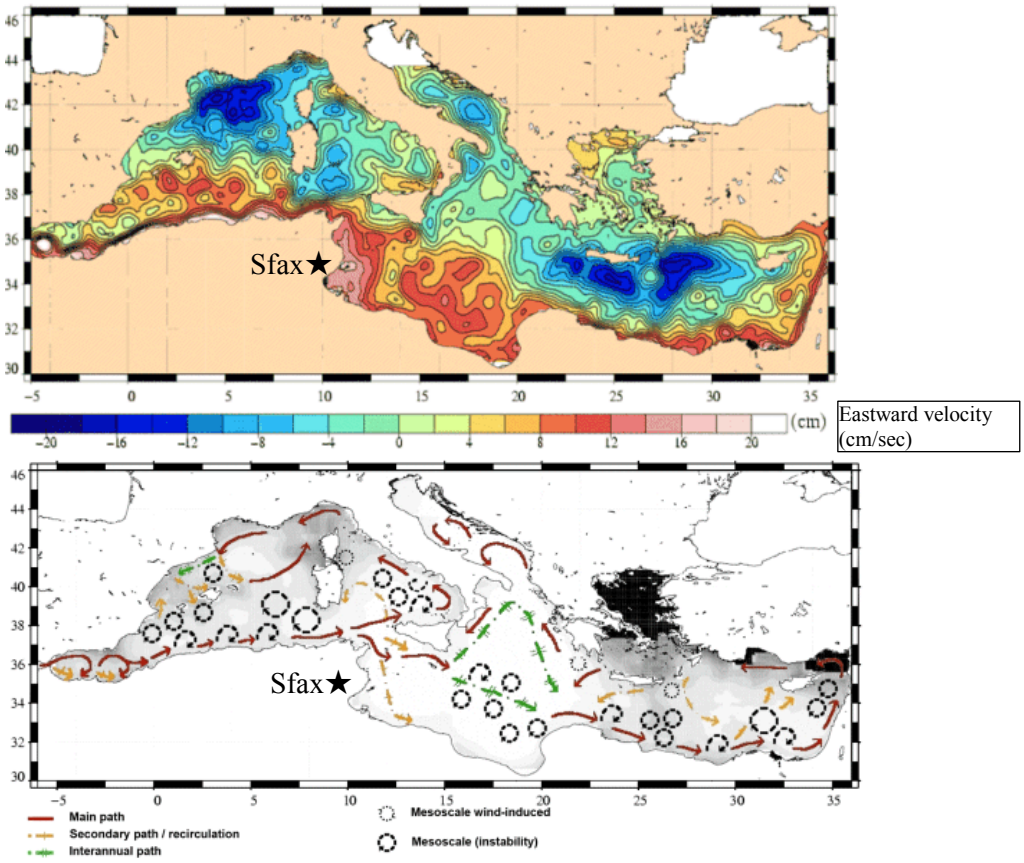
Table 2.1-4 Tidal Level in Monthly Record (2011-2013)

		1 月	2 月	3 月	4 月	5 月	6 月	7 月	8 月	9 月	10 月	11 月	12 月
2011	Day	1/21	2/19	3/20	4/18	5/17	6/15	7/31	8/29	9/28	10/27	11/25	12/25
	Max	1.8m	1.9m	1.9m	1.9m	1.8m	1.7m	1.8m	1.9m	2.0m	1.9m	1.9m	1.8m
	Min	0.2m	0.1m	0.1m	0.2m	0.2m	0.3m	0.2m	0.2m	0.2m	0.2m	0.3m	0.3m
2012	Day	1/23	2/9	3/9	4/7	5/6	6/4	7/4	8/19	9/17	10/16	11/13	12/14
	Max	1.8m	1.9m	1.9m	1.9m	1.8m	1.8m	1.7m	1.9m	1.9m	2.0m	1.9m	1.9m
	Min	0.3m	0.2m	0.1m	0.1m	0.2m	0.3m	0.3m	0.2m	0.2m	0.2m	0.3m	0.3m
2013	Day	1/12	2/10	3/28	4/26	5/25	6/24	7/23	8/21	9/19	10/5	11/3	12/3
	Max	1.8m	1.8m	1.9m	1.8m	1.8m	1.8m	1.8m	1.9m	1.9m	1.9m	1.9m	1.9m
	Min	0.3m	0.2m	0.2m	0.2m	0.2m	0.2m	0.2m	0.2m	0.2m	0.3m	0.3m	0.3m

※ 0m is relative to the 0m point of Sfax port.
Source ：Tide table for Sfax

(2) Sea Current

The sea current in the Mediterranean is generally very weak, flowing towards the east Mediterranean from the west Mediterranean, arid region of high temperature and high amount of evaporation region. In the offshore of Sfax the current flows slowly along the coast from Sousse to Gabes. The cyclic tidal current follows along the coast of the Greater Sfax corresponding to the rise and fall of the tide.



(upper: current velocity, lower: current direction)

Souce: AVISO+

Figure 2.1-4 Current Flow in East Mediterranean

(3) Bathymetric Survey

The coast of the Greater Sfax has slope gently away from the water's edge. The offshore seabed from La Cheba to Sfax through Kerkennah continues with less than 5 m in depth. The seabed with less than 10m depth spreads to 5km offshore along Gabes Bay, south of Sfax. A 60 m wide channel to the Sfax seaport has been dredged to 11m depth to offshore of about 4.5 km.

(4) Water Quality

The marine status of the Greater Sfax coast area is in calm and generally shallow. Fish and shrimp farming, handling net fishery, the shellfishery, etc. are carried out extensively in this area. On the other hand, the Greater Sfax has a large industrial area along the coast area. Wastewater containing oils, metals (Ni, Cd, Pb, Cr, Cu, Zn, Fe), radioactive material, etc. have been discharged to sea from phosphorus purification plants, olive oil production plants, metal processing plants, etc. located in Sfax coastal zone. As a result, marine pollution has occurred along the coast. In particular, hydrogen sulfide (H_2S), which is produced by the sulphate-reducing bacteria from calcium sulfate ($CaSO_4$) in seabed sediments, aggravates the marine pollution. Calcium sulfate ($CaSO_4$) is contained in the wastewater resulting from the purification process of phosphorus from phosphate rock in the phosphorus purification plant.

To cope with the situation, the TAPARURA project was implemented for the purpose of purification of the coast of the Greater Sfax. It was conducted from 2006 under the joint fund of the European Investment Bank (EIB) as the main member. Replacement of beach sand and dredging of seabed sediments were carried out in this project with positive effects. The completed purification at this time, however, was limited to the northern side of the coasts of the Greater Sfax, and is planned to be implemented to the southern area although the specific plans have not been built.

Results of water quality analysis conducted in the Survey are presented in Section 5.1.2.

2.1.4 Hydrological, Hydrogeological and Geological Features

According to DGRE of MOA, the average annual rainfall in Tunisia is 36 billion m^3/year, while the evapotranspiration amounts to 12.6 billion m^3/year or 35% of the annual rainfall. The discharge to the sea through the rivers is amounted at 18.6 billion m^3/year. Currently, the utilizable amount as water source is 4.8 billion m^3/year.

In category of the water source, the utilizable amount at dam lakes is 2.43 billion m^3/year. From rivers and reservoirs, 0.27 billion m^3/year is utilizable. Both water sources are mainly utilized for irrigation. In addition, the available amount of groundwater is 2.1 billion m^3/year, which is mainly utilized for domestic, agricultural, and industrial purposes.

Source : http://commons.wikimedia.org/wiki /File:Medjerda_river_drainage_basin-fr.svg

Figure 2.1-5 Major Rivers

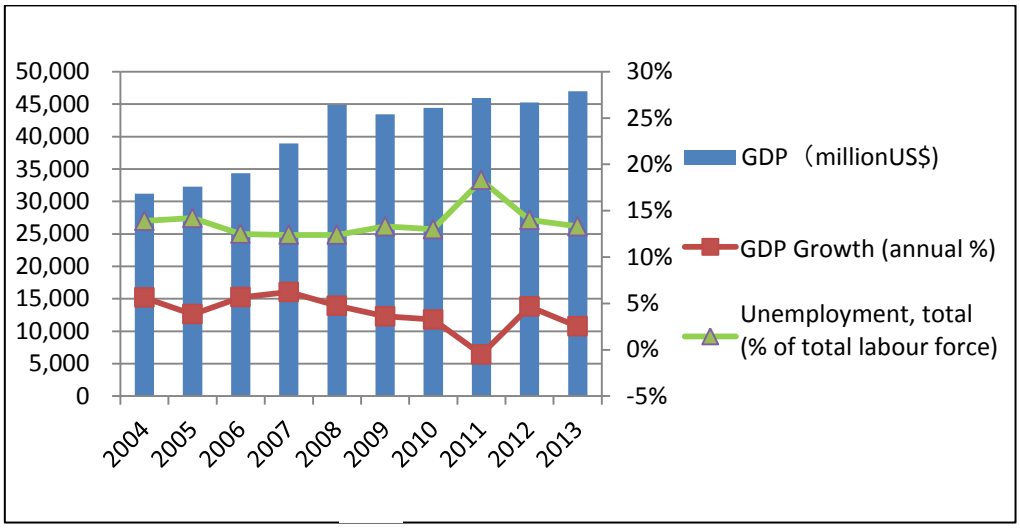
There are no large rivers that are available as water sources near the Greater Sfax. Therefore, the surface water is not considered for the water source. In addition, extraction of groundwater in this area is regulated to control big drops in groundwater levels. As a result, the further extraction of the groundwater in the area cannot be considered for the water source. The water source in the area is to depend on the treated water transmitted from north area of the country, and the groundwater with low salinity (i.e. TDS: 1,000 mg/L to 1,800 mg/L), transmitted from Jelma-Sbeitla area. There are deep wells at each reservoir, i.e. PK10, PK11, PK13, PK10, PK14, PK15, Bou Merra, Sidi Salah EH. These wells, however, have high salinity (i.e. TDS: 3,100 mg/L to 3,200 mg/L) and high iron content. The water in these deep wells cannot be used as drinking water without treatment or dilution by clean water.

2.2 Social Condition Survey

2.2.1 Social and Economic Situation

Tunisia is positioned as a more developed country in the income classification by the World Bank. In 2013, Tunisian GDP was US$46.99 Billion and GDP growth rate was 2.5%. GNP per capita was US$4,317

although growth has slowed down. Overall unemployment rate for the second quarter of 2013 was 13.3% and the unemployment rate of young people was particularly high and has remained at high levels over a long period.



Source: http://api.worldbank.org/v2/en/country/tun?downloadformat=excel

Figure 2.2-1 GDP and Unemployment Ratio Changes

2.2.2 Population

The population of Tunisia was 10.89 million in 2013. Urban population is 66%, and 34% of the population lives in rural area. Working-age population was 43% and young working-age population is high at 33%.

The Greater Sfax, whose main area is inside the Route 11 bypass, is the second biggest city in Tunisia. It is a commercial hub where 620 thousand people out of 970 thousand of the entire Sfax region live as of July 2013. Many students, reaching almost 50,000, live in this area, but they come from other regions. During the summer holydays, the student population decreases. Many tourists stay in Tunisia during the summer holyday season, but most of them go to the resort areas such as Djerba and Sousse as tourists do not stay in Sfax.

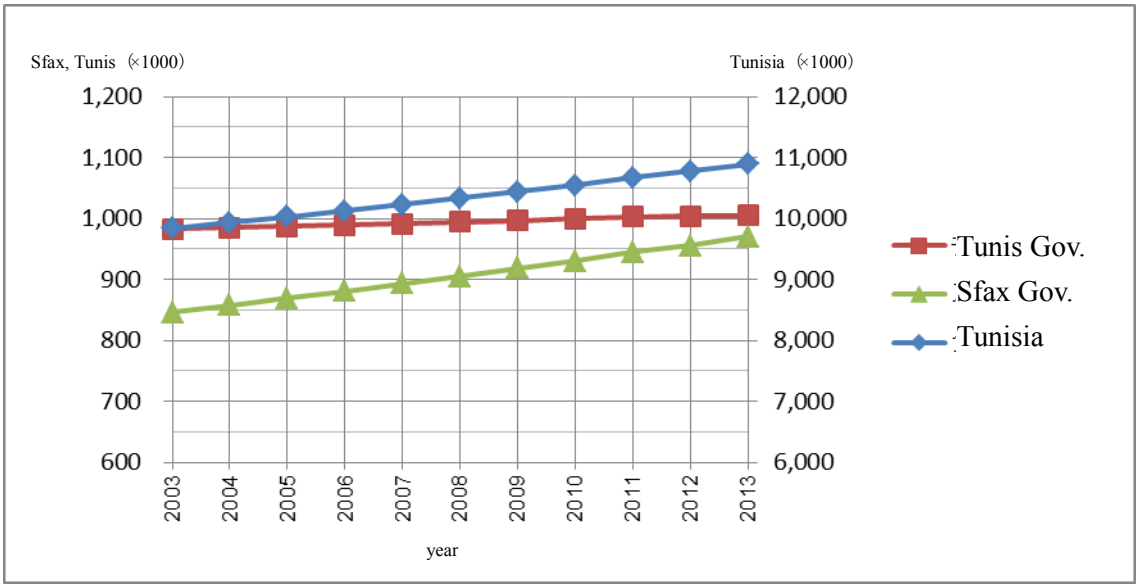
For the period between 2003 and 2013, the average population increase rate of Tunisia was 1.02%/p.a. It in the Tunis governorate was 0.21 %/p.a., while 1.37%/p.a. for the Sfax governorate exceeding that of Tunis. Table 2.2-1 and Figure 2.2-2 shows history of population increase of Tunisia, and governorates of Tunis and Sfax.

表 2.2-1　Population Change in Tunisia, and Governorates of Tunis and Sfax

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2003-2013 Increase Rate*
Total	9,839.8	9,932.4	10,029.0	10,127.9	10,225.1	10,328.7	10,439.6	10,547.0	10,673.8	10,776.4	10,886.5	1.02%
Tunis	983.2	985.3	986.7	989.0	991.3	993.9	996.4	999.7	1,002.9	1,003.7	1,004.5	0.21%
Sfax	846.5	857.1	869.4	881.0	893.0	905.0	918.5	930.1	944.5	955.5	969.8	1.37%

*: Average Annual Increase Rate in the period between 2003 and 2013

Source: http://www.ins.nat.tn/en/serie_annuelle.php?Code_indicateur=0201060

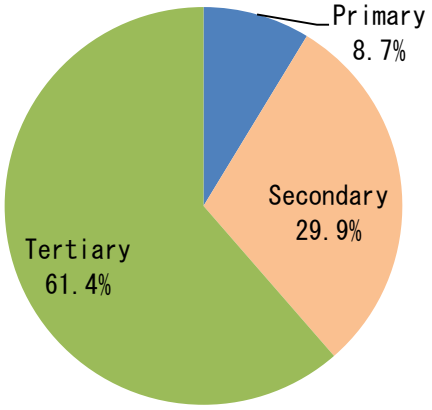


source: http://www.ins.nat.tn/en/serie_annuelle.php?Code_indicateur=0201060

Figure 2.2-2 Population Change

2.2.3 Major Industry

The percentage of the major industries of Tunisia is distributed as; Primary 8.7%, Secondary 29.9%, and Tertiary 61.4% as of 2013. The tertiary industry, which includes tourism, transportation and ICT (information and communication technology), has the large percentage. The main products of agriculture are olive and wheat. Textile is the main product of manufacturing industry and phosphate rock is the main product of mining industry. Resources such as crude oil and natural gas have been produced, but Tunisia imports oil to cover the domestic energy demand. Tourism and service industries drive Tunisian economy.



Source: http://data.worldbank.org/country/tunisia

Figure 2.2-3　GDP Structure of Industries

Sfax Governorate is the second city next to Tunis in Tunisia and various industries have been developed. There are approximately 2,300 manufacturing enterprises in the Sfax governorate and approximately 204,000 people are employed by these industries as of 2013. This population is equivalent to 37% of total employee of manufacturing enterprises in Tunisia, and it exceed more than 3 times of those of Monastir, second largest industrialized governorate. Of this member, more than 700 manufacturing enterprises employ more than 10 employees. Major activities are textiles and clothing, agro food, mechanical industries and chemical industries. There are also more than 20,000 retailers and more than 800 wholesalers, and more than 70 firms doing business with overseas. As stated above, the Sfax governorate including the Greater Sfax has the largest employee population in all industries except agriculture, fisheries and mining. But, agriculture and fishery are also thriving, accounting for 40%; olive oil, 30%; almonds, and 20%; fish catches, in domestic market. They also dominate large part of export of Tunisia, accounting for 60% of olive oil and 45% of seafood.

2.2.4 Land Use

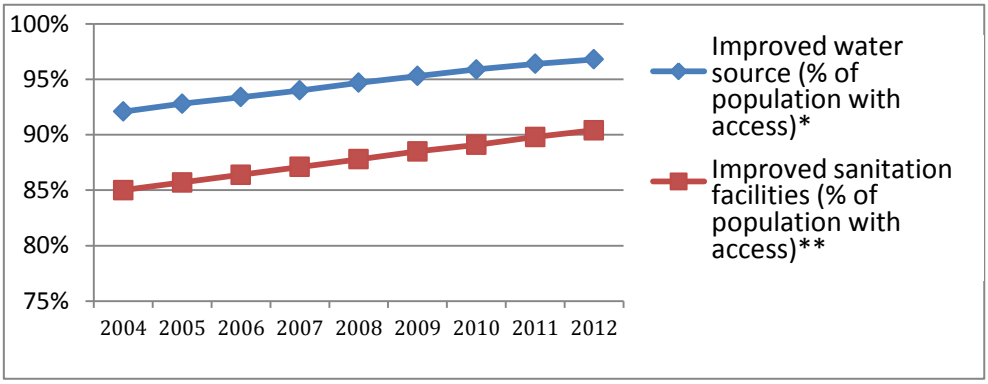
Tunisian land area is about 163,610 km^2, which consist of 155,360 km^2 inland and 8,250 km^2 of water area. Percentage of agricultural land area in the whole country is about 64.83%, arable land area is about 18.27%, permanent agricultural land is about 15.40%, and forest area is about 6.58%.

Land is divided into private property and state-owned land, and ownership is generally clear. If the acquisition of private land is required for public works, consultation is advanced between the owner of the land in accordance with the related laws and regulations, but in case consideration the importance of the public nature of the public works, public works are priority.

2.2.5 Infrastructure Development

Infrastructure development is progressing in Tunisia to keep up with both the economic and population growth. Thus, the development and realization of infrastructure projects, a long-term perspective is needed.

Access to water supply has become 100% in urban areas, 89.2 % in rural areas, and 96.4 % overall. Maintenance of sewer also is progressing, reaching up to about 90 % in 2011. Electrification access has become 99.5% in 2009 covering almost all the country. Maintaining the current service levels while meeting the demand for infrastructure such as quality water supply will be required.



*: % against national total administrative population
**: % against administrative urban population of cities served by ONAS
Source: http://api.worldbank.org/v2/en/country/tun?downloadformat=excel

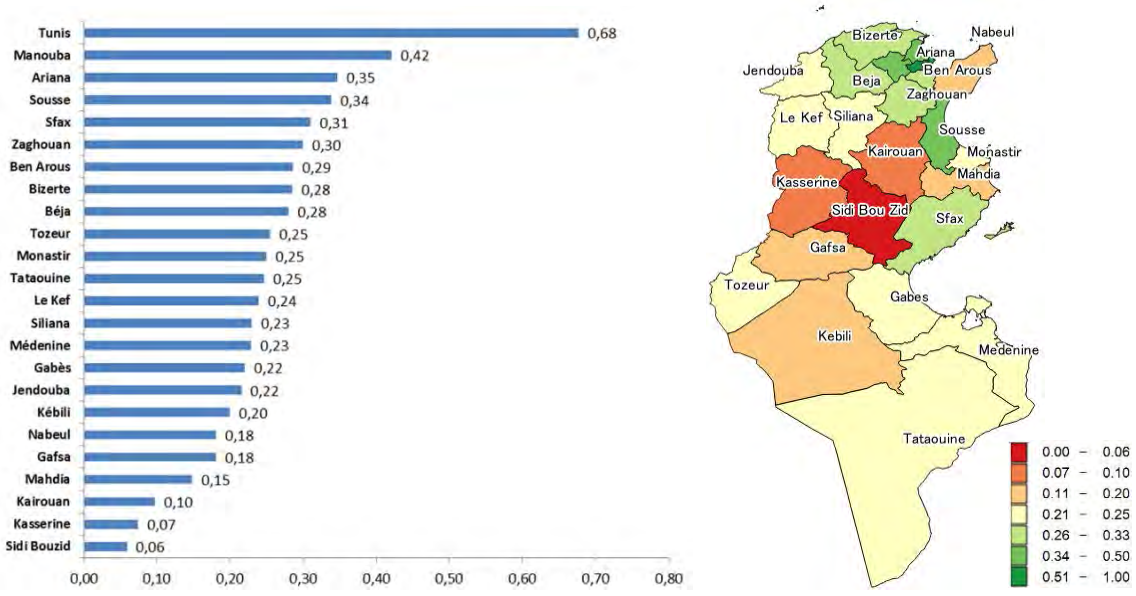
Figure 2.2-4 Accessibility of Improved Water and Sanitation Facilities

2.2.6 Trend of Economic Condition in the Future

Along with the global recession of 2008 and the impact of the Jasmine Revolution that occurred in Tunisia in December 18, 2010, GDP growth decelerated then became negative in 2011. GDP growth rate in 2012 was 3.6 % and showed sign of recovery, but the unemployment rate has remained at a high level. Job creation for young people remains a major challenge. Economic development and recovery hinge on the further expansion of the tertiary industries as well as improvements in the productivity of primary and secondary industries.

2.2.7 Public Health

The indicator of public health for each governorate according to the Ministry of Development, Investment, and International Cooperation (then Ministry of Regional Development and Planning) is shown in the figure below. The indicator for Sfax governorate is relatively high.



Source: Ministry of Regional Development and Plan (then) 2012, JICA Survey Team (map)

Figure 2.2-5 Public Health Indicator

The pollution level of shallow aquifer and seawater surrounding Sfax is thought to be high. This originates from;

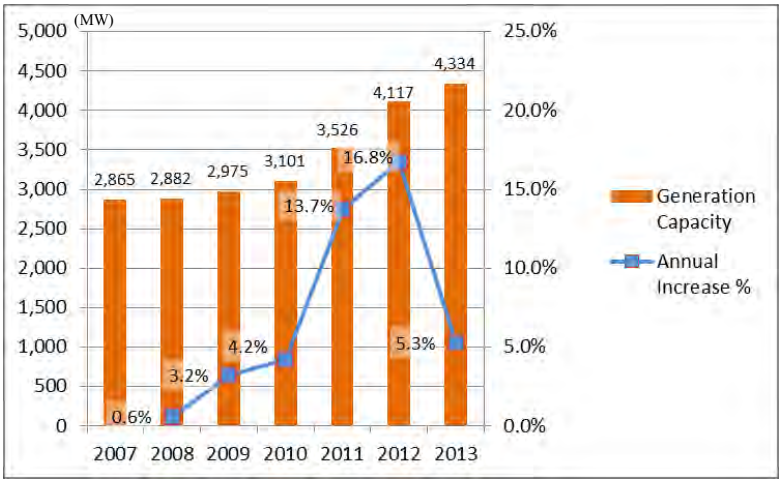
– Waste water coming from the deposit of phosphogypsum
– Waste water coming from the olive oil industry
– Waste water from the sewage treatment plant
– Waste water from garbage dumping site around the port
– Harbour (waste oil discharge)

According to hearing at the Sfax branch of SONEDE, due to the non-satisfaction in the water supply service, many households are still using rainfall and wells to complement water supply. Considering the potential pollution of these water resources, this situation stands as a public health concern.

The non-satisfaction to the water supply service could be attributed to high salinity content and water shortage, that was proven through the survey conducted to the people of Sfax (refer to sub-section 10.12.2).

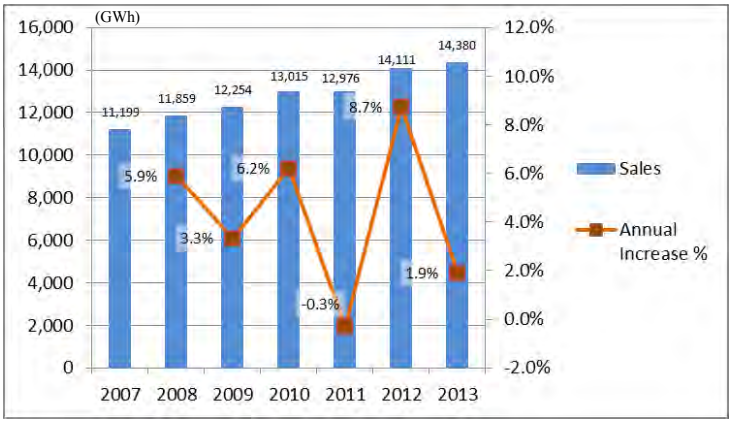
2.2.8 Situation of Power Supply

STEG is a main power supplier in Tunisia. Its status of the power generation and power sales are as shown in Figures 2.2-6 and 2.2-7.



Source: Annuaire Statistique de la Tunisie 2007-11, https://www.steg.com.tn/en/institutionnel/produire.html (2012-13)

Figure 2.2-6 STEG Power Generation Capacity



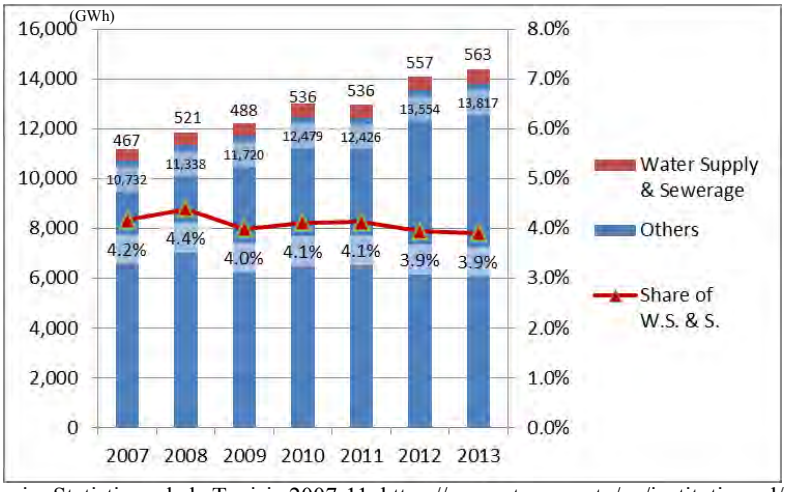
Source: Annuaire Statistique de la Tunisie 2007-11, https://www.steg.com.tn/en/institutionnel/produire.html (2012-13)

Figure 2.2-7 STEG Power Sales

The power generation of STEG has been continuously increasing since 2008 at a relatively high rate. It was 3,526 MW in 2011 with an annual increase rate of 13.7%, 4,117MW with 16.8% increase in 2012, and 4,334 MW with 5.3% increase in 2013. Total power sales has generally shown increasing tendency. It in 2011, however, showed slight decrease of 0.3% over the previous year at 12,976 GWh. It could be caused by the stagnation of industrial activities due to the Jasmine Revolution. It increased to 14,111 GWh in 2012 and 14,380 GWh in 2013.

Power Sales in 2007 was 44.6% (= (11,199 x 10^9) / (2,865 x 10^6 x 24 x 365)) of Generation Capacity. It was decreased to 37.9% (= (14,380 x 10^9) / 4,334 x 10^6 x 24 x 365)). This fact shows the improvement of balance between power supply and demand. STEG has been making effort to improve the situation.

As shown in Figure 2.2-8, the power sales for Water Supply & Sewerage Sector was 563 GWh in 2013 and it accounted for 3.9% of the total power sales. Although the power sales for the sector has increased by 28% for 6 years from 2007, its ratio for the total power sales has been stable at around 4.0% and it does not show an increasing trend. Regarding issue concerning power supply to the desalination plant is discussed in Section 11.3.



Source: Annuaire Statistique de la Tunisie 2007-11, https://www.steg.com.tn/en/institutionnel/produire.html (2012-13)

Figure 2.2-8 Share of Water Supply & Sewerage in Power Sales

CHAPTER 3

PRESENT STATUS OF WATER SUPPLY SERVICE IN TUNISIA

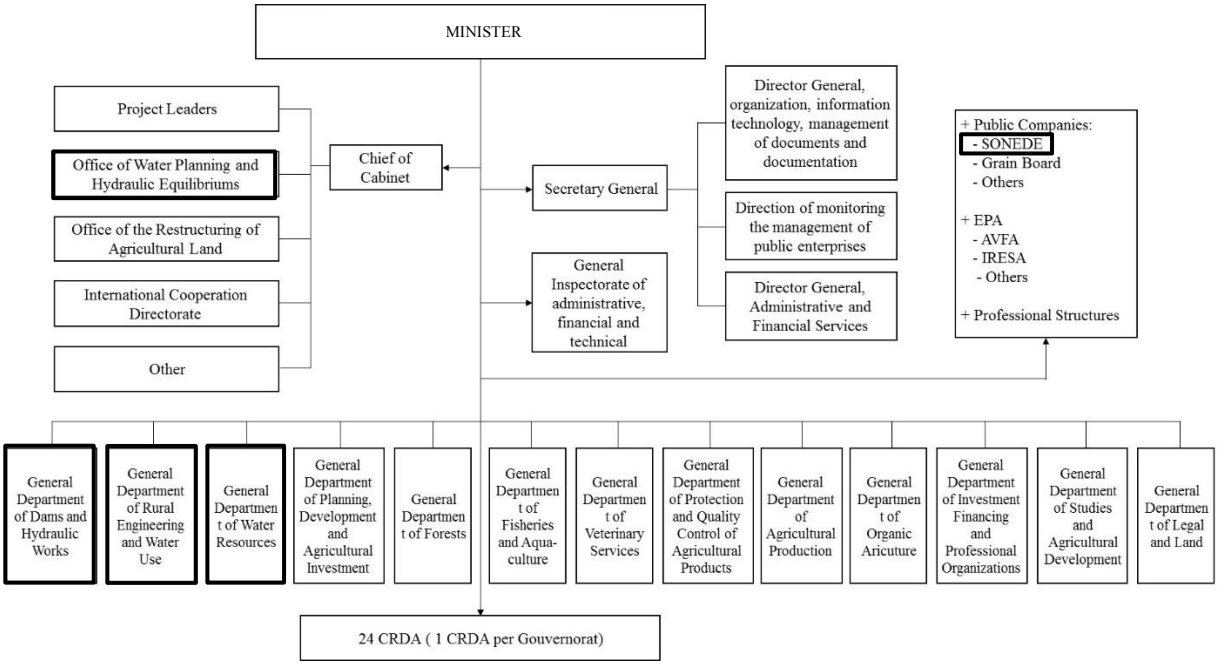
CHAPTER 3 PRESENT STATUS OF WATER SUPPLY SERVICE IN TUNISIA

3.1 Relevant Organization and Legal Framework of Water Sector

3.1.1 Outline of Relevant Organization

The MOA develops the policy framework of the water sector in Tunisia, based on the Water Act stipulated in 1975. The MOA is the governing authority of SONEDE develops policy and plans for the water sector as well as constructs, operates and maintains large-scale hydraulic structures. SONEDE, on the other hand, supplies drinking and industrial water to urban and large-scale rural communities aligned with the policy and developed plan using the hydraulic structures managed by the MOA.

The MOA responsibilities and mandates spans the field of agriculture, farming land and rural communities (see Figure 3.1-1) in addition to the water sector and the organizations of water sector within/under the control of the MOA including SONEDE, which are listed in Table 3.1-1.



Source: MOA

Figure 3.1-1 Organogram of Ministry of Agriculture, Water Resources and Fisheries

Table 3.1-1 Relevant Organizations of Water Sector within/under the Control of MOA

Name		Notes
Internal Organization of MOA	BIRH (Office of Hydraulic Inventory and Researches)	Financially autonomous pubic institution under the authority of DGRE
	BPEH (Office of Water Planning and Hydraulic Equilibriums)	Attached unit to the cabinet of the Minister of MOA
	DGRE (General Directorate of Water Resources)	Responsible for developing nationwide plan and policy on water resource; refer to 3.1.2
	DGGREE (General Directorate of Rural Engineering and Water Exploitation)	Responsible for agricultural water use and its resource in general; refer to 3.1.3
	DGBGTH (General Directorate of Dams and Large Hydraulic Works)	Responsible for large-scale water resource development by means of dams, etc.; refer to 3.1.4
Affiliated Organization of MOA	INRGREF (National institute of Researches on Rural Engineering, Water and Forests)	
	CRDA (Regional Office of Agriculture Development)	Refer to 3.1.5
	RSH (Hydraulic Drilling Cooperation)	
	SECADENORD (National Corporation for Exploitation of Northern Water Channel and Conveyors)	Financially autonomous pubic company providing water to SONEDE and CRDA
	SONEDE (National Corporation of Water Exploitation and Distribution)	Refer to 3.1.6, Executing Agency of the Project

Source: JICA Survey Team

The General Directorate of Water Resources (DGRE) is the agency in charge of policy for water resource development for the entire country. The drinking and industrial water supply service is provided by SONEDE for both urban area and large rural communities; while small-scale rural community and agricultural water falls under the General Directorate of Rural Engineering and Water Exploitation (DGGREE) in terms of policy development, planning and evaluation, with the Regional Office of Agricultural Development (CRDA) in charge of policy implementation. The Agricultural Development Group (GDA) takes charge of operation and maintenance of hydraulic works for agricultural use as an entity of users' cooperation, supported by CRDA both financially and technically.

In addition to MOA above, the Ministry of Foreign Affairs (French: Ministère des Affaires Etrangères), the Ministry of Finance (French: Ministère des Finances), the Ministry of Development, Investment and International Cooperation (MDICI, French: Ministère du Développement, de l'Investissement et de la Coopération internationale), the National Agency of Environmental Protection (ANPE, French: Agence Nationale de Protection de l'Environnemen), the Coastal Protection and Development Agency (APAL, French: Agence de Protection et d'Aménagement du Littoral), and the High Authority for Public Procurement (HAICOP, French: Haute Instance de la Commande Publique) are related organizations of Tunisian side for the Project.

The Ministry of Foreign Affairs is the responsible entity of Tunisian side for its international affairs. The Ministry of Finance is responsible for borrowing and repayment. MDICI has functions regarding economic development loans for external borrowing projects and management of the projects, and is responsible for the coordination related to the loan agreement for the Project. Both ANPE and APAL are responsible for the EIA review process prior to the bidding procedure of the Project. HAICOP is in charge of approval process

of evaluating/selecting the bidders before the final concurrence of JICA. The MOA gives approval for the establishment of the Project Implementation Unit (PIU) in SONEDE and the organization restructuring of SONEDE, as the controlling entity of SONEDE.

3.1.2 General Directorate of Water Resource (DGRE)

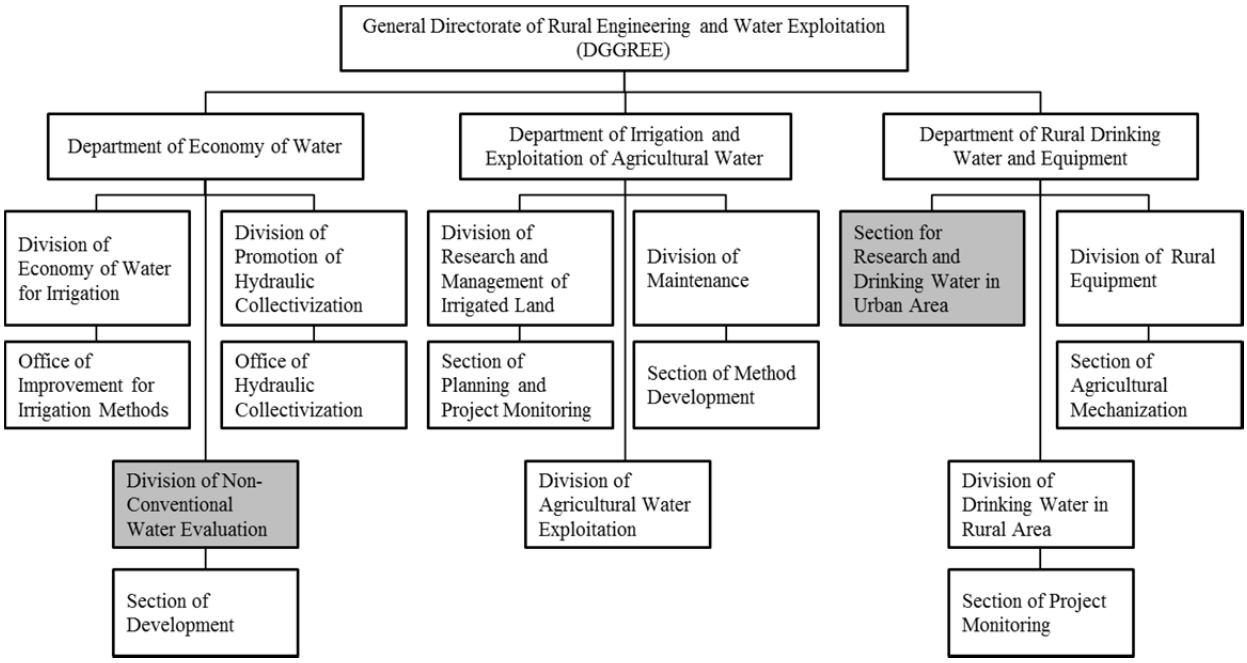
The General Directorate of Water Resource (DGRE) of the MOA is the agency in charge of developing policy and planning of water resource for the water sector nationwide. Its responsibilities are;

a) Setting up managing and measuring networks as it pertains to the various components of the country's water resources;
b) Implementing basic and applied studies on the evaluation of water resources;
c) Developing principles and methods for the management and the use of hydraulic resources to meet the demands;
d) Promoting research and experimental activities on conventional water resources in order to secure their development;
e) Preparation of master plans for the mobilization of hydraulic resources.

3.1.3 General Directorate of Rural Engineering and Water Exploitation (DGGREE)

The organogram of the General Directorate of Rural Engineering and Water Exploitation (DGGREE) of the MOA is shown on Figure 3.1-2. Its responsibilities lie on;

a) Implementing studies, developing policies and drafting plans that relate to the rural engineering field and the use of water in the agricultural sector;
b) Following up and assessing the projects of developing irrigated areas, programs for the use of irrigation water and the maintenance of hydraulic structures and equipment and designing the most appropriate technical and economic method in this field;
c) Rationalizing the use of water, evaluating the use of non-conventional water resource in agriculture, following up the institutional aspects for the promotion of water association and implementing the tools of water demand management in the agricultural sector;
d) Coordinating programs of drinking water in urban and rural environment, drawing up program for the supply of drinking water to rural zones, following up and assessing the projects relating to such program;
e) Coordinating rural infrastructure program and studying the technological and economic aspects of agriculture equipment in order to encourage the mechanization of the farming sector.



Source: JICA Survey Team

Figure 3.1-2 Organogram of DGGREE

3.1.4 General Directorate of Dams and Large Hydraulic Works (DGBGTH)

The General Directorate of Dams and Large Hydraulic Works (DGBGTH) of the MOA is in charge of research on the control of surface water and the mobilization of water resource, construction of dams and hydraulic works for the mobilization of water, as well as control, operation and maintenance of such constructed works.

3.1.5 Regional Office of Agriculture Development (CRDA)

The Regional Office of Agricultural Development (CRDA) is the financially autonomous public entity under the control of the MOA, and has its regional arms in all 24 regions. It is responsible for; a) the construction of hydraulic works except for the national structures to be provided by the MOA, and b) carrying out operation and maintenance of hydraulic works and supplying water for agricultural use.

3.1.6 National Water Distribution Utility (SONEDE)

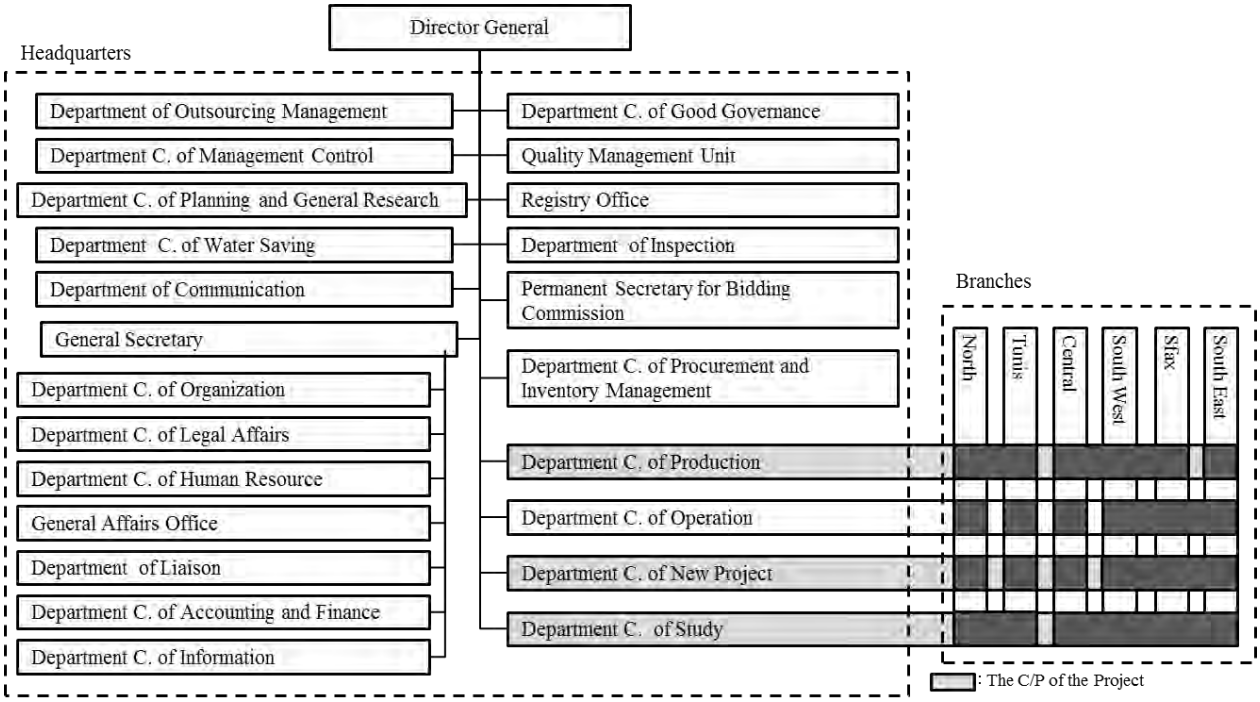
The National Water Distribution Utility (French: Société Nationale d'Exploitation et de Distribution des Eaux, SONEDE) was established in 1968 as a financially autonomous public company under the control of the MOA. It is in charge of supplying drinking water nationwide, and conducts research and planning on the intake, transfer, treatment, transmission and distribution of water, as well as uses, renews, operates and maintains constructed hydraulic works. The outline of organization and its activities as of 2013 are shown in Table 3.1-2.

Table 3.1-2 Outline of Organization and Activities of SONEDE (2013)

Item	Description	Remarks
Number connections	2,550,318 connections	Number of employees per 1,000 connections: 6,818 employees /2,550,318 connections /1000 =2.67
Served Population	9.11 million	
Annual Volume of Production	609.4 million m^3	Details of production: - Surface water: 347.2 million m^3 - Groundwater: 234.4 million m^3 - Desalinated water: 19.7 million m^3 - Deferrizated water: 6.2 million m^3
Annual Volume of Distribution	555.5 million m^3	
Annual Volume of Revenue Water	449.9 million m^3	
Length of Pipelines	49,500 km	Details: - Intake and Conveyance: 9,400 km - Transmission and Distribution:40,100 km
Personnel	Total 6,818 Permanent Employee 6,039 Temporary Employee 779	Breakdown of Permanent Employee - Technical: 4,505 - Administrative: 1,534

Source: SONEDE and JICA Survey Team

The organogram of SONEDE is shown in Figure 3.1-3. The Central Department of Production has three branches of North-Tunis, Central-Sfax-South West and South East; the Central Department of Operation and the Central Department of New Project have four branches of North, Tunis, Central, and South, respectively; and the Central Department of Study has two branches of North-Tunis, and Central- South. Further, the branches of the Central Department of Operation have 37 customer service arms, of which 10 in North Branch, nine in Tunis Branch, seven in Central Branch and 11 in South Branch.



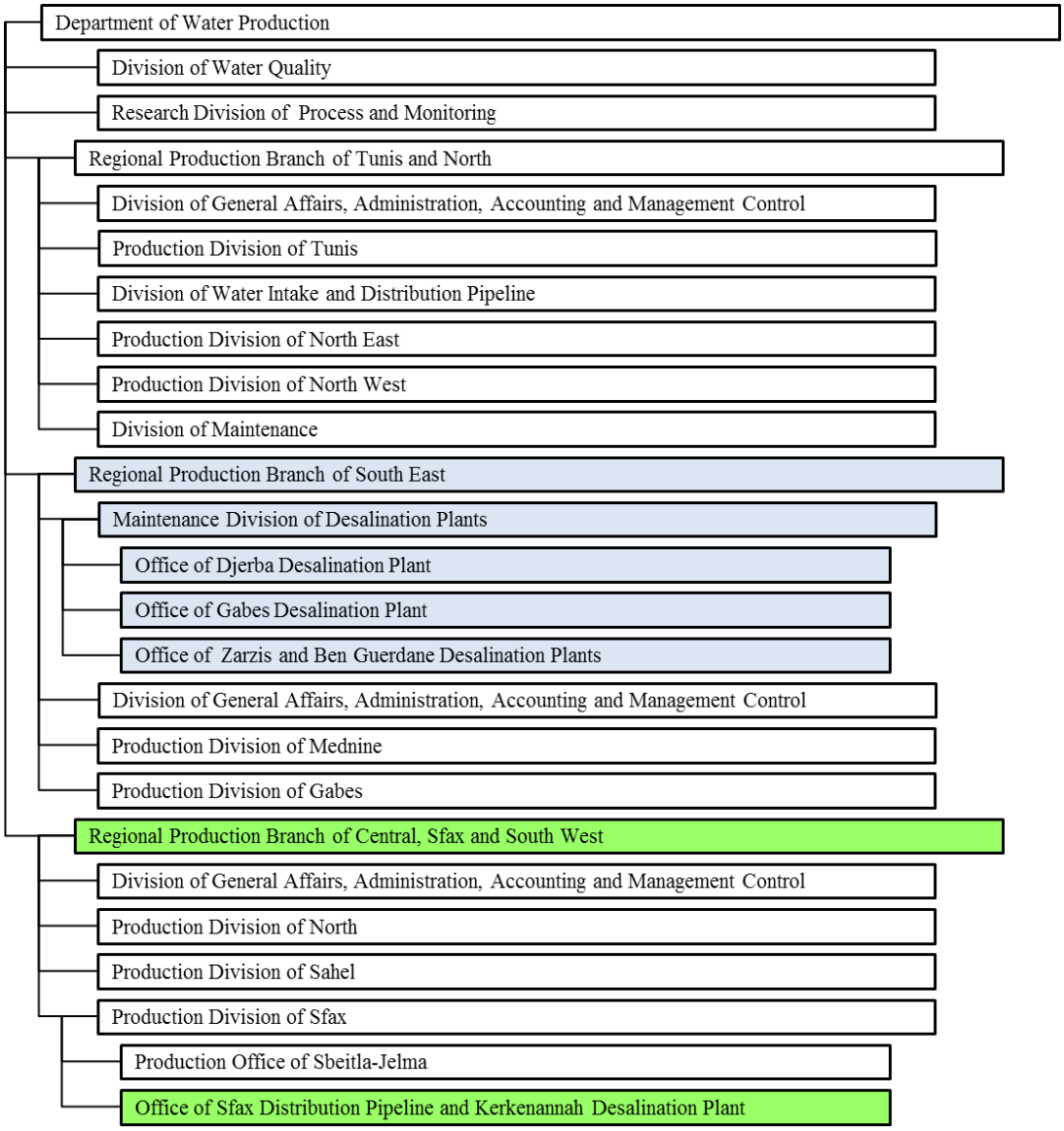
Source: SONEDE and JICA Survey Team

Figure 3.1-3 Organogram of SONEDE (as of October 2014)

The counterparts of the Project are expected to be the Central Department of Study in the planning and designing phase up to the contract of construction work, the Central Department of New Project in the

construction phase after the contract of construction work, and the Central Department of Production in the operation and maintenance phase.

The Central Department of Production is in charge of the operation and maintenance of water works and its organogram is shown in Figure 3.1-4. Of the five desalination plants currently in operation i.e. Djerba, Gabes, Zarzis, Kerkennah and Ben Guerdane, the four plants except Kerkennah are under the control of its South-East Branch, and the Kerkennah is under the control of Central-Sfax-South West Branch.



Source: SONEDE and JICA Survey Team

Figure 3.1-4 Organogram of Water Production Department of SONEDE

As for the operation and maintenance of the four desalination plants being managed by the South-East Branch of the Central Department of Production as stated above, daily operation, surveillance, inspection and minor repair are conducted by the Operation Division of each plant. Technically high-level

maintenance and large repair are conducted by the Maintenance Division of the branch or the Central Department of Production at headquarters in accordance with the degree.

The current staffing for the operation and maintenance of each desalination plant is shown in Table 3.1-3. The former "Operation Division of Zarzis Desalination Plant" was reorganized as the "Operation Division of Zarzis and Ben Guerdane Desalination Plants" and the latter is in charge of the operation and maintenance of Ben Guerdane Desalination Plant, which started operation in 2013. Thus, there are remarkable vacancies in the operation and maintenance staff of this reorganized division, but it will be filled in a phased manner after technological transfer from other divisions.

The operation and maintenance of the planned plant will be conducted by Central-Sfax-South West Branch. The existing desalination plant under the control of this branch is only the Kerkennah plant (capacity: 3,300 m^3/day) and the organization structure to deal with the higher maintenance and large-scale maintenance is not established yet, which is different from South East Branch. In addition, the Seawater Desalination Plant of the Project will be the second[1] plant for SONEDE as a seawater desalination plant. Although there is no remarkable difference in operation and control process between the seawater and groundwater desalination, the method of operation and maintenance should be established in accordance with the raw water quality in terms of setting up the frequency of cleaning and replacing membrane unit and the adjustment of flux. Thus, the reorganization of the two branches and the staffing of necessary personnel, as well as providing for the initial training of operation and maintenance are essential for the implementation of the Project. For the purpose of the latter, it is recommended that SONEDE should allocate the main engineers/technicians and administrative manager for the plant from the construction stage, particularly from the stage of setting up mechanical and electrical equipment, so that they can participate in the OJT (on-the-job training) including the monitoring of the setting up process.

[1] In September 2014, the contract for construction of Djerba Sea Water Desalination Project was signed. Existing 5 desalination plants treats brackish water from wells.

Table 3.1-3 Staffing Status for O&M of Current Desalination Plants (as of November 2013)

Category		South-East Branch, Water Production Department								Central, Sfax and South-West Branch, Water Production Department	
		Maintenance Division of Desalination Plants		Office of Djerba Desalination Plant		Office of Gabes Desalination Plant		Office of Zarzis and Ben Guerdane Desalination Plants		Office of Kekennah Desalination Plant	
		Qualification	Staff	Qualification	Staff	Qualification	Staff	Qualification	Staff	Qualification	Staff
Permanent	Chief Engineer	Head of division Chief engineer	1 1	Head of office	1	Chief engineer	1				
	Engineer										
	Deputy Engineer			Head, inspection Head, water quality test Head, Operation Operator (mechanical)	1 1 4 1	Head, operation	1	Head, inspection Head, water quality test Head, operation Operator	1 1 3 1		4
	Chief Technician	Section head	1	Operator (electrical) Inspector (electrical)	1 1	Head, inspection Operator (electrical)	1 2			Head of Office	1 1
	Technician					Welder	1				3
	Deputy Technician	Electrical (vacancy) Mechanical (vacancy)	1 1					Operator (electrical) Operator (mechanical) Operator Inspector	2 1 1 1		
	Worker					Inspection	1	Welder Plumber (vacancy)	1 1		4
	Others	Head of section Planning and dispatcher Planning and dispatcher (vacancy) Pumper Mechanical Electrical Driver	1 1 2 2 1 1 1	Head, operation Secretary Driver Others	1 1 1 3	Head of office (vacancy) Head, water quality test Head, operation Driver	1 1 4 2	Head of office (vacancy) Head, operation (vacancy) Head, operation (vacancy) Inspection (electrical, vacancy) Office Clerk Driver	1 1 1 1 1 1		
	Total		14		16		15		19		13
	Total (without vacancy)		10		16		14		14		13
Temporary				Inspection (electrical, chief technician class) Inspection (electrical) Worker Gardiner Others	1 1 1 1 4	Worker Plumber Operator Others	1 1 2 3	Gardiner Clearner Guardman	2 1 2		
	Total		0		8		7		5		0
Sum	Vacancies included:		14		24		22		24		13
	- Operation		-		8		11		11		-
	- Inspection		-		5		4		6		-
	- Others		-		11		7		7		-
	Vacancies excluded:		10		24		21		19		13
	- Operation		-		8		11		9		-
	- Inspection		-		5		4		4		-
	- Others		-		11		6		6		-

Source: SONEDE and JICA Survey Team

3.1.7 Legal Framework of Water Sector

The Water Law (Code des Eaux), stipulated in March 1975, was a basic law on water sector in Tunisia. The outline of this law is shown in Table 3.1-4. The laws and regulations related to the environmental impact, land acquisition and construction permit relevant to the Project are described in Chapter 8 and Chapter 9.

Table 3.1-4 Outline of Water Law

Chapter	Synopsis	Remarks
1	Public water bodies	- Definition of public water bodies (Article #1) - The public water bodies are governed in principle by the MOA. (Article #4) - The establishment of Regulatory Commissions on water usage and public water bodies (Article #4, #19 and #20); these commissions have not functioned until today due to the influence of the Revolution
2	Water reservation and monitoring of public water bodies	
3	Rights on water utilization	- The right for the ownership of water should be transcribed to water utilization right. (Article #21)
4	Regulation on land use	- The land of 3m width from the periphery of public water bodies should be reserved as free-zone. (Article #40)
5	Permission and concession of water of public water bodies - General requirement - Special regulation on surface water - Special regulation on underground water - Limitation of concession	- Temporary permission (Article #52) for the installation of temporary hydraulic works within public water bodies and in free-zone land - Concession permission (Article #53) for the installation of permanent works in river bed for water intake and for the utilization of underground water
6	Water utilization - Water saving - Special regulation on drinking water - Special regulation on agricultural water	- Development of un-conventional water resource (Article #87): wastewater reuse, utilization of brine water and seawater with no potential impact by highly concentrated salt water, artificial refill of underground water, etc.
7	Countermeasures against water pollution and flooding	
8	The association of water users	
9	Penalties	

Source: JICA Survey Team

3.1.8 Drinking Water Quality Standard

The Drinking Water Quality Standard of Tunisia (NT09.14:1983), those in the WHO Guidelines (2004), the EC Directive (1998), and the Japanese Drinking Water Quality Standard (2003) are presented in Table 3.1-5. SONEDE employed TDS concentration as a general indicator for salinity in drinking water in Tunisia. Unless otherwise stated, the water quality stated as “salinity” means TDS concentration.

Table 3.1-5 Drinking Water Quality Standard in Tunisia (NT09.14:1983)

Analysis Item	unit	Tunisian Drinking Water Standard (NT09.14:1983)		WHO Guidelines (2004)	EC Directive (1998)	Japanese Sandard (2003)
		Recommendation	Standard			
Arcenic (As)	mg/l		0.05	0.01	0.01	0.01
Cadmium (Cd)	mg/l		0.005	0.003	0.005	0.01
Cyan (CN)	mg/l		0.05	0.07	0.05	0.01
Mercury (Hg)	mg/l		0.001	0.001	0.001	0.0005
Lead (Pb)	mg/l		0.05	0.01	0.01	0.01
Selenium (Se)	mg/l		0.01	0.01	0.01	0.01
Antimon (Sb)	mg/l		0.02			
Silver (Ag)	mg/l		0.02	-	-	-
Fluoline (F)	mg/l		0.8-1.7	1.5	1.5	0.8
Nitrate-Nitrogen (NO_3^-)	mg/l		45	50	50	10 (Nitrate/Nitlite)
Turbidity	NTU	5	25	5	Acceptable to consumers	2
Total Disolved Solids (TDS)	mg/l	500	2,000-2500	1,000	(Electric Conductivity 2,500μS/cm)	500
pH	-	7.0-8.0	6.5-8.5	-	6.5-9.5	5.8-8.6
Total Hardness	mg/l	10°F (as $CaCO_3$)	100°F (as $CaCO_3$)	-	-	300
Carcium (Ca^{++})	mg/l	75	300	-	-	
Chloride (Cl^-)	mg/l	200	600	250	250	200
Copper (Cu)	mg/l	0.05	1	1	2	1
Iron (Fe)	mg/l	0.1	0.5-1	0.3	0.2	0.3
Magnesium (Mg^{++})	mg/l	30	150	-	-	-
Mangan (Mn)	mg/l	0.05	0.5	0.1	0.05	0.05
Sulfae ion (SO_4^{2-})	mg/l	200	600	250	250	-
Zinc (Zn)	mg/l	1	5	3	0.1	1
Coliform Group	MPN/100ml		0	0	0	0
Boron (B)	mg/l		-	0.5	1	1

Note: Turbidity of Japanese standard is degree of Kaolin.

3.2 Current Situation of Water Supply and Demand in Tunisia

3.2.1 Water Resources in Tunisia

The Office of Water Planning and Hydraulic Equilibriums (BPEH, French: Bureau de la Planification et des Équilibres Hydrauliques), the MOA prepares the water distribution amount allocation plan to each region together with organizations/institutes related to water resources.

The quantity of water resource in Tunisia is presented in Table 3.2-1. Salinity is the biggest problem in the water resources in Tunisia and the TDS of more than 50% of the groundwater exceeds 1500 mg/L.

Table 3.2-1 Water Resources and Water Availability for Use in Tunisia (2013)

unit: Million m^3/year

	Water Resources	Water Availability for Use*			
		TDS <1500mg/L	1500<TDS <3000mg/L	3000mg/L <TDS	Total
Surface Water	2,700	1,200	400	100	1,700
Groundwater	2,100	300	800	500	1,600
Total	4,800	1,500	1,200	600	3,300

Remarks* : MOA plans to take measures to increase the water availability for use.
Source: MOA Documents

3.2.2 Water Demand in Tunisia

SONEDE supplies water for drinking, industries and tourism as follows:

Table 3.2-2 Water Demand in Tunisia (2013)

unit: Million m^3/year

Administration	MOA	SONEDE			Total
Usage	Irrigation	Drinking	Industries	Tourism	
Water Demand	2,160	380	130	30	2,700

Source: MOA Documents, SONEDE Documents

3.2.3 Water Balance in Tunisia

As shown in Table 3.2-3 and Table 3.2-4, among the available water resources of below 3000mg/L TDS, 100% of the surface water and almost of all of the groundwater have been utilized and only water of more than 3000mg/L are available. The utilization of the remaining water is limited to be utilized due to the salinity. For example, in accordance with the water norm for agricultural use, TDS is permissible up to 2000mg/L, but actually, the remaining water clearing this criterion is very limited. For olive cultivation the permissible TDS is about 3000mg/L; however, in the long run the salinity will be accumulated in the ground and exceed the permissible value.

Table 3.2-3 Water Demand and Resources in Tunisia (2013)

unit: million m^3/year

Usage	Demand	Surface Water			Groundwater		
		TDS <1500mg/L	1500<TDS <3000mg/L	3000mg/L <TDS	TDS <1500mg/L	1500<TDS <3000mg/L	3000mg/L <TDS
Irrigation	2,160	970	370	0	250	570	0
Drinking	380	160	0	0	40	110	70
Industries	130	60	20	0	10	40	0
Tourism	30	10	10	0	0	10	0
Total	2,700	1,200	400	0	300	730	70
Utilized rate		100%	100%	0%	100%	91%	14%

Source: MOA Documents, SONEDE Documents

Table 3.2-4 Water Balance between Demand and Resources in Tunisia (2013)

unit: million m^3/year

	Demand			Water Available to Use			Utilized rate		
Usage	Surface Water	Ground water	Total	Surface Water	Ground water	Total	Surface Water	Ground water	Total
Irrigation	1,340	820	2,160						
Drinking	160	220	380						
Industries	80	50	130						
Tourism	20	10	30						
Total	1,600	1,100	2,700	1,700	1,600	3,300	94%	69%	82%

Source: Ministry Agriculture Documents, SONEDE Documents

3.3 Future Plan of Water Sector

The Tunisian Government released the 12th Five Year Plan (2010 – 2014), before the revolution in 2011. This national plan, which includes water service rate of 100% in urban area and an installation of seawater desalination plants for the drinking water quality improvement, was cancelled because of the revolution. SONEDE, however, works based on the national plan.

This project is to construct a seawater desalination plant contributing the improvement of drinking water quality with sustaining 100 % service rate in the urban area. Therefore, this project meets the policy of the water sector in Tunisia. Presently, Tunisian Government is preparing to implement its new social economic development plan from 2016 to 2020, which aims 7% annual increase of GDP. As a reference, the 12th Five Year Plan is introduced below.

[Reference: 12th Five-Year Plan for Economic & Social Development in Tunisia 2010 – 2014]

Tunisia has set its national target to take necessary action for construction and reform towards comprehensive and balanced development to catch up with developed countries, and consequently to win the confidence of the international community.

In the 12th Five Year Plan, from 2010 to 2014, Tunisia aims to establish a new growth model by consolidation of social welfare and economic progress in the process of catching up with developed countries, and sets following policies.

1) To introduce new contents of growth through innovation
2) To increase the per capita income and reduce poverty to the lowest level
3) To increase job and reduce unemployment for graduates of higher education
4) To adapt education and training system to the requirements of the actual economy
5) To consolidate social gains
6) To integrate all regions and strengthen their competitiveness
7) To introduce environmental economy to improve the quality of life

In accordance with the National 12th Five Year Plan, the MOA sets their policies, (1) Food Security, (2) Strength the economic competitiveness, (3) Export promotion, and (4) National resources mobilization. The following water sector policies align with the National Resources Mobilization policy, as follows:

- Water resources in Tunisia are scarce and are unevenly located. In addition to uneven rains and the inequality in distribution of water resources through the country, high salinity and possible contamination of water resources are issues to be dealt with.
- Master plans for exploitation of water resources and the strategies for water resources mobilization, development and preservation shall be prepared. Issue of effective use of water resources shall be tackled in the medium and long terms in all sectors taking water saving as a nucleus. In addition, the existing public irrigation area shall be rehabilitated, and the management of irrigation and potable water networks shall be enhanced.
- The water infrastructure in Tunisia has been developed as 29 large dams, 226 small dams, 827 mountain lakes, about 95,000 shallow wells and more than 5,000 deep wells in use. Those facilities mobilize more than 88% of the exploitable water resources.
- Concerning potable water, the projects under execution by SONEDE and Rural Engineering Department will supply potable water to the rural areas and the supply rate will be 98% by 2014. In the coming period, improvement of supply rate shall be achieved by implementation of project in the north-western region (Kef, Beja, Bizerte and Jendouba).
- As to urban areas, keeping 100% supply rate, SONEDE will increase water production and improve water quality in the areas suffering from the deterioration through the implementation of water desalination stations or transporting good quality water from other regions.
- The agricultural sector is one of the most water consuming sectors at 78% and followed by household consumption at 16% and industrial and touristic sectors at 6%.
- The mobilization rate shall be increased up to 95% around the year 2016 and mobilization of untraditional waters shall be promoted to ensure potable water supply.
- The program to rehabilitate public irrigation areas and water network system and introduce modern technologies for water saving shall be extended from current area of 120,000ha to 200,000ha in 2016.

3.4 Future Plan for Water for Agriculture Sector

(1) Current Situation on Agriculture Sector in Tunisia

It is forecasted that in case the whole dam construction projects be completed up to the end of 2015, 95% of the potential resources of 4.8 billion m^3/year are to be utilized. On the other hand, the agricultural sector, which consumes approximately 80% of the available water, is required to sift some of their consumption to other sectors in accordance with the national policy and take necessary action for construction and reform towards comprehensive and balanced social and economic development.

Recently completed and on-going dam construction projects are as shown in Table 3.4-1.

Table 3.4-1 Recently Completed and On-going Dam Construction Projects

Dam	Region	Capacity (million m^3)	Completion year	Status	Project Name	Fund
Zarga	Jendouba	22.0	2012	completed	a	FADES
El Kbir	Jendouba	64.0	2012	completed	b	FADES
El Maoula	Jendouba	26.3	2012	completed	b	FADES
Zaiatine	Bizerte	33.0	2012	completed	c	FADES
Gamgoum	Bizerte	18.3	2012	completed	c	FADES
El Harka	Bizerte	30.3	2012	completed	c	FADES
El Maleh	Bizerte	41.0	2015	on-going	c	FADES
Ettin	Bizerte	34.0	2015	on-going	c	FADES
Serat	El kef	21.0	2015	completed	d	Abu Dhabi & FADES
El Kbir Gafsa	Gafsa	24.0	2016	on-going	e	FADES
Eddouimiss	Bizerte	45.6	2018	on-going	c	FADES
Melleg El Aloui	El kef	195.0	2020	on-going	f	FADES

Project Name:
a. Projet du barrage de Zarga et d'irrigation des plaines de Tabarka et de Makna
b. Projet des barrages Kebir et Moula
c. Projet de construction de six barrages au nord pour l'eau potable
d. Projet du barrage Sarrat et d'irrigation des plaines de Ouled Boughanem et Mahjouba
e. Projet Barrage Oued El Kebir
f. Projet Barrage Mallègue Supérieur

Source: DGBGTH, Ministry of Agriculture, Water Resources and Fisheries, 02 June, 2015

(2) SONEDE's Program to Take Water from Agricultural Dam

SONEDE has reached an agreement with the MOA to divert annually agricultural water of 6 million m^3 in 2012. However, it is not an agreement to use the water throughout the year but during the agricultural off-season only. SONEDE, for the water supply in Sousse, has already started to take some of agricultural water and sifted it for drinking water.

To supply water for irrigation in Sahel, Barrage Nabhana had been constructed in Kairouan Governorate, which located in the west of Sahel. This barrage had been planned only for irrigation purpose and the water from this barrage is preserved by the MOA and its agricultural association.

SONEDE discussed with the ministry and the association, and in 2005, an agreement was reached to divert a part of irrigation water to the potable water for 15 days in the seasonal peak period. After the initial agreement, SONEDE encountered more serious problem of water shortage in summer season than expected. Then they discussed again and agreed to extend the period of the special arrangement to a total of four (4) months, two months in summer season and one or two months in agricultural off-season.

(3) Policy and Future Plan for Agricultural Water

The MOA has compiled water management policies and future plans into their water management strategy. The followings approaches are to be taken to use the limited water resources more effectively.

- Comprehensive water mobilization system shall be organized involving dam construction projects and networks between big dams and water conveyance to the regions where there is a water shortage.
- Water conservative technologies shall be introduced rigorously in modernization of water collective networks, water utilization and water saving equipment.
- Recycling of water for irrigation use
- In association with all water management sectors institutional and regulatory frameworks shall be organized.
- Increase water value policies such as shifting to higher valuated cropping systems and more effective irrigation networks shall be adopted.

3.5 Future Plan for Water for Industrial Sector

Generally, medium and small size industrial firms in Tunisia get their water from SONEDE and relatively large scale firms dig their own wells and extract groundwater.

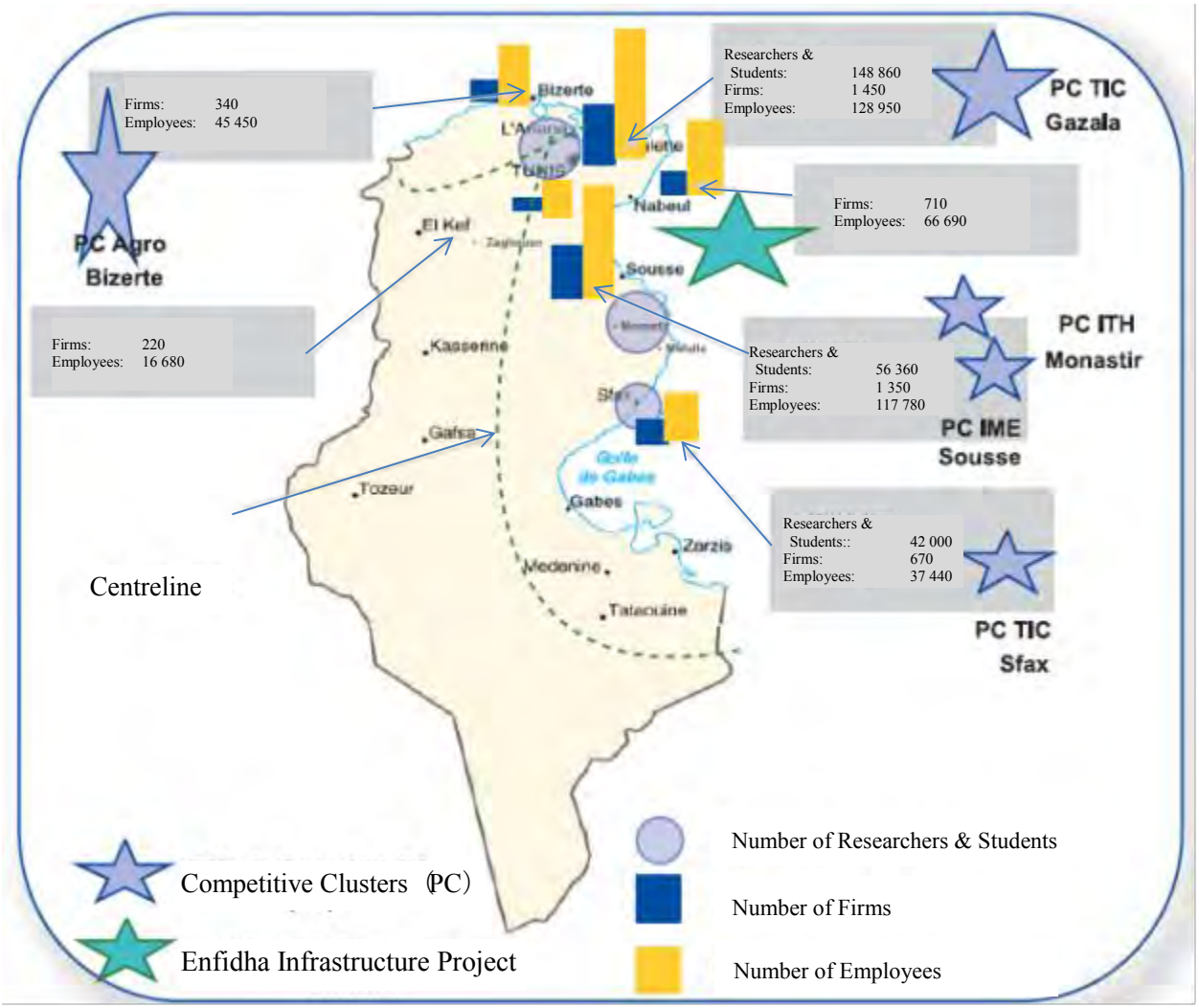
In 2008, the Ministry of Industry, Energy and Small and Middle Enterprises (then, French: Ministere de l'industrie, del'energie et des petites et moyennes entreprises) proclaimed the national policies for the medium and small size industry centring on three important industries, i.e. Industries Textile and Apparel (Industries textile et habillement /ITH), Farm Product-Food Industry (Industries agroalimentaries), and Mechanical and Electric Industries (Industries mecaniques et electroniques /IME). In addition, there is now a focus on Technology for Information and Communication (Technologies de l'information et de la communication /TIC) for Tunisian's future development. The industries competitive clusters (Pôle de compétitivité /PC) are shown in Figure 3.5-1.

Monastir in Sahel area is categorized as PC for ITH, and Souse in Sahel area is classified as PC for IME and up to 2009. It was supposed to accommodate 56,360 researchers and students, 1,350 firms and 117,780 employees. Regarding Sfax, it is categorized as PC for TIC and up to 2009, it was supposed to accommodate 42,000 researchers and students, 670 firms and 37,440 employees. TIC does not require the industrial water.

While large-scale firms have drilled own wells to fill their demands for water; over-extraction has led to regulation and it is now very difficult to get authorized permission to drill new wells in Sfax. Firms have started constructing their own seawater desalination plant as a second choice.

As to the reuse of the treated wastewater there are still problematic issues to be clarified up to the actually extension in terms of water quality and cost performance.

For Tunisia, it is inevitable to face to the reality of water shortage. This fact may shift the focus from examining for new water resources to monitoring the increasing water demand. The MOA had already conducted many studies financed by international funds such as AFD, KfW, AfDB, etc. However, those studies recommended short-term solutions.



Source: National Horizon 2016, Ministry of Industry, Energy and SMEs, 2008

Figure 3.5-1 Main Industrial Area in Tunisia

CHAPTER 4

WATER SUPPLY PLAN FOR GREATER SFAX

CHAPTER 4 WATER SUPPLY PLAN FOR GREATER SFAX

Water consumed in the Greater Sfax is mainly transmitted from the North Water Transmission System and the Jelma-Sbeitla groundwater transmission system. The Greater Sfax does not have its own local water sources. In addition, since the Greater Sfax is located in the lowermost portion of the North Water Transmission System, water supply is dependent on water consumption in seven governorates upstream of the North Water Transmission System. This situation makes it necessary to evaluate water demand and supply starting with the North Water Transmission System, then the Sfax Governorate, and finally with the Greater Sfax. This chapter presents the water supply plan for the Greater Sfax using this order. Outline of the locations of those governorates is shown in the Figure 4.1-1.

Source: SONEDE

Figure 4.1-1 Location of Seven Governorates in North Water Transmission System and Greater Sfax

In this Chapter, present status of water supply for domestic use, agricultural use and industrial use in the Sfax Governorate was discussed, and the balance of water supply and demand in the Greater Sfax was examined. Regarding water demand projection, water supply and demand in seven governorates relating to the North Water Transmission system and Jelma-Sbeitla was examined at first. Then, those in the Sfax Governorate and the Greater Sfax were further studied. Based on the results of examination, required capacity of the desalination plant was considered.

4.1 Current Status and Future Plan of Water Sector

4.1.1 Current Status of Water Sector

SONEDE is in charge of water supply in urban areas and large rural centres in the Sfax Governorate, while DGGREE of the MOA is in charge of medium and small water supply systems. The population and the population served data in the Sfax Governorate from 2006 to 2012 are shown in Table 4.1-1.

Table 4.1-1 Administrative and Served Populations in Sfax Governorate

unit: 1,000m^3/year

Item \ Year		2006	2007	2008	2009	2010	2011	2012
Total Population		887.9	900.0	911.3	923.8	936.7	938.7	963.1
Urban	Population	570.0	578.9	586.5	595.6	605.0	613.8	624.2
	SONEDE Covered Pop.	570.0	578.9	586.5	595.6	605.0	613.8	624.2
	Covered Rate	100%	100%	100%	100%	100%	100%	100%
Rural	Population	317.9	321.1	324.8	328.2	331.7	334.9	338.9
	SONEDE Covered Pop.	179.2	183.8	188.6	192.3	194.4	197.6	199.9
	DGGR Covered Pop.	131.6	134.4	134.6	118.0	119.4	119.1	120.6
	Covered Rate	97.8%	99.1%	99.5%	94.5%	94.6%	94.6%	94.6%
Covered Rate in Sfax Governorate		99.2%	99.7%	99.8%	98.1%	98.1%	98.1%	98.1%

Source: SONEDE Annual Report

The annual water supplies (consumption) in the Sfax Governorate from SONEDE are shown in Table 4.1-2.

Table 4.1-2 Annual Water Supply in Sfax Governorate (Consumption)

unit: 1,000m^3/year

Item \ Year		2006	2007	2008	2009	2010	2011	2012
House Hold Water	Connection Supply	23,037	24,064	26,164	26,388	28,093	29,138	31,440
	Communal Tap	1,364	1,560	2,116	1,965	3,072	2.396	2,862
	Total	24,401	25,624	28,280	28,353	31,165	31,534	34,302
Public Office & Commercial		3,186	3,278	3,257	3,307	3,428	3.464	3,648
Industrial		2,784	2,817	2,921	2,786	2,963	2,826	3,441
Tourism		191	199	209	205	189	173	182
Others		229	246	188	136	138	177	97
Total		30,791	32,164	34,855	34,787	37,883	38,174	41,670

Source: SONEDE Annual Report

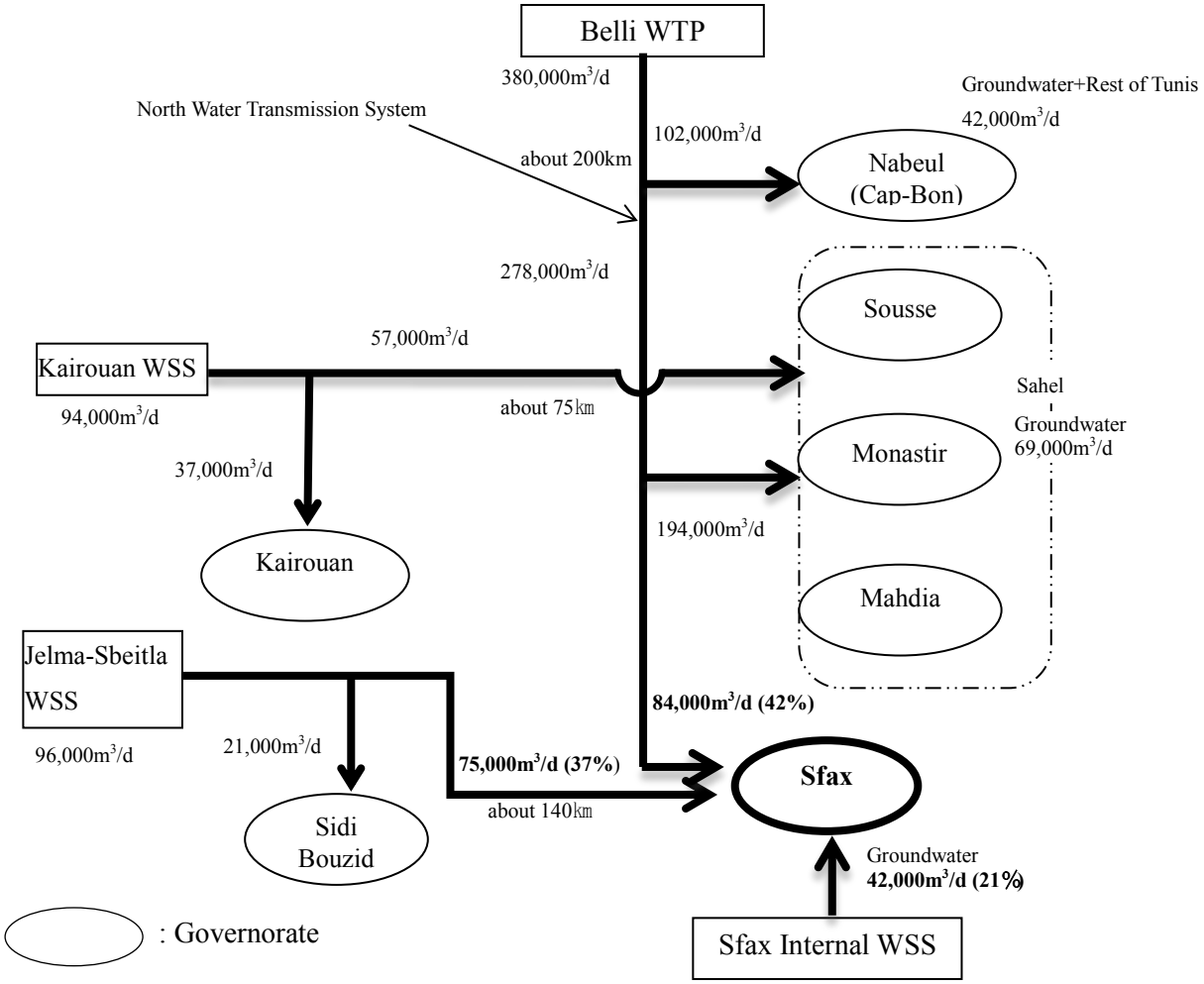
The usage-wise rates of SONEDE water supply in 2012 are as follows; Household; 82.3%, Administration and Commercial; 8.8%, Industrial; 8.3%, Tourism; 0.4%, Others; 0.2%. Regarding the water supply for

industries, the figures are only for SONEDE's subscribers and relatively large-scale consumers such as factories which have their own private wells and to obtain required water supply. With the growth of population and industrial expansion, the water demand is also increasing. SONEDE's responsibility is to ensure continuous water supply services to their growing customer bases.

4.1.2 Water Resources for Water Supply in Sfax

(1) Outline of Water Resources

Water resources for the water supply in the Sfax Governorate are from the North Water Transmission System, the Jelma-Sbeitla Groundwater Transmission System from Sidi Bouzid Governorate and Sfax's own groundwater supply. Figure 4.1-2 shows a schematic diagram of the water resources for the water supply in the Sfax Governorate. Total available water supply volume at peak period in 2013 was 201,000 m^3/day and ratios by each water source are 42%, 37%, and 21% respectively.



Source: JICA Survey Team
Note: Water flow rate is estimated at the peak in 2013.

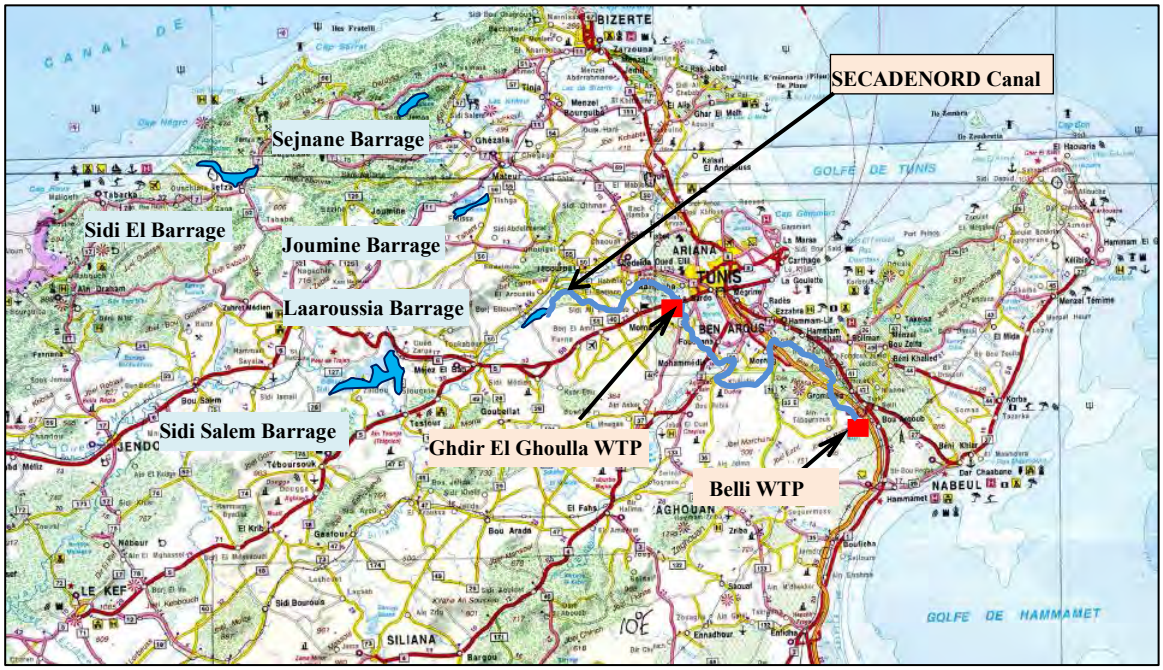
Figure 4.1-2 Schematic Diagram of the Water Resources for Sfax Governorate

(2) North Water Transmission System

a) Water Sources for North Water Transmission System

The water supply system in the Sfax Governorate is one of the components of the wide area water supply system which supplies surface water from the northern Tunisia to the areas which require water. The North Water Transmission System supplies water to governorates of Nabeul, Sousse, Monastir, Mahdia and Sfax. The system also obtains the water from Kairouan where groundwater resources are located. This Kairouan system, however, is not connected with the North Water Transmission System.

The North Water Transmission System is a wide area water supply system with the water from the Belli Water Treatment Plant. Dams in the Majerda River Basin and other rivers supply water to the Belli Plant through the canal and conduits managed by SECADENORD (North Canal and Conduit Development Corporation, French: Société d'Exploitation du Canal et des Adductions des Eaux du Nord). Figure 4.1-3 shows locations of the canals and dams and SONEDE's water intakes for the Gedir El Golla Water Treatment Plant (WTP) and the Belli WTP.



Source: JICA Survey Team

Figure 4.1-3 SECADENORD Canal and SONEDE Water Treatment Plants for North Water Transmission System

SECADENORD, a public establishment possessing legal personality and financial autonomy, under the authority of the MOA, operates, manages, services and maintains the canal and pipelines used to transport water from the dams of Sidi Salem and others. SECADENORD, without obtaining any subsidiary from the ministry, sells water to SONEDE and CRDA, and gains profit from water sales.

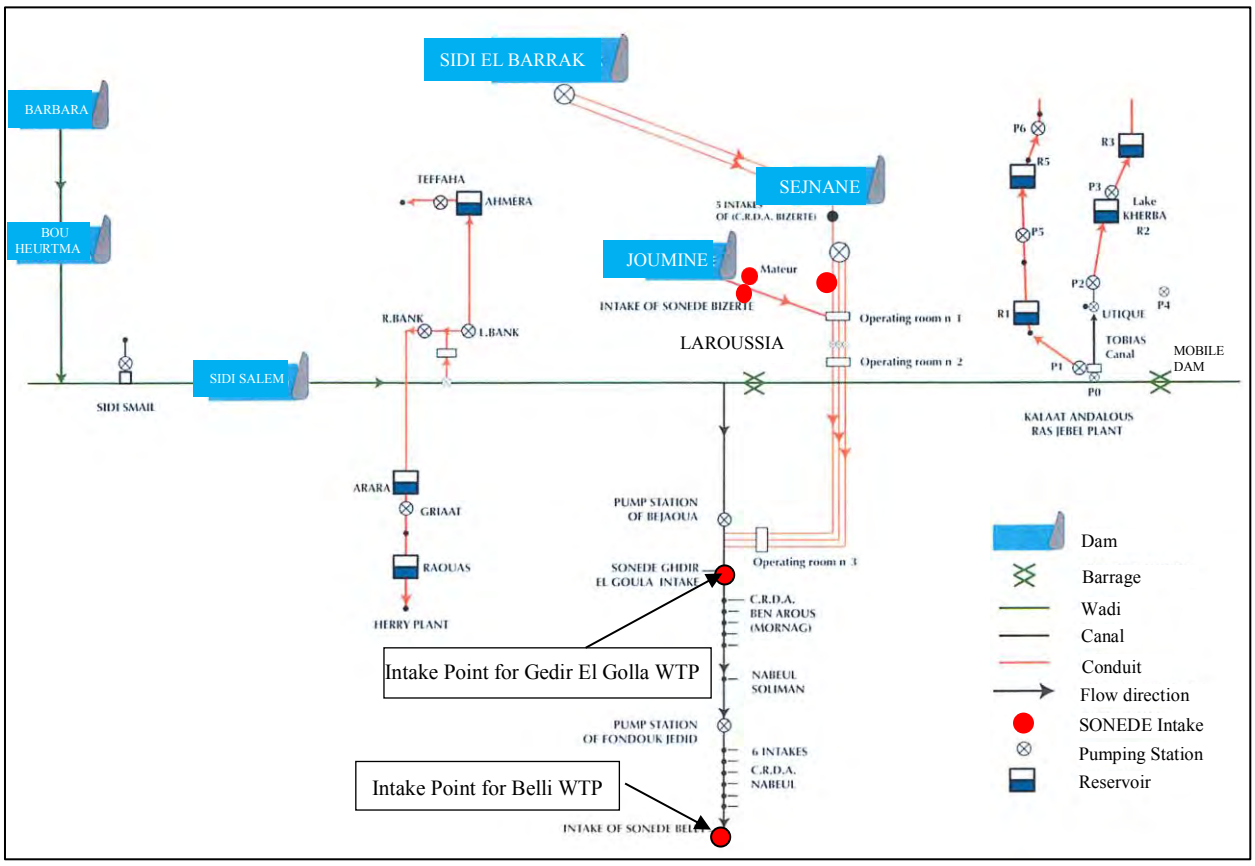
SONEDE made a contract with SECADENORD to purchase water. Current contract is effective for three years, from 01/04/2015 to 31/03/2018. The contents of the contract are as follows:

(i) Raw Water Intake Site (see Figure 4.1-4)

- Sejnane intake through Sejnane-Joumine pipeline for Matour WTP at the 34.750 km point

(March to June)[1]

- Joumine intake through the Joumine-Medjerdah pipeline for Matour WTP at the 4.430 km point (July to February)
- Two intakes of Gedir El Golla WTP through the canal at the 35.430 km point
- Belli WTP intake through the canal at the 120.165 km point



Source: SONEDE

Figure 4.1-4 Schematic Diagram of SECADENORD Canals and SONEDE Water Intakes

(ii) Water Flow to be Supplied

- From 01/04/2015 to 31/03/2016
  Min. Annual Volume = 250 million m^3, Max Annual Volume = 320 million m^3
- From 01/04/2016 to 31/03/2017
  Min. Annual Volume = 256 million m^3, Max Annual Volume = 325 million m^3
- From 01/04/2017 to 31/03/2018
  Min. Annual Volume = 262 million m^3, Max Annual Volume = 330 million m^3

(iii) Water Quality

- Maximum salinity shall be less than 1500mg/L
- Maximum turbidity shall be less than 2000NTU

[1] The pipelines transmit water from Dams of Sidi El Barak, Sejnane, and Joumine to a suburb of Tunis and discharge it to the middle point of the canal. The Matour WTP supplies water to Matour located at western suburb of Tunis.

(iv) Price

- The price for 1 m^3 of water excluding the value-added tax is TND 0.04911 at water intake sites for Matour WTP and Gedir El Golla WTP
- The price for 1 m^3 of water excluding the value-added tax is TND 0.05161 at water intake site for Belli WTP

(v) Amount of Framework Deal

- The minimum amount of the deal corresponding to the first year is fixed at TND14,820,800 including value-added tax, and the maximum amount at TND18,912,686.

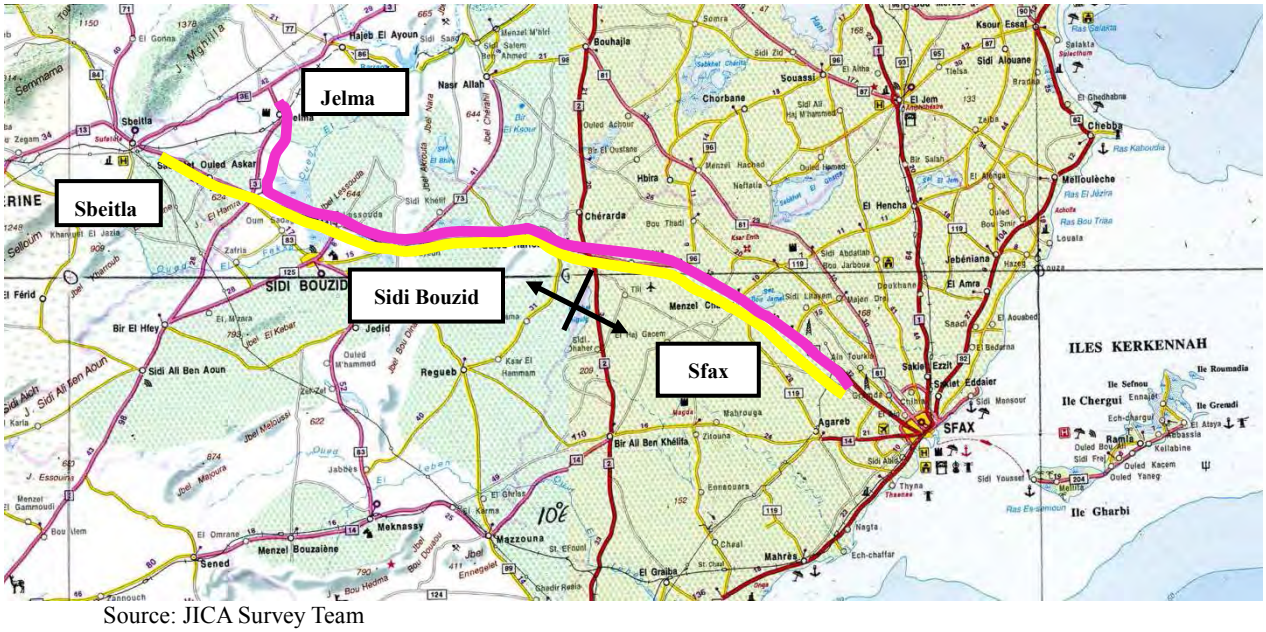
b) Water Treatment Plants for North Water Transmission System

In the North Water Transmission System, raw water is treated at the Gedir El Golla WTP and the Belli WTP, and the treated water is delivered to the service area.

The water treated at the Gedir El Golla WTP is delivered to the water supply system in Tunis and the Nabeul Governorate. The water treated at the Belli WTP is delivered to the water supply system in Nabeul and the southern areas through the North Water Transmission System. (Refer to Figure 4.2-2)

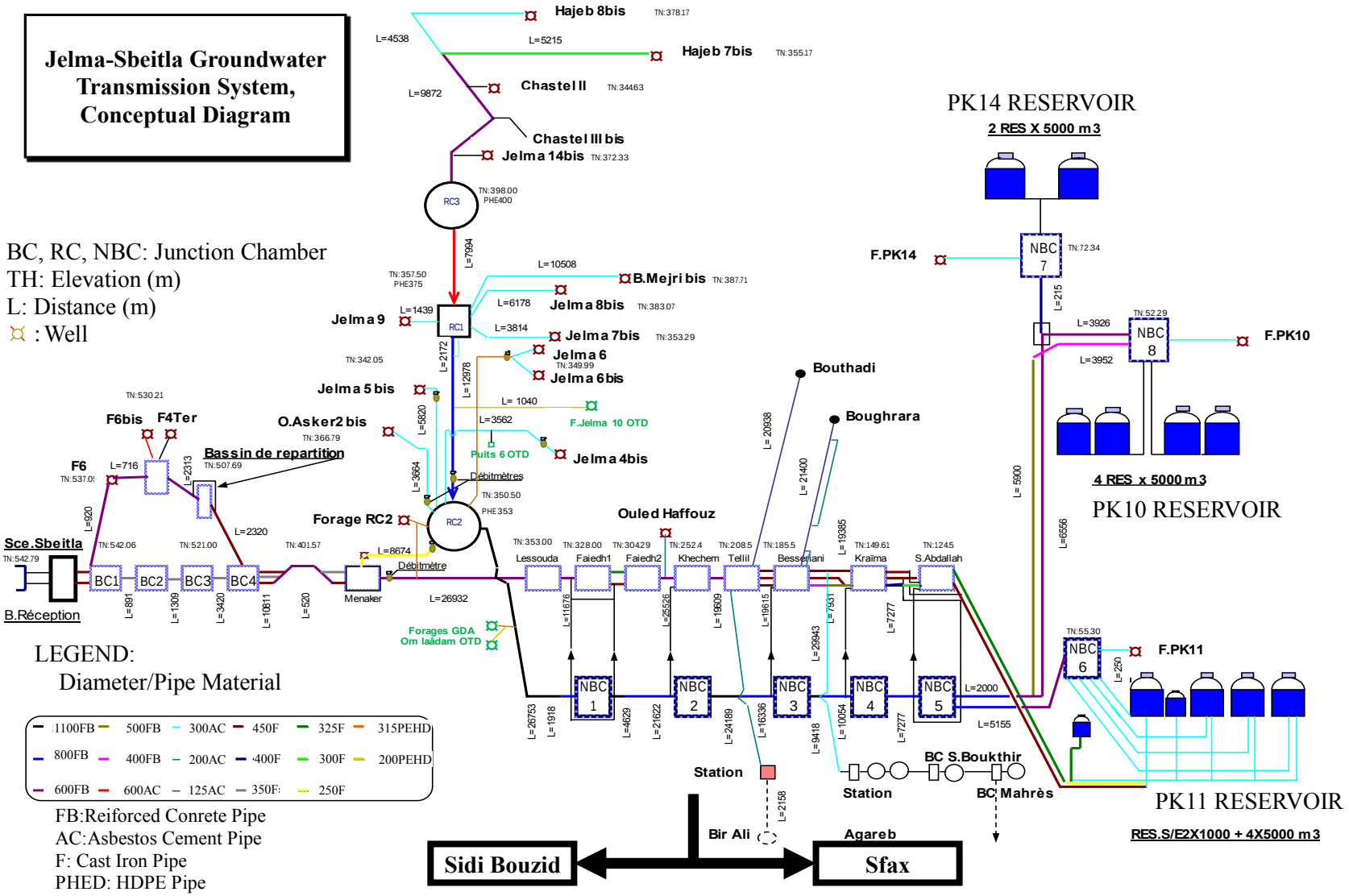
(3) Jelma-Sbeitla Groundwater Transmission System

The Sbeitla water resources area in the Kasserine Governorate and the Jelma water resources area in the Sidi Bouzid Governorate are located in the mountainous area spread from the western area of the Sfax Governorate to the state borderline. Both water resources produce groundwater of good quality. The water extracted from these two water resources is transferred to the Greater Sfax by water conveyance pipelines of about 140kms in length. Before arriving at the Greater Sfax, a part of the water is diverted to the rural areas. SONEDE operates and maintains the all water supply system such as the water intake facilities of those water resources, water conveyance pipelines, and facilities for water distribution.



Source: JICA Survey Team

Figure 4.1-5 Location Map of Jelma-Sbeitla Groundwater Transmission System



Source: SONEDE

Figure 4.1-6 Schematic Diagram of Jelma-Sbeitla Groundwater Transmission System

During the peak seasonal demand period in 2012, the Greater Sfax was beset with serious water shortage, which was considered a serious social problem. SONEDE received an exceptional government approval for the construction of new wells as one of measures to meet the peak seasonal demand. The approval came in the face of stringent regulations which banned any new construction of wells. In 2013 in Sidi Bouzid, three new wells were constructed and operations commenced soon after.

Table 4.1-3 New Wells in Sidi Bouzid Governorate

Name	Year	Designed Capacity (L/s)	Actual Operation (L/s)	Remarks
Garaat Hadid 2	2013	20	15	Operating Rate 75%
Garaat Hadid 3	2013	20	25	Operating Rate: 125%
Ouled Asker 2	2013	40	40	Operating Rate: 100%

Source: SONEDE
Operating Rate = Actual Operation / Designed Capacity. Overdraft at the operating rate more than 100%

Sidi Bouzid water supply system totally depends on its own groundwater. To control the increase of water demand in Sidi Bouzid, all new groundwater development within six areas in the governorate have been regulated since 1985. The pipeline route of the transmission includes the controlled area (Declaration et N 85-251 on 07/02/1985 Sidi Bouzid Governorate). Since the system started to deal increased water demand in Sidi Bouzid, operating status has been on overdraft.

Actual values of extractions from Jelma water resources in 2010 and Sbeitla water resource in 2009 are shown in Table 4.1-4.

Table 4.1-4 Actual Value of Extractions from Jelma and Sbeitla Water Resources

unit: million m^3/year

Jelma water resources in 2010	SONEDE	Industry	Irrigation	Total	Regulated Value	Extraction Rate
	22.0	-	9.0	31.0	27.8	111%
Sbeitla water resource in 2009	SONEDE	Industry	Irrigation	Total	Regulated Value	Extraction Rate
	9.15	0.13	6.82	16.1	13.5	119%

Source: SONEDE

(4) Sfax Groundwater Supply System

In addition to the main water resources for the Greater Sfax, i.e. the North Water Transmission System and the Jelma-Sbeitla Groundwater Transmission System, SONEDE extracts groundwater from 14 water resources in the Sfax Governorate during the peak seasonal demand period. The water resources where SONEDE maintains and operates wells in 2012 are shown in Table 4.1-5.

Table 4.1-5 Water Resources of Wells of SONEDE in Sfax Governorate (2012)

No	Name	Code	Location	Commenced Year	Water Level (m)	Extraction (L/s)	TDS (mg/L)	Depth (m)	Remarks
1	Ramla 1	5611	Kerkennah	1951	+24.1	6.25	3,500	702	Operating
2	Ramla 2	16693	Kerkennah	1979	+24.1	16.88	3,900	363	Operating
3	Wells in PK 11	18805	Sfax South	1978	-21.1	49.21	3,030	570	Operating
4	Wells in PK 10	19059	Sfax South	1982	-20.35	48.2	3,160	497	Operating

No	Name	Code	Location	Commenced Year	Water Level (m)	Extraction (L/s)	TDS (mg/L)	Depth (m)	Remarks
5	Wells in PK 14	19706	Sfax South	1990	-42.6	52.16	3,200	482	Operating
6	Sidi Salah	20729	Sakiet Zit	2000	-48	46.52	3,100	471	Operating
7	Aouabed	20740	Sfax South	2000	-33.75	51.74	3,100	500	Operating
8	Sidi Boukthir	21367	Agareb	2004	-104.8	23	4,000	700	Operating
9	Hancha	21365	Hancha	2003	-32.54	0	3,580	512	Not Operating
10	Bir Sidi Abdallah	21366	Sfax South	2003	-57.6	47.38	3,060	580	Operating
11	Ramla 4	21340	Kerkennah	2004	+19.00	25	3,620	370	Operating
12	Ouled Youssef	21518	Jebeniana	2006	-42.6	17	3,600	360	Operating
13	Ramla 5	21800	Kerkennah	2009	18.00	8.8	3,700	360	Operating
14	Bir Chabba	20397	Hancha	1998	-40.75	22	4,000	505	Operating

Source: CRDA Sfax 2012 Annual Report

The national water quality code in Tunisia, NT09.14:1983, permits salinity or TDS up to 2500 mg/L; however, TDS of the groundwater in the Governorate of Sfax is approximately 3500 mg/L which is higher than the regulated value. Accordingly, SONEDE mixes the water of Sfax with water from other sources in reservoirs prior to water distribution. SONEDE tries to keep the mixed TDS concentration less than the target quality, i.e. 2000 mg/L.

Faced with the water shortage in 2012, SONEDE constructed additional wells upon getting the government's special permits. The situation of the new well programs is as follows:

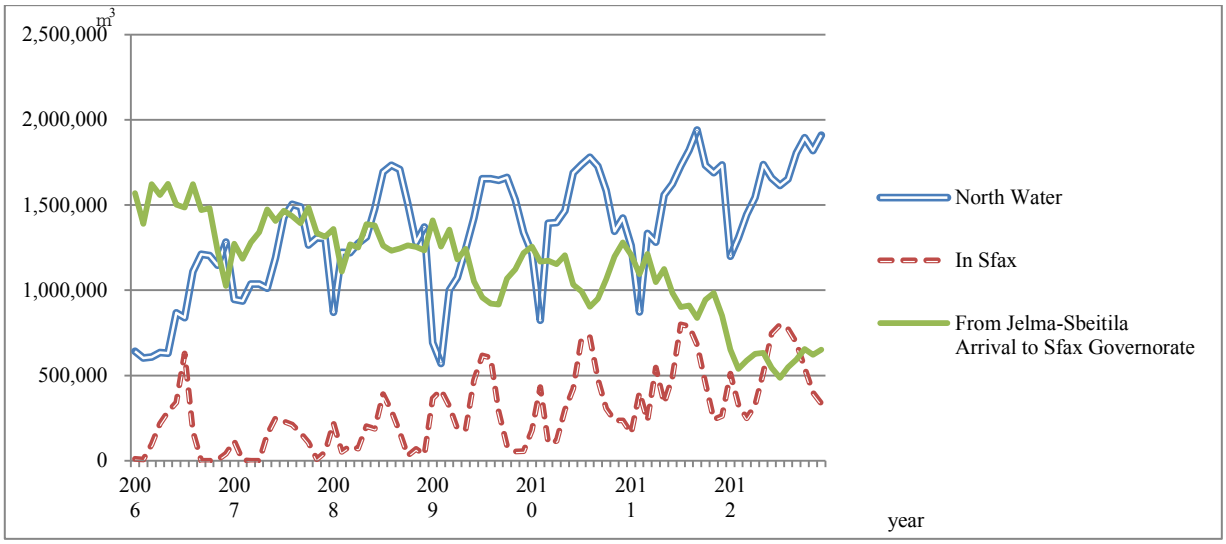
Table 4.1-6 New Well Programs in Sfax Governorate

Name/Location	Year	Design Capacity (L/s)	Operation Capacity (L/s)	Operating Rate*
Mahrouga	2013	30	30	100%
PK 15	2013	40	50	125%
Agareb	2013	30	15	50%
Oued Batha	Under Construction	30	30	100%
Saint Louis	2013	20	20	100%
Bir Chooba	2013	20	20	100%
Hencha	2013	20	20	100%
Markez Kammoun	Scheduled in 2014	-	20	

Source: SONEDE
*: Operating Rate = Operation Capacity / Design Capacity. Overdraft at the operating rate more than 100%

(5) Issues on Water Resources in Sfax Governorate

Lacking its own water resources, the Sfax Governorate inevitably relies on water resources from outside of its jurisdiction, such as from the North Water Transmission System and the Jelma-Sbeitla Groundwater Transmission System.

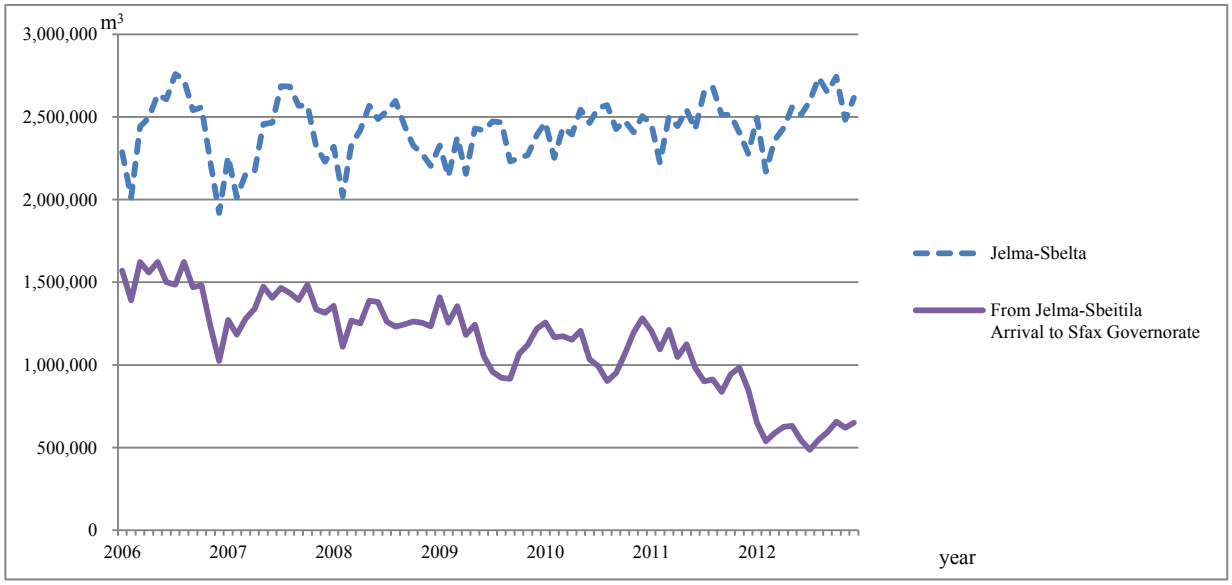


Source: SONEDE

Figure 4.1-7 Monthly Water from Three Water Resources to Sfax Governorate (2006~2012)

To continue having water from the North Water Transmission System, SONEDE renews its contract with SECADENORD every three years. For SONEDE, the security of its water resources greatly depends on how SECADENORD manages the water balance among water demands of SONEDE and other sectors.

Regarding the water from the Jelma-Sbeitla Groundwater Transmission System to the Sfax Governorate, water flow has been on a steady decline.



Source: SONEDE

Figure 4.1-8 Monthly Water from Jelma-Sbeitla Groundwater Transmission System to Sfax Governorate (2006~2012)

SONEDE has to determine how to delineate the limited water resources by taking into consideration the balance between the water demand in the groundwater origin area and the demand in the area where water

is transmitted. Getting the agreement of all stakeholders is not easy, especially when it comes to filling in the gap between water demand and supply availability by increasing the extraction of the groundwater in the Sfax Governorate. The extraction of groundwater must still adhere to limitations set in terms of both time period and extraction volume.

4.1.3 Current Status and Future Plan of Water Sector for Agriculture and Industry

(1) Current Status of Water Sector for Agriculture

Annual rainfall in the Sfax Governorate is approximately 230mm. The "Wadi" has water only during times of heavy rain or simply an intermittent stream could be found. Therefore, the quantity of surface water for irrigation is very limited such that agriculture is dependent on groundwater. After installation of many wells, especially shallow wells, decline of groundwater levels had become a big issue in the Sfax Governorate. Currently well construction is restricted and permission from the MOA is required.

The Water Resources Department of CRDA Sfax Office is responsible for managing irrigation wells through the Water Conservation Section, the Agricultural Infrastructure Section, and the Irrigation Section.

Current status of the irrigation wells that CRDA Sfax Office operates and maintains is as follows.

1) Shallow Wells

Depth:	0 to 50m
Registered Number:	13,788
Salinity Concentration:	TDS 2000to 6000mg/L (52% of them exceed 4000mg/L)
Current Status:	The annual production capacity is estimated at 39.8 million m^3/year according to the MOA's survey result in 2003. Extraction of existing wells has already reached 53 million m^3, meaning that extraction is well over the limit of 136%. A new well installation work is restricted and periodically inspected by the Water Conservation Section, especially for the densely installed areas.

2) Mid-layer Wells

Depth:	70 to 200m
Registered Number:	125
Salinity Concentration:	TDS 3000 to 4000 mg/L
Current Status:	The aquifer was confirmed in recent studies and its capacity is approximately 11.3 million m^3/year. Mainly private farmers have constructed wells and CRDA is confirming the actual situation.

3) Deep Wells

Depth:	250 to 400m
Registered Number:	Equipped Wells 28, Artesian Wells 9
Salinity Concentration:	TDS 3000 to 4000 mg/L
Current Status:	The entire production capacity in the Sfax Governorate is assumed to be

25.5 million m^3/year. SONEDE extract water from this aquifer. Relatively big firms also extract water using their own wells in the industrious area in Skihira.

Due to scarcity of rainfalls in the Sfax Governorate, agriculture is dependent on groundwater; however, shallow aquifers have been fully developed. Water from deep aquifers have been extracted by SONEDE and industrious users up to the regulated limit. There is also the need to clarify and acknowledge the issue of salinity. This requires not only water transmission from outside to Sfax, but also recommends the reuse treated wastewater for the agricultural sector within Sfax. The latter is an ambitious program that must also be clarified further.

(2) Current Status of Water Sector for Industry

In the Sfax Governorate, industrial water is supplied by SONEDE and private entities which have installed their own wells under authority permission.

1) Industry Water Supplied by SONEDE

Annual consumption of industrial water supply by SONEDE in the Sfax Governorate is as follows:

Table 4.1-7 Water for Industry supplied by SONEDE in Sfax Governorate

Year	2006	2007	2008	2009	2010	2011	2012
Annual Consumption in Sfax (1,000m^3/year)	2,784	2,817	2,921	1,942	2,113	1,999	2,471
Comparison with previous year	-	1.01	1.04	0.66	1.09	0.95	1.24

Source: SONEDE Annual Report

2) Industry Water Extracted by Private Entities

Annual consumption volumes of water by private industrial entities in the Sfax Governorate are as follows.

Table 4.1-8 Water for Industry extracted by Private Firms in Sfax Governorate

Year	2010	2011	2012
Annual Consumption in Sfax (1,000m^3/year)	12,690	11,760	8,460
Comparison with previous year	-	0.93	0.72

Source: CRDA Annual Report (2012)

The list of the registered wells in the Sfax Governorate that private industrial entities operate and maintain in 2012 is as follows.

Table 4.1-9 Registered Industrial Wells in Sfax Governorate (in 2012)

No	Name	Code	Location	Commenced Year	Water Level (m)	Extraction (L/s)	Salinity (mg/L)	Depth (m)	Remarks
1	NPK Well 4	19472	Sfax City	1987	+27.38	49	3,100	592	Not Operating
2	SFTB Well	19658	Menzel Chaker	1988	-120	9.5	2,900	332	Operating (12L/s)
3	British Gas	21743	Mahares	2007-2008	+1.04	18	3,500	539	Operating (18L/s)
4	SIAPE 15		Sfax South	2012	+12.8	39.72	3,390	560	Operating (37L/s)

No	Name	Code	Location	Commenced Year	Water Level (m)	Extraction (L/s)	Salinity (mg/L)	Depth (m)	Remarks
5	TRAPSA 7	19765	Skhira	1997	-6.79	40	8,000	240	Operating (8L/s)
6	SIAPE II 7	20671	Skhira	1999	-27.49	50	10,300	315	Operating (50L/s)
7	SEPT	21104	Skhira	2002	-10.53	5	9,260	263	Operating (16L/s)
8	SIAPE II 4	21105	Skhira	2003	-27.73	40	8,000	264	Operating (50L/s)
9	SIAPE 14	21342	Sfax South	2004	+15.60	55	3,460	555	Operating (35.3L/s)
10	TRAPSA 6	21521	Skhira	2004	-11.19	25	8,300	242	Operating (9L/s)
11	SIAPE II 1	21798	Skhira	2008	-24.65	40	8,100	260	Operating (57.66L/s)
12	TPAP Poulina	21702	Agareb	2008	-59	25	3,800	326	Operating (25L/s)
13	SIAPE II 5	21797	Skhira	2008	-22.35	40	9,600	270	Operating (57.77L/s)
14	SIAPE II 3	21794	Skhira	2008	-26.04	50	9.6	274	Operating (41.66L/s)
15	SIAPE II 7	20277	Skhira	1997	-16.2	68.5	11,500	327	Not Operating

Source: CRDA Annual Report (2012)

3) Issues on Water Supply for Industrial Use in Sfax Governorate

In the Sfax governorate, many private entities extract groundwater under expressed authority or permission. The extracted water volume is larger than the volume that SONEDE can supply. However, the total extraction of water for households, agriculture and industry has already exceeded the permissible volume. The limitation on water extraction has been prevents Sfax's industries from growing.

Accordingly, one of Tunisian national companies, Groupe Cheimique, located at Skhira has constructed a desalination plant to supply their own water requirements. The capacity of the plant is 12,000m^3/day and its operations commenced in 2013.

Groundwater consumption for industrial use decreased because of the influence of the revolution. It, however, is expected to increase in accordance with recovery of the industrial activities. Therefore, it is not practical to convert those water resources to domestic use, because an alternative water source will be necessary for said conversion. Such groundwater has high TDS concentration. Especially, those wells located near sea seem being suffered by sea water intrusion due to excessive pumping. Therefore, it is not appropriate to convert groundwater sources being used for industrial use to domestic use.

4.2 Development Plans of SONEDE

Current plans and studies for the water supply system in the Greater Sfax are shown in Table 4.2-1.

Table 4.2-1 Existing Plan and Studies for the Water Supply System in Greater Sfax

Plan or Study	year	Outline	Relationship to the Project
1) Plan of Distribution Networks and Distribution in Greater Sfax	March 2003	Development Plan of Distribution System of Greater Sfax Water Supply System	Distribution Plan
2) Feasibility Study on the Mid-South Area Water Supply Scheme	March 2005	Plan of Several Seawater Desalination Plants in Mid-South Area and Water Transmission Plan for Produced Water	Outlines of Seawater Desalination Plants
3) Study on Water Supply Network of Tourba-Agareb-Mahres-Skhira	January 2011	Water Distribution System Development Plan in the Area South of Greater Sfax	Demand-Supply Water Balance
4) Strategic Study	April 2013	Development Plan of Water Supply System in Greater Sfax urgent developed to cope with the draught in the summer 2012.	Outline of Sfax Seawater Desalination Plant, Water Demand

Source: SONEDE

Outlines of each plan and study are as follows:

(1) Plan of Distribution Networks and Distribution in Greater Sfax

Plan of Distribution Networks and Distribution in the Greater Sfax ("Etude du Plan Directeur des Réseaux de Répartition et de Distribution du Grand Sfax"), was conducted by SONEDE and its contracted engineering consortium of two Tunisian Consultants, SCET-TUNISI and BRL Engineering.

The main objective of the master plan was to propose the optimal plan for the service area of the Greater Sfax, i.e. Sfax, North Sfax and South Sfax. The study was conducted from 2001, and had four stages as follows:

i) Mission A: To collect information on existing facilities and their evaluations
ii) Mission B: To collect basic information on social-urban development and study future water demand
iii) Mission C: To examine alternatives for phased water distribution network augmentation plan
iv) Mission D: To select the optimal alternative and conduct detailed design for the programs of Phase 1

The capacities of the facilities were determined based on the target year of 2032. In addition, the detailed design of Phase 1 project was implemented for the facilities constructed until 2011. The following is the facilities constructed in Phase 1 and by 2032.

Facilities constructed in Phase 1:

- New construction of Sidi Issa High Altitude Zone Reservoir
- Augmentation of Sidi Salah Low Altitude Zone Reservoir
- Augmentation of existing main distribution pipes
- Augmentation of Bou Merra Reservoir

Facilities constructed until 2032:

- Augmentation of Sidi Salah Low Altitude Zone Reservoir
- Augmentation of the transfer pipe from Mahrouga Pressure Regulation Chamber to Sidi Salah Low Altitude Zone Reservoir
- Transmission Pipe up to PK11 Reservoir

- Augmentation of Bou Merra Reservoir

Although the project has been delayed due to financial issues, it is still being implemented following to the plan. In fact a part of the plan, Sidi Salah Low Reservoir and the distribution network has been constructed by Local Cities Water Supply Network Improvement Project under the JICA ODA loan project.

(2) Feasibility Study on the Mid-South Area Water Supply Scheme

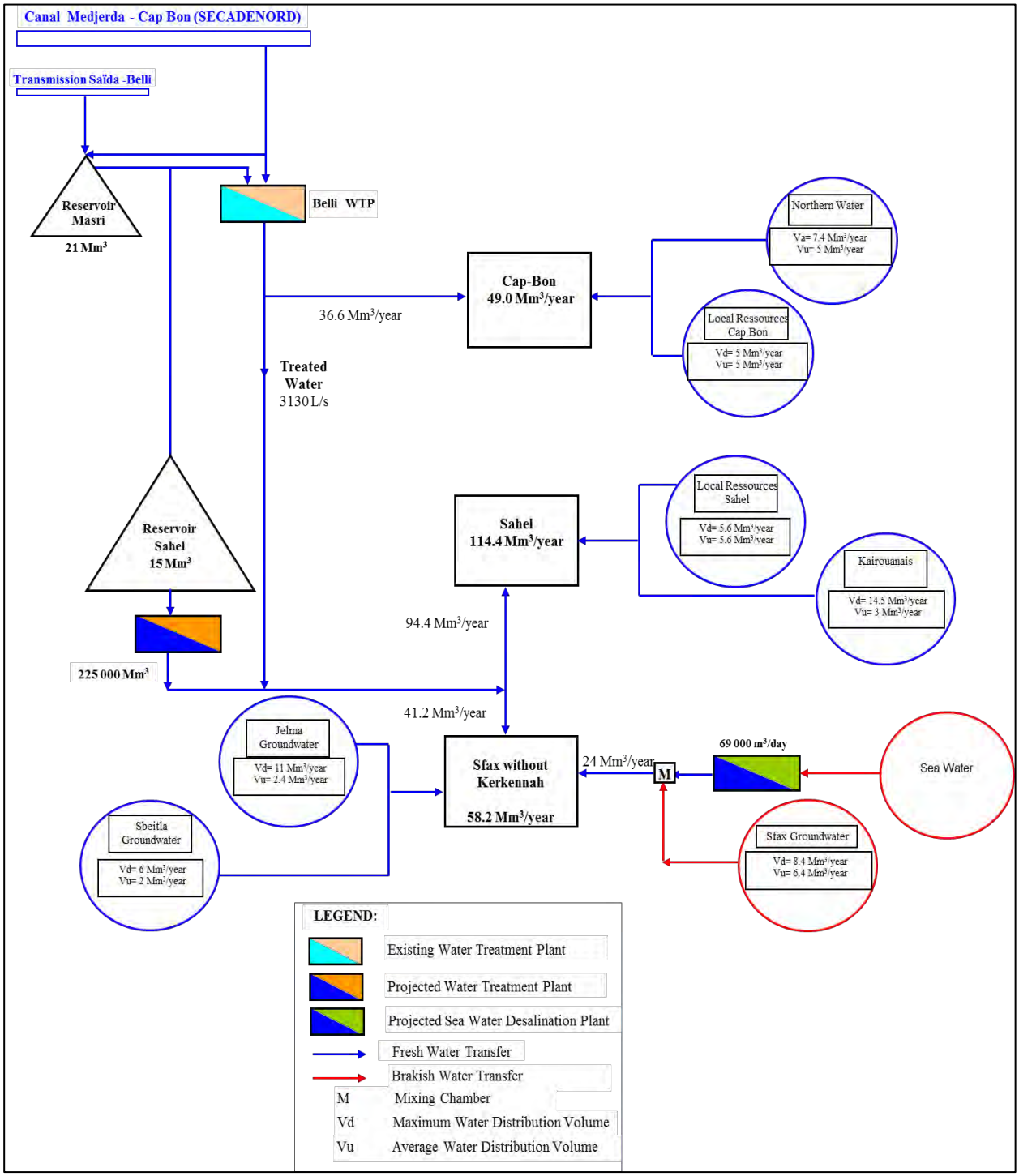
The Feasibility Study on the Mid-South Area Water Supply Scheme ("L'étude de faisabilité du projet d'alimentation en eau potable jusqu'à l'horizon 2030 du Cap-Bon, Sahel, Sfax, Gabès, Médenine et Tataouine) was conducted, utilizing Japanese fund to the World Bank, SONEDE contracted the study with an engineering consortium consisting of a French Consultant, SOGREAH and two Tunisian Consultants, STUDI and IDEACONSULT.

The main objective of the feasibility study was to propose the optimal plan for the supply area of Cap-Bon (Nabeul Governorate), Sahel (Sousse, Monastir and Mahdia), Sfax, Gabes, Medenine and Tataouine, and it was conducted from 2003with three stages as follows:

i) Mission 1: To meet the increasing water demand especially in Sahel region at the seasonal peak demand period up to 2025 a reservoir for potable water was examined. The capacity of the reservoir was 8 million m^3 for 15 days peak demand.
ii) Mission 2: An investigation about the balance between future water demand and water resources was conducted and based on the result eight options were proposed and in terms of water production method two solutions where offered. In the context of discussion, the Engineering Consulting Committee proposed to extend the target year from 2025 to 2030.
iii) Mission 3: Based on the result of technological, environmental and economic-financial assessment, the optimal plan for water supply system in the study area, 2nd Option-Solution 2, was selected

The general contents of the most optimal plan for water supply system in the study area, 2nd Option-Solution 2, are as follows (see Figure 4.2-1 as an extract of conceptual schematic relating to the Greater Sfax):

i) Water for Cap-Bon and Sahel will be transmitted from North Water Transmission System and in Sfax Governorate a new seawater desalination plant will be introduced.
ii) In Gabes to fill the gap between water demand and its existing water resources, a new brine water desalination plant and a seawater desalination plant will be installed.
iii) In Medenine and Tataouine in addition to the existing brine water desalination plants new brine water desalination plant will be installed in Djerba Island.



Source: SONEDE

Figure 4.2-1 Optimal Plan, 2nd Option-Solution 2（F/S Report Mission 2: SOLUTION 2V2）

The Draft Final Report of the Study was discussed in the Engineering Consulting Committee and the Committee permitted the finalization of the report with these comments. In accordance with the permission granted by the Engineering Consulting Committee, the implementation of the plan was authorized together with the proposed schemes.

The Engineering Consulting Committee had been organized with the following members.

- SONEDE General Director
- General Directorate, DGRE, Ministry of Agriculture and Environment (then)
- General Directorate, DGBGTH, Ministry of Agriculture and Environment (then)
- DGRE, Ministry of Agriculture and Environment (then)
- DGGREE, Ministry of Agriculture and Environment (then)
- SECADENORD
- Ministry of Scientific Research and Promotion of Competences (then)
- Ministry of Investment and International Cooperation (then)
- Ministry of Industry, Energy and Small and Middle Enterprises (then)

Based on the study results, the schemes for the Sfax Governorate planned as national projects are as follows:

- In the Sfax Governorate, the annual water demand in 2030 was assumed to be 58.2 million m^3. To meet this demand the water from the North Water Transmission System for Wide Area was planned as 29.8 million m^3, the water from Jelma-Sbeitla Groundwater Transmission System as 4.4 million m^3, the water from Sfax Groundwater Supply System as 6.4 million m^3, and the water from newly constructed seawater desalination plant as 17.6 million m^3.
- The raw water reservoir in Sahel was planned to be 15 million m^3 to meet the seasonal peak demand in 2030 (This was determined in the Mission 2 discussion).
- The capacity of the new seawater desalination plant is planned to be 69,000m^3/day.
- Based on the study result, SONEDE further took into consideration the changing of circumstances from the time of the study, i.e. 2005, to the present, and called for flexibility in the implementation of the programs.

As stated above, the capacity of the Sfax Seawater desalination Plant was planned as 69,000m^3/day in this study. However, it was considered to be revised because of water shortage issue occurred in 2012. Consequently, the Strategic Study shown in item (4) below was established.

(3) Study on Water Supply Network of Tourba-Agareb-Mahres-Skhira

Study on Water Supply Network of Tourba-Agareb-Mahres-Skhira ("Etude du réseau d'adduction Tourba - Agareb - Mahrès – Skhira") was conducted by SONEDE and its contracted Tunisian consultant, BICHE.

The main objective of the study was to propose urgent measures for increasing water demand in the southern area of the Sfax Governorate, Tourba - Agareb - Mahrès – Skhira, including how to transmit the water from the Jelma-Sbeitla Groundwater Transmission System. However, with the issue on water scarcity as experienced in 2012, the organization of planned programs to deal with and properly manage actual emergency situation needs further discussions.

(4) Strategic Study

As stated in above item "(2) Feasibility Study on the Mid-South Area Water Supply Scheme", development of a Seawater Desalination Plant in the Sfax Governorate was confirmed as the national

project. Its urgent implementation became necessary because of water shortage in southern Tunisia including the Sfax Governorate at the seasonal peak demand period in 2012. In order to implement the project, SONEDE formulated the Strategic Study ("ETUDE STRATEGIQUE") and laid out plans and programs that should be implemented up to 2030.

In the study, future water demand was evaluated based on not collected basic planning data such as population, industry, tourism but statistic assessments of past actual water consumption.

The study area covers governorates being supplied of water from the North Water Transmission System; namely, Cap-Bon (Nabeul Governorate), Sahel (Sousse, Monastir and Mahdia), Kairouan, Sfax, and Sidi Bouzid; the origin of Jelma-Sbeitla Groundwater Transmission System. Water supply facilities to be constructed were examined to meet the water demand in the study area.

In addition to the desalination plant in Sfax, water transfer schemes consisting of two water reservoirs; Saida reservoir in the west area of Tunis and the other reservoir in Sahel (Kalaa Kebira) with its treatment plant were also planned. The outline of this scheme is to transmit water from Saida reservoir to Kalaa Kebira reservoir, and from Kalaa Kebira treatment plant, water of 4 m^3/second or 345,600 m^3/day will be supplied to the Sahel area and the Sfax Governorate through the North Water Transmission System during the summer water demand peak season.

Major component of planned facilities are as follows (see Figure 4.2-2):

- Saida reservoir: about 45 million m^3
- Transmission pipeline from Majerda river to Saida Reservoir: Pump Stations 3, Pipeline 13km, Reservoir 5000m^3
- Canal from Saida Reservoir to Belli Treatment Plant: 60km, Pump Stations 2
- Sahel (Kalaa Kebira) Reservoir: 28 million m^3
- Sahel (Kalaa Kebira) Treatment Plant: 4 m^3/sec.
- Sfax Seawater Desalination Plant: 200,000 m^3/day

Table 4.2-2 shows treatment plant and desalination plant planned in the Strategic Study.

Table 4.2-2 Treatment Plant and Desalination Plant planned in the Strategic Study

Name	Operation year	Capacity	Water supply to Greater Sfax (maximum)
Saida Reservoir, and Kalaa Kebira Reservoir and Treatment Plant	2019	4,000L/sec. (345,600m^3/day)	-
Seawater Desalination Plant in Greater Sfax	2018	1,157 L/sec. (100,000m^3/day)	1,157 L/sec. (100,000m^3/day)
	2028	2,325 L/sec. (200,000m^3/day)	2,325 L/sec. (200,000m^3/day)

Based on the results of this study, the Tunisian Government requested the Japanese Government to extend the Japanese ODA loan for the project of seawater desalination plant of 200,000m^3/day in Sfax to be constructed by 2018.

出典：ETUDE STRATEGIQUE, SONEDE

Figure 4.2-2 Location of Planned Facilities in the Strategic Study

4.3 Appropriateness of Seawater as Water Source

In the Strategic Study, a plan for seawater desalination facility was added. In this section, the appropriateness of seawater as water source is reviewed.

Existing water sources are surface and groundwater, but these have already been used up according to a study by the MOA. Groundwater is strictly regulated in terms of increasing extraction flow and the new construction of wells to conserve the water resources. The details of groundwater extraction are presented in Table 4.3-1.

Table 4.3-1 Extraction Volume of Groundwater in Sfax and Jelma-Sbeitla

(unit: million m^3/year)

Location	Year	Domestic use	Industrial use	Agricultural use	Total	Limit of extraction	Margin of extraction
Sfax Governorate	2010	5.6	12.7	7.6	25.9	25.5	▲0.4
	2011	6.3	11.8	8.7	26.8	25.5	▲1.3
	2012	8.8	8.5	6.6	23.9	25.5	1.6
Jelma water sources	2010	22.0	-	9.0	31.0	27.8	▲3.2
Sbeitla water sources	2009	9.2	0.1	6.8	16.1	13.5	▲2.6

Note: The extraction for industrial use was decreased largely in 2011 and 2012 due to the revolution.
Source: JICA Survey Team

As shown in Table 4.3-1, the groundwater extraction exceeded the limit or is close to the limit. It is obvious that an increase of groundwater extraction is not possible. Besides groundwater, the new water resources mentioned below could be considered for an increase in water supply.

1) Utilization of water for agricultural use
2) Utilization of treated water from wastewater treatment plant
3) Utilization of excess water for agricultural use obtained by utilization of treated water at wastewater treatment plant to the agriculture
4) Increase of Effective water by reduction of Leakage

Said four types of the approaches, however, are not practical from the reasons mentioned as follows:

1) Utilization of water for agricultural use

In 2012, MOA gave the permission to SONEDE for utilizing water for agricultural use at 600 million m^3/year. This availability, however, is limited to agricultural off-season. Therefore, the water cannot be utilized for the entire year. In addition, the farmers protest this permission, and claim strongly for a decrease of providing water to the MOA. Therefore, it is not a practical idea to increase the water transfer volume from the agricultural use to SONEDE.

2) Utilization of treated water from wastewater treatment plant

Treated effluent from wastewater treatment plant utilised for orchards due to water shortage is believed dirty or contaminated. In addition, it is also thought that the land irrigated by the treated effluent is be dirty or contaminated. Considering such situation, utilization of the treated water as raw water of

SONEDE's water supply system is not possible.

3) Utilization of excess water for agricultural use obtained by using treated water from wastewater treatment plant to agricultural use

Actually, the treated effluent from wastewater treatment plant has been utilized for agriculture as substitute. The treated effluent, however, has limited use because of high salinity concentration and high operation cost for transmission of the water by pumps. With this condition, a utilization ratio of the treated water at Sfax South Wastewater Treatment Plant decreased from 36% in 2007 to 14% in 2011. Therefore, it will be difficult to expect an increased utilization ratio of the treated effluent for agricultural use.

Therefore, it is not practical idea to shift the water presently used for agriculture to SONEDE's water resource.

4) Increase of Effective Water by Reduction of Leakage

According to the SONEDE's record, the ratio of Non-Revenue Water of the water supply system in the Greater Sfax already reached 16% in 2013 (see Table 4.6-1). Taking account of cost effectiveness and required period for obtaining satisfactory result, it is not practical as a measure for increase of effective water for urgent needs.

Consideration all the arguments, the most practical approach to augment water source in the Greater Sfax is to utilize and desalinate for increasing water supply.

4.4 Water Demand and Supply in North Water Transmission System

4.4.1 Water Demand in North Water Transmission System

SONEDE formulated the "Feasibility Study on the Mid-South Area Water Supply Scheme" in 2005 in which the target year was 2030. As the countermeasure against severe water shortage which occurred in 2012, the "Strategic Study" was formulated in 2013. The Strategic Study, however, was not prepared with spending a couple years because the Feasibility Study was formulated, and the formulated plan was requested to be implemented urgently. The future water demand was estimated by a statistical analysis on the past water supply data in seven governorates such as Cap-Bon (Nabeul Governorate), Sahel (Sousse, Monastir and Mahdia), Kairouan, Sfax, and Sidi Bouzid, on the following detailed assumptions:

1) Based on the consumption data in the seven governorates for 10 years, from 2001 to 2010, average water demand growth rates of each governorate were calculated based on actual consumption data from 2001 to 2010.
2) Average water demand growth rates of each governorate from 2011 to 2020 were calculated by increasing the average water demand growth rates from 2001 to 2010. The increased rate of the average water demand varies from 0.3% to 1.1% and SONEDE determined each figure as per assumed weight of each area.
3) Water demand growth rates from 2021 to 2030 was assumed to decline somehow, for this reason,

the average increase rates from 2021 to 2030 decrease by 0.5% from the ones from 2011 to 2020.

4) Daily peak factor for each governorate was determined based on the actual data in 2010 and for Sfax it is 1.4.
5) Performance factor was assumed for each governorate and for Sfax it will gradually improve from 76% to 80% from 2010 to 2030.
6) Based on the above-mentioned assumptions the calculated water demands for 2010 are different from actual water demands in 2010. The difference comes from the accuracies of the assumptions and that in reality, the peak flows do not occur simultaneously. Thus the results for all governorates except for three governorates in Sahel were adjusted using multiplier 0.89. The adjustment takes into consideration the socio-economic importance of Sahel from SONEDE's viewpoint.

In this survey, water demand was reviewed based on the method applied in the Strategic Study with revision by following adjustment parameters. Then, appropriateness of results was examined by consideration of calculated per capita consumption.

1) Increase rate in demand

SONEDE assumed the average water demand growth for each governorate from 2011 to 2020 by increasing the average growth rate for each governorate from 2001 to 2010. For example, in case the average rate from 2001 to 2010 is 3.0% per year during the 10 years and the growth rate exceeds 3.5% five times, then the annual increase rate from 2011 to 2020 is assumed to be 3.5%. After that from 2021 to 2030 the annual growth rate goes back to 3.0%. This planning justification, in the first decade taking upper value and in the second decade taking the average value, is not based on a rationale reason. Therefore, clarifying future demand should be forecasted based on the previous actual consumption, the assumption is that the annual growth rate of water demand for each governorate is equal to the calculated average rate, so this rate should be constant.

2) Regional factor

In the Strategic Study, to fill the gap between the actual measured figure and the estimate, the adjustment factor 0.89 was applied. SONEDE applied this adjustment rate to four governorates except three governorates in the Sahel region. This arrangement is based on the importance of Sahel's tourism peak during the summer season. Meanwhile the regional gravities have already been taken care of in the past water consumption data. Therefore in the calculation for the study report a common factor 0.944[2] for the entire area is adopted.

3) Peak factor

The peak demand generally does not occur at the same time. According to this assumption, the peak factor is applied to the entire Governorate with the uniform value of 0.95.

4) Target Year

[2] The calculated result in 2010 is 8,251 L/s, the actual production in 2010 is 7,893 L/s; therefore, the adjustment rate is 7,893/8,251 = 0.944.

SONEDE set 2030 as the target year of the plan in the Strategic Survey. In this survey, the target year was changed to 2035 because said year of 2030 is 15 years after present time, and it seems to be too short for planning final facilities in the future.

Comparison of SONEDE's projection method in the Strategic Study and revisions in this survey are summarized in Table 4.4-1.

Table 4.4-1 Comparison of SONEDE's Projection Method in the Strategic Study and Revisions

Item	Projection Method in Strategic Study	Revisions in this Survey
1. Average increase rate of water consumption by governorate	Calculated based on 10 years records from 2001 to 2010 by governorates	No revision
2. Increase Rate for the period between 2011and 2020.	Increase of the recorded rates by 0.3% to 1.1%, considering regional importance.	Apply the average rates calculated for the period between 2001 and 2010.
3. Increase Rate for the period between 2021and 2030.	Decrease of increase rate from those applied for 2011 to 2020 by 0.5% considering decrease of population increase.	Same as above. Target year was extended to 2035.
4. Peak Factor	Applied based on the actual record of each governorate. In Sfax Governorate, it is 1.4.	No revision
5. Revenue Water rate	Assumed based on the actual record by governorate considering improvement in future. It is assumed to be improved from 76% in 2010 to 80% in 2030in Sfax Governorate.	No revision[3]。
6. Adjustment Factor	To adjust the calculated volume, the regional adjustment factor of 0.89 derived from actual record and assumed volume in 2010 was applied to 4 governorates except 3 governorates in Sahel area.	Regional adjustment factor of 0.944 is applied to all governorates. Further, Peak adjustment factor of 0.95 was introduced considering peak consumption would not occur in all regions at same time. It is not applied for calculation of distribution volume within sole governorate.

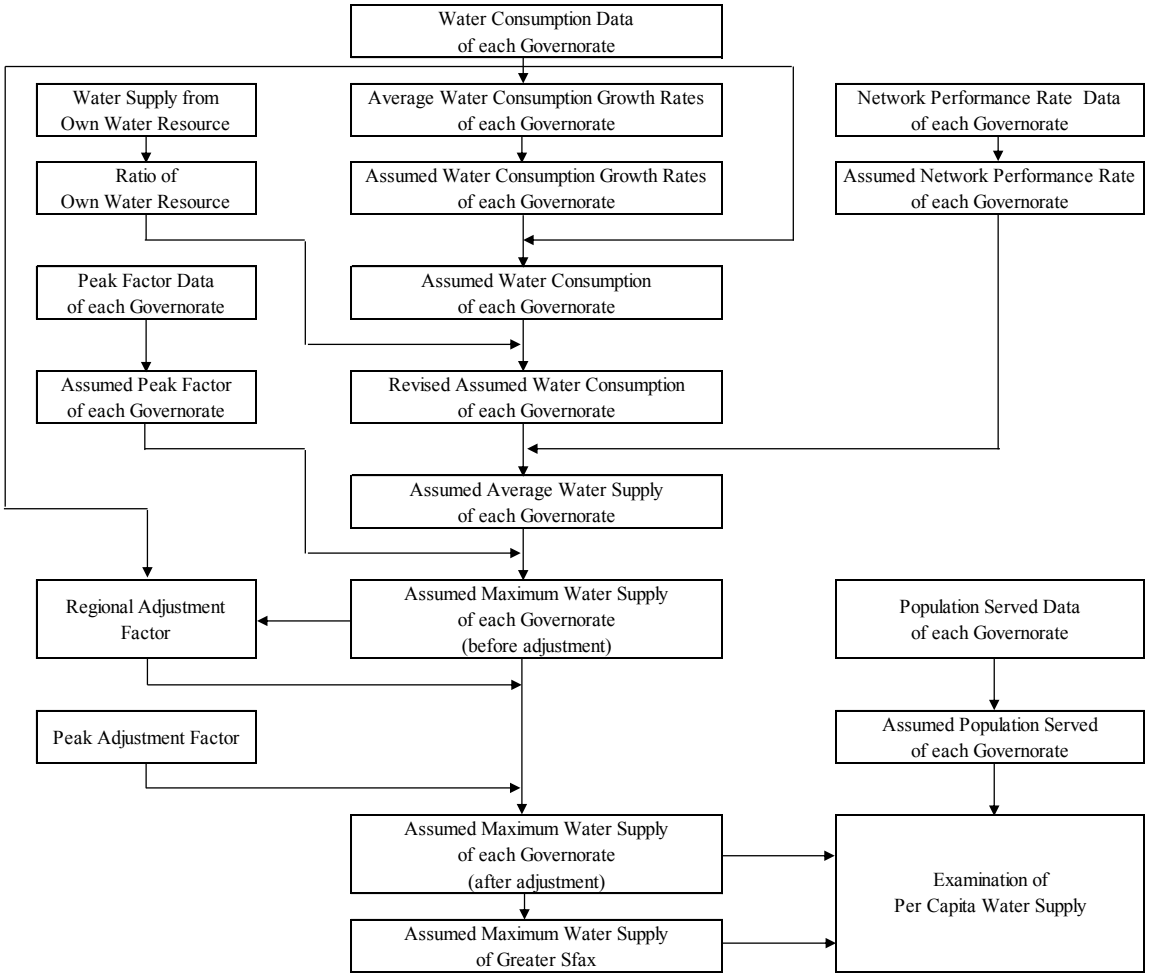
Projection method applied in this Survey is as follows:

1) Calculate average annual increase rate of water consumption by governorate base on the record from 2001 to 2010 (Table 4.4-2)
2) Calculate average water consumption by governorate based on the assumed average annual increase rate (Table 4.4-2)
3) Calculate ratio of own water resource by governorate based on the water consumption of own water source (Table 4.4-3)

[3] According to SONEDE's Operation Department Sfax Branch Office, the network performance rate in the Greater Sfax was 87.6% at the highest in 2012, and 79.4% at the lowest in 2005 during the period from 2002 to 2013. That of the Sfax Governorate was assumed to be lower than that of the Greater Sfax.

4) Calculate adjusted water consumption by governorate based on the average water consumption by governorate and the ratio of own water resource by governorate (Table 4.4-4)
5) Calculate network performance rate by each governorate based on the record from 2001to 2010 (Table 4.4-5)
6) Calculate average water consumption by government based on the adjusted water consumption by governorate and the network performance rate by each governorate (Table 4.4-6)
7) Calculate peak factor by governorate based on the record (Table 4.4-7)
8) Calculate regional adjustment factor based on the water consumption record in 2010 and the calculated water consumption for 2010 (Table 4.4-7)
9) Calculate maximum water demand by governorate based on the regional adjustment factor and the peak factor by governorate (Table 4.4-8)
10) Project population served by governorate based on the records (Table 4.4-9)
11) Calculate and examine per capita water consumption based on the maximum water demand and projected population served

The flow diagram of projection of the survey stated above is as shown in Figure 4.4-1 below:



Source：JICA Survey Team

Figure 4.4-1 Flow Diagram of Water Demand Projection of the Survey

Table 4.4-2 Water Consumption by Governorate

Unit: million m^3/year

	Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
1	2001	22.9	23.1	17.8	9.4	27.4	7.1	3.9	111.6
2	2002	22.5	22.8	17.6	9.6	27.2	6.6	3.9	110.2
3	2003	23.6	23.5	18.2	9.9	27.6	7.0	3.8	113.6
4	2004	24.7	25.2	19.2	10.5	28.9	7.2	3.9	119.6
5	2005	25.7	25.4	20.0	11.2	30.8	7.6	4.4	125.1
6	2006	27.5	26.2	20.7	12.0	30.8	7.9	4.5	129.6
7	2007	27.9	27.2	21.3	12.7	32.2	8.1	4.6	134.0
8	2008	29.1	28.0	21.8	13.2	34.8	8.6	5.1	140.6
9	2009	29.8	28.5	22.3	13.4	34.8	8.9	5.2	142.9
10	2010	31.3	30.2	23.5	14.7	37.9	9.2	5.6	152.4
	Average Annual Increase Rate								
	%p.a.	3.6%	3.0%	3.1%	5.0%	3.7%	2.9%	4.2%	
11	2011	32.4	31.1	24.2	15.4	39.3	9.5	5.8	157.7
12	2012	33.6	32.0	25.0	16.2	40.8	9.8	6.0	163.4
13	2013	34.8	33.0	25.8	17.0	42.3	10.1	6.3	169.3
14	2014	36.1	34.0	26.6	17.9	43.9	10.4	6.6	175.5
15	2015	37.4	35.0	27.4	18.8	45.5	10.7	6.9	181.7
16	2016	38.7	36.1	28.2	19.7	47.2	11.0	7.2	188.1
17	2017	40.1	37.2	29.1	20.7	48.9	11.3	7.5	194.8
18	2018	41.5	38.3	30.0	21.7	50.7	11.6	7.8	201.6
19	2019	43.0	39.4	30.9	22.8	52.6	11.9	8.1	208.7
20	2020	44.5	40.6	31.9	23.9	54.5	12.2	8.4	216.0
21	2021	46.1	41.8	32.9	25.1	56.5	12.6	8.8	223.8
22	2022	47.8	43.1	33.9	26.4	58.6	13.0	9.2	232.0
23	2023	49.5	44.4	35.0	27.7	60.8	13.4	9.6	240.4
24	2024	51.3	45.7	36.1	29.1	63.0	13.8	10.0	249.0
25	2025	53.1	47.1	37.2	30.6	65.3	14.2	10.4	257.9
26	2026	55.0	48.5	38.4	32.1	67.7	14.6	10.8	267.1
27	2027	57.0	50.0	39.6	33.7	70.2	15.0	11.3	276.8
28	2028	59.1	51.5	40.8	35.4	72.8	15.4	11.8	286.8
29	2029	61.2	53.0	42.1	37.2	75.5	15.8	12.3	297.1
30	2030	63.4	54.6	43.4	39.1	78.3	16.3	12.8	307.9
31	2031	65.7	56.2	44.7	41.1	81.2	16.8	13.3	319.0
32	2032	68.1	57.9	46.1	43.2	84.2	17.3	13.9	330.7
33	2033	70.6	59.6	47.5	45.4	87.3	17.8	14.5	342.7
34	2034	73.1	61.4	49.0	47.7	90.5	18.3	15.1	355.1
35	2035	75.7	63.2	50.5	50.1	93.8	18.8	15.7	367.8

Source : 2001-2010 : Actual record ETUDE STRATEGIQUE, SONEDE, 2013
2011-2035 : Projection by JICA Survey Team

Table 4.4-3 Rate of Water Consumption from Own Water Sources*

Unit: million m^3/year

	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
Consumption	2.1	0.4	0.4	-	0.9	2.7	2.0	8.5
Rate	6.7%	1.4%	1.9%	0.0%	2.4%	29.3%	34.9%	5.6%

*: small scale water supply system without any relation with the North water transmission system.
Source: ETUDE STRATEGIQUE, SONEDE, 2013

Table 4.4-4 Adjusted Water Consumption by Governorate

Unit: million m^3/year

Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
2011	30.2	30.7	23.7	15.4	38.4	6.7	3.8	148.9
2012	31.3	31.6	24.5	16.2	39.8	6.9	3.9	154.2
2013	32.5	32.5	25.3	17.0	41.3	7.1	4.1	159.8
2014	33.7	33.5	26.1	17.9	42.8	7.4	4.3	165.7
2015	34.9	34.5	26.9	18.8	44.4	7.6	4.5	171.6
2016	36.1	35.6	27.7	19.7	46.1	7.8	4.7	177.7
2017	37.4	36.7	28.5	20.7	47.7	8.0	4.9	183.9
2018	38.7	37.8	29.4	21.7	49.5	8.2	5.1	190.4
2019	40.1	38.8	30.3	22.8	51.3	8.4	5.3	197.0
2020	41.5	40.0	31.3	23.9	53.2	8.6	5.5	204.0
2021	43.0	41.2	32.3	25.1	55.1	8.9	5.7	211.3
2022	44.6	42.5	33.3	26.4	57.2	9.2	6.0	219.2
2023	46.2	43.8	34.3	27.7	59.3	9.5	6.2	227.0
2024	47.9	45.1	35.4	29.1	61.5	9.8	6.5	235.3
2025	49.5	46.4	36.5	30.6	63.7	10.0	6.8	243.5
2026	51.3	47.8	37.7	32.1	66.1	10.3	7.0	252.3
2027	53.2	49.3	38.8	33.7	68.5	10.6	7.4	261.5
2028	55.1	50.8	40.0	35.4	71.1	10.9	7.7	271.0
2029	57.1	52.3	41.3	37.2	73.7	11.2	8.0	280.8
2030	59.2	53.8	42.6	39.1	76.4	11.5	8.3	290.9
2031	61.3	55.4	43.9	41.1	79.3	11.9	8.7	301.6
2032	63.5	57.1	45.2	43.2	82.2	12.2	9.0	312.4
2033	65.9	58.8	46.6	45.4	85.2	12.6	9.4	323.9
2034	68.2	60.5	48.1	47.7	88.3	12.9	9.8	335.5
2035	70.6	62.3	49.5	50.1	91.5	13.3	10.2	347.5

Source: JICA Survey Team

Table 4.4-5 Network Performance Rate by Governorate

Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid
2010					0.76	0.70	0.71
|	0.83	0.85	0.85	0.8	|	|	|
2030					0.80	0.78	0.78

Source: ETUDE STRATEGIQUE, SONEDE, 2013

Table 4.4-6 Average Water Demand by Governorate

Unit: million m^3/year

Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
2011	36.4	36.1	27.9	19.3	50.4	9.5	5.3	184.9
2012	37.7	37.2	28.8	20.3	52.1	9.7	5.4	191.2
2013	39.2	38.2	29.8	21.3	53.9	10.0	5.7	198.1
2014	40.6	39.4	30.7	22.4	55.7	10.3	5.9	205.0
2015	42.0	40.6	31.6	23.5	57.7	10.6	6.2	212.2
2016	43.5	41.9	32.6	24.6	59.7	10.8	6.4	219.5
2017	45.1	43.2	33.5	25.9	61.6	11.0	6.7	227.0
2018	46.6	44.5	34.6	27.1	63.8	11.2	6.9	234.7
2019	48.3	45.6	35.6	28.5	65.9	11.4	7.1	242.4
2020	50.0	47.1	36.8	29.9	68.2	11.6	7.4	251.0
2021	51.8	48.5	38.0	31.4	70.5	12.0	7.6	259.8
2022	53.7	50.0	39.2	33.0	73.0	12.3	8.0	269.2
2023	55.7	51.5	40.4	34.6	75.4	12.6	8.2	278.4
2024	57.7	53.1	41.6	36.4	78.0	13.0	8.6	288.4
2025	59.6	54.6	42.9	38.3	80.6	13.2	8.9	298.1
2026	61.8	56.2	44.4	40.1	83.5	13.5	9.1	308.6
2027	64.1	58.0	45.6	42.1	86.3	13.8	9.6	319.5
2028	66.4	59.8	47.1	44.3	89.3	14.1	10.0	331.0
2029	68.8	61.5	48.6	46.5	92.4	14.4	10.3	342.5
2030	71.3	63.3	50.1	48.9	95.5	14.7	10.6	354.4
2031	73.9	65.2	51.6	51.4	99.1	15.3	11.2	367.7
2032	76.5	67.2	53.2	54.0	102.8	15.6	11.5	380.8
2033	79.4	69.2	54.8	56.8	106.5	16.2	12.1	395.0
2034	82.2	71.2	56.6	59.6	110.4	16.5	12.6	409.1
2035	85.1	73.3	58.2	62.6	114.4	17.1	13.1	423.8

Source: JICA Survey Team

Table 4.4-7 Adjustment Factors by Governorate

Adjustment Factor	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid
1.Peak factor (Daily Max./Daily Ave.)	1.500	1.400	1.500	1.500	1.400	1.500	1.500
2. Regional Adjustment Factor	0.944	0.944	0.944	0.944	0.944	0.944	0.944
3. Peak Adjustment Factor	0.950	0.950	0.950	0.950	0.950	0.950	0.950
Integrated Adjustment factor 1x2x3	1.3452	1.2555	1.3452	1.3452	1.2555	1.3452	1.3452

Source: JICA Survey Team

Table 4.4-8 Maximum Water Demand by Governorate

Unit: million m^3/year

Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
2011	49.0	45.3	37.5	26.0	63.3	12.8	7.1	241.0
2012	50.7	46.7	38.7	27.3	65.4	13.0	7.3	249.1
2013	52.7	48.0	40.1	28.7	67.7	13.5	7.7	258.4
2014	54.6	49.5	41.3	30.1	69.9	13.9	7.9	267.2
2015	56.5	51.0	42.5	31.6	72.4	14.3	8.3	276.6
2016	58.5	52.6	43.9	33.1	75.0	14.5	8.6	286.2
2017	60.7	54.2	45.1	34.8	77.3	14.8	9.0	295.9
2018	62.7	55.9	46.5	36.5	80.1	15.1	9.3	306.1
2019	65.0	57.3	47.9	38.3	82.7	15.3	9.6	316.1
2020	67.3	59.1	49.5	40.2	85.6	15.6	10.0	327.3
2021	69.7	60.9	51.1	42.2	88.5	16.1	10.2	338.7
2022	72.2	62.8	52.7	44.4	91.7	16.5	10.8	351.1
2023	74.9	64.7	54.3	46.5	94.7	16.9	11.0	363.0
2024	77.6	66.7	56.0	49.0	97.9	17.5	11.6	376.3
2025	80.2	68.6	57.7	51.5	101.2	17.8	12.0	389.0
2026	83.1	70.6	59.7	53.9	104.8	18.2	12.2	402.5
2027	86.2	72.8	61.3	56.6	108.4	18.6	12.9	416.8
2028	89.3	75.1	63.4	59.6	112.1	19.0	13.5	432.0
2029	92.5	77.2	65.4	62.6	116.0	19.4	13.9	447.0
2030	95.9	79.5	67.4	65.8	119.9	19.8	14.3	462.6
2031	99.4	81.9	69.4	69.1	124.4	20.6	15.1	479.9
2032	102.9	84.4	71.6	72.6	129.1	21.0	15.5	497.1
2033	106.8	86.9	73.7	76.4	133.7	21.8	16.3	515.6
2034	110.6	89.4	76.1	80.2	138.6	22.2	16.9	534.0
2035	114.5	92.0	78.3	84.2	143.6	23.0	17.6	553.2

Unit: m^3/day

Year	Nabeul	Sousse	Monastir	Mahdia	Sfax	Kairouan	Sidi Bouzid	Total
2011	134,247	124,110	102,740	71,233	173,425	35,068	19,452	660,274
2012	138,904	127,945	106,027	74,795	179,178	35,616	20,000	682,466
2013	144,384	131,507	109,863	78,630	185,479	36,986	21,096	707,945
2014	149,589	135,616	113,151	82,466	191,507	38,082	21,644	732,055
2015	154,795	139,726	116,438	86,575	198,356	39,178	22,740	757,808
2016	160,274	144,110	120,274	90,685	205,479	39,726	23,562	784,110
2017	166,301	148,493	123,562	95,342	211,781	40,548	24,658	810,685
2018	171,781	153,151	127,397	100,000	219,452	41,370	25,479	838,630
2019	178,082	156,986	131,233	104,932	226,575	41,918	26,301	866,027
2020	184,384	161,918	135,616	110,137	234,521	42,740	27,397	896,712
2021	190,959	166,849	140,000	115,616	242,466	44,110	27,945	927,945
2022	197,808	172,055	144,384	121,644	251,233	45,205	29,589	961,918
2023	205,205	177,260	148,767	127,397	259,452	46,301	30,137	994,521
2024	212,603	182,740	153,425	134,247	268,219	47,945	31,781	1,030,959
2025	219,726	187,945	158,082	141,096	277,260	48,767	32,877	1,065,753
2026	227,671	193,425	163,562	147,671	287,123	49,863	33,425	1,102,740
2027	236,164	199,452	167,945	155,068	296,986	50,959	35,342	1,141,918
2028	244,658	205,753	173,699	163,288	307,123	52,055	36,986	1,183,562
2029	253,425	211,507	179,178	171,507	317,808	53,151	38,082	1,224,658
2030	262,740	217,808	184,658	180,274	328,493	54,247	39,178	1,267,397
2031	272,329	224,384	190,137	189,315	340,822	56,438	41,370	1,314,795
2032	281,918	231,233	196,164	198,904	353,699	57,534	42,466	1,361,918
2033	292,603	238,082	201,918	209,315	366,301	59,726	44,658	1,412,603
2034	303,014	244,932	208,493	219,726	379,726	60,822	46,301	1,463,014
2035	313,699	252,055	214,521	230,685	393,425	63,014	48,219	1,515,616

Table 4.4-9 Administrative and Served Populations by Governorate

Unit: 1000

Administrative Population

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Nabeul	709.7	719.2	728.5	738.4	747.4	757.6	768.5	779.4	788.1	798.0	807.9	817.8	827.7	837.5	847.4	857.3	867.2	877.1	887.0	896.9	906.8	916.7	926.5	936.4	946.3	956.2	966.1	976.0	985.9	995.8	1005.7
Sousse	562.4	573.6	584.5	596.3	605.3	616.2	633.8	648.7	656.7	668.7	680.7	692.7	704.7	716.7	728.8	740.8	752.8	764.8	776.8	788.8	800.8	812.8	824.9	836.9	848.9	860.9	872.9	884.9	896.9	909.0	921.0
Monastir	470.5	479.8	490.0	499.8	509.6	520.2	533.2	539.3	550.8	560.9	571.0	581.1	591.2	601.3	611.4	621.5	631.6	641.7	651.9	662.0	672.1	682.2	692.3	702.4	712.5	722.6	732.7	742.8	752.9	763.0	773.1
Mahdia	383.1	385.5	388.4	391.4	394.1	398.7	399.0	395.0	401.8	404.0	406.2	408.4	410.6	412.8	415.0	417.1	419.3	421.5	423.7	425.9	428.1	430.3	432.5	434.7	436.9	439.1	441.3	443.5	445.7	447.9	450.1
Sfax	875.1	887.9	898.8	910.9	923.8	937.9	948.7	963.1	974.5	987.0	999.5	1012.0	1024.5	1037.0	1049.5	1062.0	1074.5	1087.0	1099.5	1112.1	1124.6	1137.1	1149.6	1162.1	1174.6	1187.1	1199.6	1212.1	1224.6	1237.1	1249.6
Kairouan	549.3	551.1	552.8	554.9	558.9	563.3	564.9	569.4	571.2	574.1	577.0	580.0	582.9	585.8	588.7	591.6	594.6	597.5	600.4	603.3	606.2	609.2	612.1	615.0	617.9	620.8	623.8	626.7	629.6	632.5	635.4
Sidi Bouzid	399.8	402.3	404.5	407.3	410.9	414.4	416.3	418.4	421.7	424.5	427.3	430.1	432.9	435.6	438.4	441.2	444.0	446.8	449.5	452.3	455.1	457.9	460.7	463.4	466.2	469.0	471.8	474.6	477.3	480.1	482.9
Total	3949.9	3999.4	4047.5	4099.0	4150.0	4208.3	4264.4	4313.3	4364.8	4417.2	4469.6	4522.1	4574.5	4626.7	4679.2	4731.5	4784.0	4836.4	4888.8	4941.3	4993.7	5046.2	5098.6	5150.9	5203.3	5255.7	5308.2	5360.6	5412.9	5465.4	5517.8

Served Population

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Nabeul	614.8	624.3	633.0	642.0	650.1	660.6	670.6	680.5	688.9	698.2	707.5	716.8	726.2	735.5	744.8	754.1	763.4	772.7	782.0	791.3	800.7	810.0	819.3	828.6	837.9	847.2	856.5	865.8	875.2	884.5	893.8
Sousse	534.5	545.3	556.6	568.0	576.7	587.5	606.2	623.8	630.1	642.3	654.6	666.9	679.2	691.4	703.7	716.0	728.2	740.5	752.8	765.1	777.3	789.6	801.9	814.2	826.4	838.7	851.0	863.3	875.5	887.8	900.1
Monastir	470.5	479.8	490.0	499.8	509.6	520.2	533.2	539.3	550.8	560.9	571.0	581.1	591.2	601.3	611.4	621.5	631.6	641.7	651.9	662.0	672.1	682.2	692.3	702.4	712.5	722.6	732.7	742.8	752.9	763.0	773.1
Mahdia	306.0	311.5	322.3	334.8	337.5	341.5	341.8	338.4	352.7	357.9	363.2	368.4	373.6	378.8	384.1	389.3	394.5	399.7	404.9	410.2	415.4	420.6	425.8	431.0	436.3	441.5	446.7	451.9	457.2	462.4	467.6
Sfax	735.9	749.2	761.3	774.8	787.9	800.4	811.4	824.1	837.3	850.0	862.6	875.2	887.8	900.4	913.0	925.6	938.2	950.8	963.4	976.0	988.6	1001.2	1013.8	1026.4	1039.0	1051.6	1064.2	1076.8	1089.4	1102.1	1114.7
Kairouan	319.7	321.8	324.5	333.8	341.4	345.5	347.1	351.3	358.0	363.0	368.0	373.0	378.0	382.9	387.9	392.9	397.9	402.9	407.8	412.8	417.8	422.8	427.8	432.7	437.7	442.7	447.7	452.7	457.6	462.6	467.6
Sidi Bouzid	183.8	189.2	190.8	192.3	194.1	196.3	197.3	198.3	201.4	203.3	205.2	207.1	209.0	210.9	212.8	214.7	216.6	218.5	220.4	222.3	224.3	226.2	228.1	230.0	231.9	233.8	235.7	237.6	239.5	241.4	243.3
Total	3165.2	3221.1	3278.5	3345.5	3397.3	3452.0	3507.6	3555.7	3619.2	3675.6	3732.1	3788.5	3845.0	3901.2	3957.7	4014.1	4070.4	4126.8	4183.2	4239.7	4296.2	4352.6	4409.0	4465.3	4521.7	4578.1	4634.5	4690.9	4747.3	4803.8	4860.2
Service Ratio in Sfax Governorate									85.9%	86.1%	86.3%	86.5%	86.7%	86.8%	87.0%	87.2%	87.3%	87.5%	87.6%	87.8%	87.9%	88.0%	88.2%	88.3%	88.5%	88.6%	88.7%	88.8%	89.0%	89.1%	89.2%
Service Ratio in 7 Governorates									82.9%	83.2%	83.5%	83.8%	84.1%	84.3%	84.6%	84.8%	85.1%	85.3%	85.6%	85.8%	86.0%	86.3%	86.5%	86.7%	86.9%	87.1%	87.3%	87.5%	87.7%	87.9%	88.1%

Note: Populations from 2013 to 2035 were projected by linear approximation method.

Source: 2005-2012; RAPPORT DES STATISTIQUES, SONEDE, 2013-2035; JICA Survey Team

4.4.2 Water Supply Plan in North Water Transmission System

In the Strategic Study, the scenario for the water supply to meet the demand until 2030 was studied. Treatment plants planned in the Strategic Study are as shown in Table 4.2-2. In the Survey, the JICA Survey Team confirmed SONEDE about implementation of those plants. As a result of discussion, SONEDE indicated the 1 year delayed schedule of the project for Saida reservoir and Kalaa Kebira reservoir & water treatment plant as shown in Table 4.4-10. SONEDE also intends to expedite the Project for Sfax Seawater Desalination Plant as soon as possible.

In this survey, the schedule presented by SONEDE is applied for the project for Saida reservoir and Kalaa Kebira reservoir & water treatment plant. Sfax Seawater Desalination Plant, however, is scheduled considering the required period of necessary procedures for JICA ODA loan for the project. After examination of the said schedule, which is discussed in Chapter 10 in detail, commissioning of the plat is expected in 2022. The period for Phase 1 is considered as the period when the capacity of first phase facility, 100,000 m^3/day, which is a half of final capacity, can meet the demand. After that, Phase 2 will be started.

Scope of work for JICA ODA loan is considered to be the Phase 1 facilities of the seawater desalination plant and its related facilities.

Table 4.4-10 Water Treatment Plant and Seawater Treatment Plant formulated in the Strategic Study

Name	Year	Production capacity	Supply to Greater Sfax
Saida reservoir & Kalaa Kebira reservoir / water treatment plant	2020	1,500 L/s (129,600 m^3/d)	-*
	2024	3,000 L/s (259,200 m^3/d)	-*
	2029	4,000 L/s (345,600 m^3/d)	-*
Sfax sea water desalination plant	2020	1,157 L/s (100,000 m^3/d)	1,157 L/s (100,000 m^3/d)
	2026	2,325 L/s (200,000 m^3/d)	2,325 L/s (200,000 m^3/d)

*: As a part of water of the North Water Transmission System, supplied water is mixed with the water supplied from existing water sources.

Source: SONEDE, 2014

Even though new water resources stated above are developed, upstream areas of the North water transmission system will be suffered after 2031 due to water shortage caused by increase of water demand. Because of this reason, additional water source with a capacity of 250,000 m^3/day will be required as shown in Figure 4.4-3. This new water source is required to be developed at the place close to large water demand area like the Souse Governorate to avoid transmission of big volume of water.

4.4.3 Review on Demand and Supply Plan in the Strategic Study

Water demand and supply were reviewed under the conditions stipulated in Sections 4.4.1 and 4.4.2. The results are presented in Tables 4.4-11 to 4.4-13, and Figures 4.4-2 and 4.4-3. In addition, calculation table

showing demand and supply analysis in seven governorates is presented in Table 4.4-14.

Table 4.4-11 Water Demand in Seven Governorates in North Water Transmission System

	2015	2020	2025	2030	2035
Population	4,469,600	4,731,500	4,993,700	5,255,700	5,517,800
Population Served	3,732,100	4,014,100	4,296,200	4,578,100	4,860,200
Per Capita Consumption (L/person/day)	103	114	127	143	161
Non Domestic Rate (%)	22	22	22	22	22
Average Non-Revenue Water (%)	23.7	23.0	22.4	21.8	22.0
Daily Average Demand (m^3/day)	581,400	687,700	816,700	971,000	1,161,100
Peak Factor (Daily Max/Daily Average)	1.303	1.291	1.305	1.305	1.305
Daily Maximum Demand (m^3/day)	757,800	887,500	1,065,700	1,267,400	1,515,600

*: Daily Max/Daily Average of 7 governorates x adjusting coefficient (0.944)
Source: JICA Survey Team

Table 4.4-12 Water Balance in Seven Governorates in North Water Transmission System (existing facilities only)

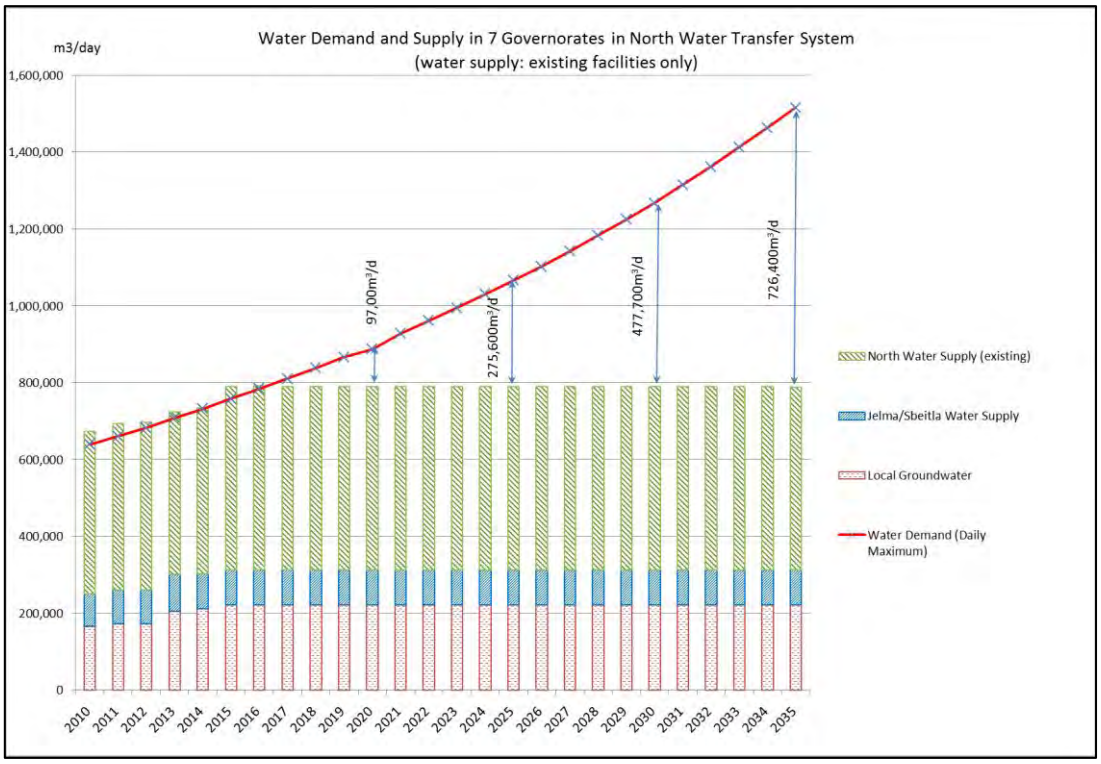
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	North Water Transmission	476,800	477,600	477,500	477,200	476,800	476,300
	Jelma-Sbeitla GW Transmission	91,600	91,600	91,600	91,600	91,600	91,600
	Local Groundwater	221,400	221,400	221,400	221,400	221,400	221,400
	Total	789,800	790,600	790,400	790,100	789,700	789,300
Daily Maximum Water Demand		757,800	887,500	961,800	1,065,700	1,267,400	1,515,600
Balance		31,900	▲97,000	▲171,400	▲275,600	▲477,700	▲726,400

Source: JICA Survey Team (Note: Due to rounding, (available volume-demand) is not equal to Balance.)

Table 4.4-13 Water Balance in Seven Governorates in North Water Transmission System (existing facilities + new facilities)

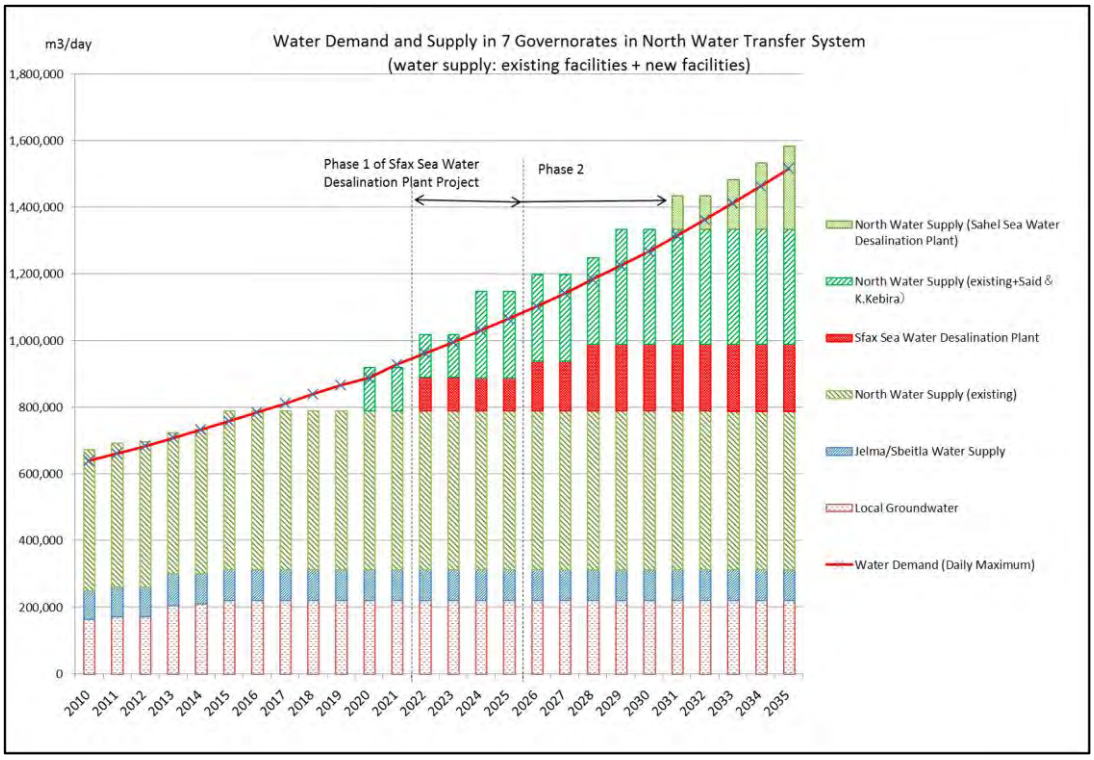
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	Sahel Desalination Plant	0	0	0	0	0	250,000
	Saida/Kalaa Kebira WTP	0	129,600	129,600	259,200	345,600	345,600
	Sfax Desalination Plant	0	0	100,000	100,000	200,000	200,000
	North Water Transmission	476,800	477,600	477,500	477,200	476,800	476,300
	Jelma-Sbeitla Groundwater Transmission	91,600	91,600	91,600	91,600	91,600	91,600
	Local Groundwater	221,400	221,400	221,400	221,400	221,400	221,400
	Total	789,700	920,200	1,020,000	1,149,300	1,335,300	1,584,900
Daily Maximum Water Demand		757,800	887,500	961,800	1,065,700	1,267,400	1,515,600
Balance		31,900	32,600	58,200	83,600	67,900	69,200

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4.4-2 Water Demand and Supply in Seven Governorates in North Water Transmission System (water supply: exiting facilities only)



Source: JICA Survey Team

Figure 4.4-3 Water Demand and Supply in Seven Governorates in North Water Transmission System (water supply: exiting facilities + new facilities)

Table 4.4-14 Water Demand and Supply in Seven Governorates in North Water Transmission System

(unit: L/sec.)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Nabeul																										
Belli Treatment Plant	4,268	4,398	4,398	4,398	4,398	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798	4,798
Local Resources +Tunis Unit	634	611	646	489	596	720	737	735	733	731	730	729	728	727	726	725	724	723	722	721	720	719	718	717	716	715
Total resources in Nabeul	4,902	5,009	5,044	4,887	4,994	5,518	5,535	5,533	5,531	5,529	5,528	5,527	5,526	5,525	5,524	5,523	5,522	5,521	5,520	5,519	5,518	5,517	5,516	5,515	5,514	5,513
Qpj	1,503	1,554	1,608	1,671	1,731	1,792	1,855	1,925	1,988	2,061	2,027	2,210	2,289	2,375	2,461	2,543	2,635	2,733	2,832	2,933	3,041	3,152	3,263	3,387	3,507	3,631
Balance of Nabeul	3,399	3,455	3,436	3,216	3,263	3,726	3,680	3,608	3,543	3,468	3,501	3,317	3,237	3,150	3,063	2,980	2,887	2,788	2,688	2,586	2,477	2,365	2,253	2,128	2,007	1,882
Kairouan																										
Local resources in Kairouan	1,085	1,085	1,085	1,091	1,091	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119	1,119
Qpj	396	406	412	428	441	453	460	469	479	485	495	511	523	536	555	564	577	590	602	615	628	653	666	691	704	729
Balance of Kairouan	689	679	673	663	650	666	659	650	640	634	624	608	596	583	564	555	542	529	517	504	491	466	453	428	415	390
Sahel (Sousse+Monastir+Mahdia)																										
Local Resources of Sahel	528	614	614	794	866	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952	952
Saida/K.Kebira Reservoirs+WTP （1500L/s + 1500L/s + 1000L/s)											1,500	1,500	1,500	1,500	3,000	3,000	3,000	3,000	3,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sahel Desalination Plant （100,000 m3/d+50,000m3/d+50,000m3/d+50,000m3/d)																						1,157	1,157	1,736	2,315	2,894
Arrival from Kairouan	689	679	673	663	650	666	659	650	640	634	624	608	596	583	564	555	542	529	517	504	491	466	453	428	415	390
Arrival from Northern Water	3,399	3,455	3,436	3,216	3,263	3,726	3,680	3,608	3,543	3,468	3,501	3,317	3,237	3,150	3,063	2,980	2,887	2,788	2,688	2,586	2,477	2,365	2,253	2,128	2,007	1,882
Total resources	4,616	4,748	4,723	4,673	4,779	5,344	5,291	5,210	5,135	5,054	6,577	6,377	6,285	6,185	7,579	7,487	7,381	7,269	7,157	8,042	7,920	8,940	8,815	9,244	9,689	10,118
Qpj in Sousse	1,398	1,436	1,481	1,522	1,570	1,617	1,668	1,719	1,773	1,817	1,874	1,931	1,991	2,052	2,115	2,175	2,239	2,308	2,381	2,448	2,521	2,597	2,676	2,756	2,835	2,917
Qpj in Monastir	1,161	1,189	1,227	1,272	1,310	1,348	1,392	1,430	1,475	1,519	1,570	1,620	1,671	1,722	1,776	1,830	1,893	1,944	2,010	2,074	2,137	2,201	2,270	2,337	2,413	2,483
Qpj in Mahdia	786	824	866	910	954	1,002	1,050	1,104	1,157	1,214	1,275	1,338	1,408	1,475	1,554	1,633	1,709	1,795	1,890	1,985	2,087	2,191	2,302	2,423	2,543	2,670
Total Qpj in Sahel	3,345	3,449	3,574	3,704	3,834	3,967	4,110	4,253	4,405	4,550	4,719	4,889	5,070	5,249	5,445	5,638	5,841	6,047	6,281	6,507	6,745	6,989	7,248	7,516	7,791	8,070
Balance of Sahel	1,271	1,299	1,149	969	945	1,377	1,181	957	730	504	1,858	1,488	1,215	936	2,134	1,849	1,540	1,222	876	1,535	1,175	1,951	1,567	1,728	1,898	2,048
Sidi Bouzid																										
Local resources in Sidi Bouzid	977	1,019	1,019	1,115	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
Qpj	219	225	231	244	251	263	273	285	295	304	317	323	342	349	368	381	387	409	428	441	453	479	492	517	536	558
Balance of Sidi Bouzid	758	794	788	871	809	797	787	775	765	756	743	737	718	711	692	679	673	651	632	619	607	581	568	543	524	502
Sfax																										
Local Resources of Sfax	301	301	301	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491
Sfax Desalination Plant Ph1/2 (100,000+100,000 m3/d)													1,157	1,157	1,157	1,157	1,736	1,736	2,315	2,315	2,315	2,315	2,315	2,315	2,315	2,315
Arrival from Northern Water	1,271	1,299	1,149	969	945	1,377	1,181	957	730	504	1,858	1,488	1,215	936	2,134	1,849	1,540	1,222	876	1,535	1,175	1,951	1,567	1,728	1,898	2,048
Arrival from Sbeitla-Jelma	758	794	788	871	809	797	787	775	765	756	743	737	718	711	692	679	673	651	632	619	607	581	568	543	524	502
Total resources in Sfax	2,330	2,394	2,238	2,331	2,245	2,665	2,459	2,223	1,986	1,751	3,092	2,716	3,581	3,295	4,474	4,176	4,440	4,100	4,314	4,960	4,588	5,338	4,941	5,077	5,228	5,355
Qpj	1,937	2,007	2,074	2,147	2,217	2,296	2,378	2,451	2,540	2,622	2,714	2,806	2,908	3,003	3,104	3,209	3,323	3,437	3,555	3,678	3,802	3,945	4,094	4,240	4,395	4,554
Balance of Sfax	393	387	164	184	28	369	81	-228	-554	-871	378	-90	673	292	1,370	967	1,117	663	759	1,282	786	1,393	847	837	833	801
Total																										
Existing Resources	7,793	8,028	8,063	8,378	8,502	9,140	9,157	9,155	9,153	9,151	9,150	9,149	9,148	9,147	9,146	9,145	9,144	9,143	9,142	9,141	9,140	9,139	9,138	9,137	9,136	9,135
Saida/K.Kebira Reservoirs+WTP	0	0	0	0	0	0	0	0	0	0	1,500	1,500	1,500	1,500	3,000	3,000	3,000	3,000	3,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Desalination (Sfax+Sahel)	0	0	0	0	0	0	0	0	0	0	0	0	1,157	1,157	1,157	1,157	1,736	1,736	2,315	2,315	2,315	3,472	3,472	4,051	4,630	5,208
Total Resources	7,793	8,028	8,063	8,378	8,502	9,140	9,157	9,155	9,153	9,151	10,650	10,649	11,805	11,804	13,303	13,302	13,880	13,879	14,457	15,456	15,455	16,611	16,610	17,188	17,766	18,343
Total Qpj	7,400	7,641	7,899	8,194	8,474	8,771	9,076	9,383	9,707	10,022	10,272	10,739	11,132	11,512	11,933	12,335	12,763	13,216	13,698	14,174	14,669	15,218	15,763	16,351	16,933	17,542
Global Balance	393	387	164	184	28	369	81	-228	-554	-871	378	-90	673	292	1,370	967	1,117	663	759	1,282	786	1,393	847	837	833	801

Qpj: Daily Maximum Water Demand

Source: JICA Survey Team

Water demand shown in Figures 4.4-2 and 4.4-3 is prepared based on Table 4.4-8. The average unit water demand was discussed with the Greater Sfax and the other countries in Section 4.6.2.

Figure 4.4-2 indicates water balance of the demand and the supply in North Water Transmission System in case new facilities or new water sources development formulated by the Strategic Study are not implemented. Water supply for the existing facilities is estimated with the maximum conveyance amount. Under this condition, a large amount of water shortage is confirmed. The shortage will be at an amount of 97,000 m^3/d in 2020, 275,600 m^3/d in 2025, 477,700 m^3/d in 2030, and 726,400 m^3/d in 2035, respectively.

Figure 4.4-3 indicates the balance in case the new facilities, or new water sources development formulated by the Strategic Study are implemented. As a result, there is an excess amount of water supply at 32,600 m^3/d in 2030. Water shortage, however, occurs after 2031. In 2035, a target year of this project, the shortage is estimated at 180,800 m^3/d. In order to avoid this shortage, SONEDE has a scheme to provide a sea water desalination plant in Sahel in addition to the facilities planned in the Strategic Study. In Figure 4.4-3, the production of this plant is added to the supply after 2031.

4.4.4 Issue on Water Supply Plan in North Water Transmission System

(1) Issue on construction of Saida Reservoir and Sahel Reservoir (Kalaa Kebira Reservoir)

In the study of the MOA conducted by a Russian consultant, SELKHOZ PROMEX POEKT, Saida Reservoir was planned to be constructed in nationally-owned land in 1999. However, the MOA has postponed the construction of the reservoir due to some financial issue and the order of among the other projects.

A reservoir and water treatment plant in Sahel were planned under the study "Etude pour L'execution D'une Retenue D'eau Brute Dans la Region de Sahel (Study for Execution of Raw Water Holding in Sahel Region)" in 2010. The facilities are planned to be located in Kalaa Kebira.

Regarding the construction of the Saida Reservoir and Sahel Reservoir (Kalaa Kebira Reservoir), SONEDE explained the outline and the expected commencement of the operation from 2019 at the international donor conference in February 2014 held in Marseille, Spain in order to obtain a support from FADES.

In a discussion with the JICA Survey Team, SONEDE explained the proposed commencement of the operation at Saida Reservoir and Kalaa Kebira Reservoir and Water Treatment Plant in 2020. FADES expressed the concurrence in principle to the MOA and SONEDE for extending the loan following the schedule.

(2) Issue on construction of a sea water desalination plant in Greater Sfax

According to the Strategic Study, Sfax sea water desalination plant and Kalaa Kebira Reservoir was planned for the construction / completion by 2018 and 2019, respectively. However, in case SONEDE utilizes the JICA ODA loan for the desalination plant works, it is very difficult to start the operation of the plant in 2018 because of the administrative procedures of the loan arrangement. The earliest time for its

operation is October 2022. As a result, the water shortage will occur between 2017 and 2022. The issue on this shortage is discussed in Section 4.4.

Issue on water shortage after 2031

As presented in Figure 4.4-3, the water demand can be satisfied by an additional facility of the sea water desalination plant in Sahel after 2032. Water source using sea water is the most applicable in increasing the supply. Therefore, it is considered that the new scheme for the construction of sea water desalination plant is appropriate.

SONEDE plans the location of the new plant in or near Sousse, where big water demand exists. The facilities, however, formulated by the Strategic Study will be constructed first. Then, the officials in Tunisia need to discuss the official plan for new plant after reviewing the demand.

4.5 Water Demand and Supply in Sfax Governorate

4.5.1 Water Demand and Supply in Sfax Governorate

Water in the Sfax Governorate is supplied from a part of North Water Transmission System. The water sources and the water treatment plants are explained in Section 4.4.2.

The large amount of water is conveyed to the Sfax Governorate by the North Water Transmission System and the Jelma-Sbeitla Groundwater Transmission System. However, it is projected that there will be an increase of consumption in the regions upstream of the Sfax Governorate. As a result, the supply amount to the Sfax Governorate is projected to decrease. Furthermore, it is expected that no water, presently being conveyed by the North Water Transmission System, may reach the Sfax Governorate during summer, the peak consumption period due to water demand increase in the upstream areas.

Water demand and supply were reviewed under the conditions stipulated. In this calculation, the peak adjustment factor which was applied for water demand projection for whole seven governorates is not applied to the Sfax Governorate. The results are presented in Tables 4.5-1 to 4.5-3, and Figures 4.5-1 and 4.5-2.

Table 4.5-1 Water Demand in Sfax Governorate

	2015	2020	2025	2030	2035
Population	999,500	1,062,000	1,124,600	1,187,100	1,249,600
Population Served	862,600	925,600	988,600	1,051,600	1,114,700
Per Capita Consumption (L/person/day)	126	140	156	176	199
Non Domestic Rate (%)	18	18	18	18	18
Average Non-Revenue Water (%)	23	22	21	20	20
Daily Average Demand (m^3/day)	158,100	186,800	220,800	261,600	313,400
Peak Factor (Daily Max/Daily Average)*	1.321	1.321	1.322	1.322	1.322
Daily Maximum Demand (m^3/day)	208,800	246,800	291,900	345,800	414,200

*: peak factor (1.4) x adjusting coefficient
Source: JICA Survey Team

Table 4.5-2 Water Balance in Sfax Governorate
(existing facilities only)

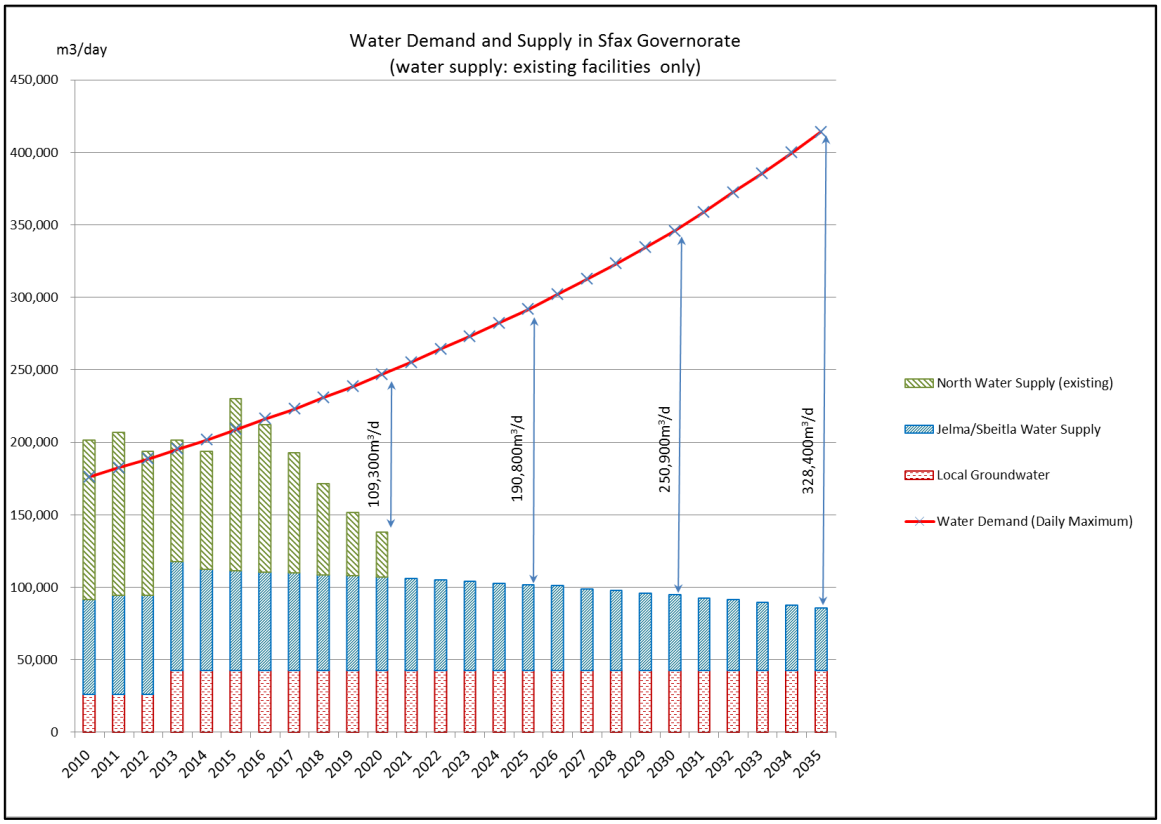
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	North Water Transmission	119,000	30,900	0	0	0	0
	Jelma-Sbeitla GW Transmission	68,900	64,200	62,000	58,700	52,400	43,400
	Local Groundwater	42,400	42,400	42,400	42,400	42,400	42,400
	Total	230,300	137,500	104,500	101,100	94,900	85,800
Daily Maximum Water Demand		208,800	246,800	264,500	291,900	345,800	414,200
Balance		21,400	▲109,300	▲160,000	▲190,800	▲250,900	▲328,400

Source: JICA Survey Team (Note: Due to rounding, (available volume-demand) is not equal to Balance.)

Table 4.5-3 Water Balance in Sfax Governorate
(existing facilities + new facilities)

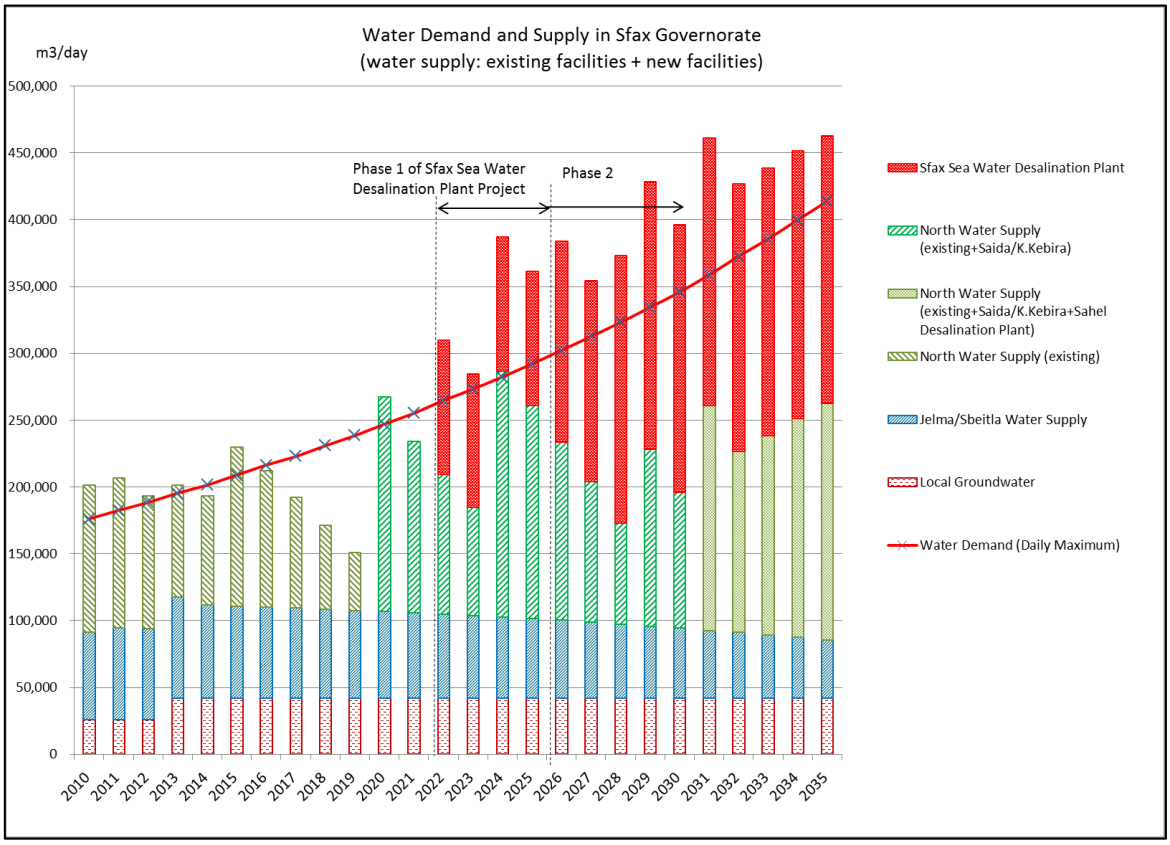
(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	Sfax Desalination Plant	0	0	100,000	100,000	200,000	200,000
	North Water Transmission	119,000	160,500	105,000	159,800	101,500	176,900
	Jelma-Sbeitla GW Transmission	68,900	64,200	62,000	58,700	52,400	43,400
	Local Groundwater	42,400	42,400	42,400	42,400	42,400	42,400
	Total	230,300	267,100	309,400	360,800	396,400	462,700
Daily Maximum Water Demand		208,800	246,800	264,500	291,900	345,800	414,200
Balance		21,400	20,300	45,000	69,000	50,600	48,500

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4.5-1 Water Demand and Supply in Sfax Governorate
(water supply: existing facilities only)



Source: JICA Survey Team

Figure 4.5-2 Water Demand and Supply in Sfax Governorate (water supply: existing facilities + new facilities)

Figure 4.5-1 indicates the water balance of demand and supply in the Sfax Governorate in case new facilities or new water sources development formulated by the Strategic Study will not be implemented. Water supply for the existing facilities is estimated with the maximum conveyance amount. Under this condition, a large amount of water shortage is confirmed. The shortage will be at 109,300 m^3/d in 2020, 190,800 m^3/d in 2025, 250,900 m^3/d in 2030, and 328,400 m^3/d in 2035, respectively.

Figure 4.5-2 indicates the water balance in case the new facilities or new water sources development formulated by the Strategic Study will be implemented. As a result, water supply amount satisfies the demand by the new facilities. However, as mentioned in Section 4.4.4(2), shortage will still occur from 2017 to 2019. The issue during this period is discussed in Section 4.7

Large variation of water supply volume from the North Water Transmission System is the result of the balance between yearly water demand increasing and water supply being increased through three times expansion of the Kalaa Kebira Water Treatment Plant. In addition, operation of the Sahel Seawater Desalination Plant will start from 2031.

4.5.2 Issue on Water Supply in Sfax Governorate

The issue on water supply plan in the Sfax Governorate is similar to the one in the Greater Sfax (see Section 4.6.3).

4.6 Water Demand and Supply in Greater Sfax

4.6.1 Present Water Supply System in Greater Sfax

The water facilities in the Greater Sfax were constructed for supplying water only to Sfax Ville in 1956, the year Tunisia gained independence. Every year thereafter, the service area has been expanded to the outer area of Sfax Ville. At the beginning, the water source was the groundwater in Sidi Bouzid which was relatively of good quality and with abundant flow. The groundwater was transmitted to two reservoirs of PK11 and PK10, then to Sfax Ville. Together with an expansion of the city, water supply was expanded and had to be supplied to higher altitude where newly developed residential areas sprung. Due to that reason, new expansion plan of water supply was formulated.

According to the "Plan of Distribution Networks and Distribution in Greater Sfax" prepared from 2003 to 2005, water was supplied from five reservoirs such as PK11, PK10, PK14, Bou Merra, and Sidi Salah EH (see Figure 4.6-1). The facilities were developed by following the Plan such as the expansion of Sidi Salah EH Reservoir and land acquisition for Sidi Salah EB Reservoir. Currently the Sidi Salah EB Reservoir is being constructed.

Figure 4.6-1 presents the existing distribution network. The expansion of distribution network is implemented in accordance with the "Plan of Distribution Networks and Distribution in Greater Sfax". The expansion is delayed as compared to the plan. At present, Lot 1 and 2 indicated in Figure 4.6-1 are being implemented. For rehabilitation of the existing pipes, there is no effective plan at this moment. One of the major reasons is that the rehabilitation is not considered as a serious issue is because the network performance rate is as high as 84% (see Table 4.6-1).

The Greater Sfax is poor in terms of water resources. It avoids having to deal with water shortages by optimally operating a system that transmits / supplies excess water to an area that has an impending shortage.

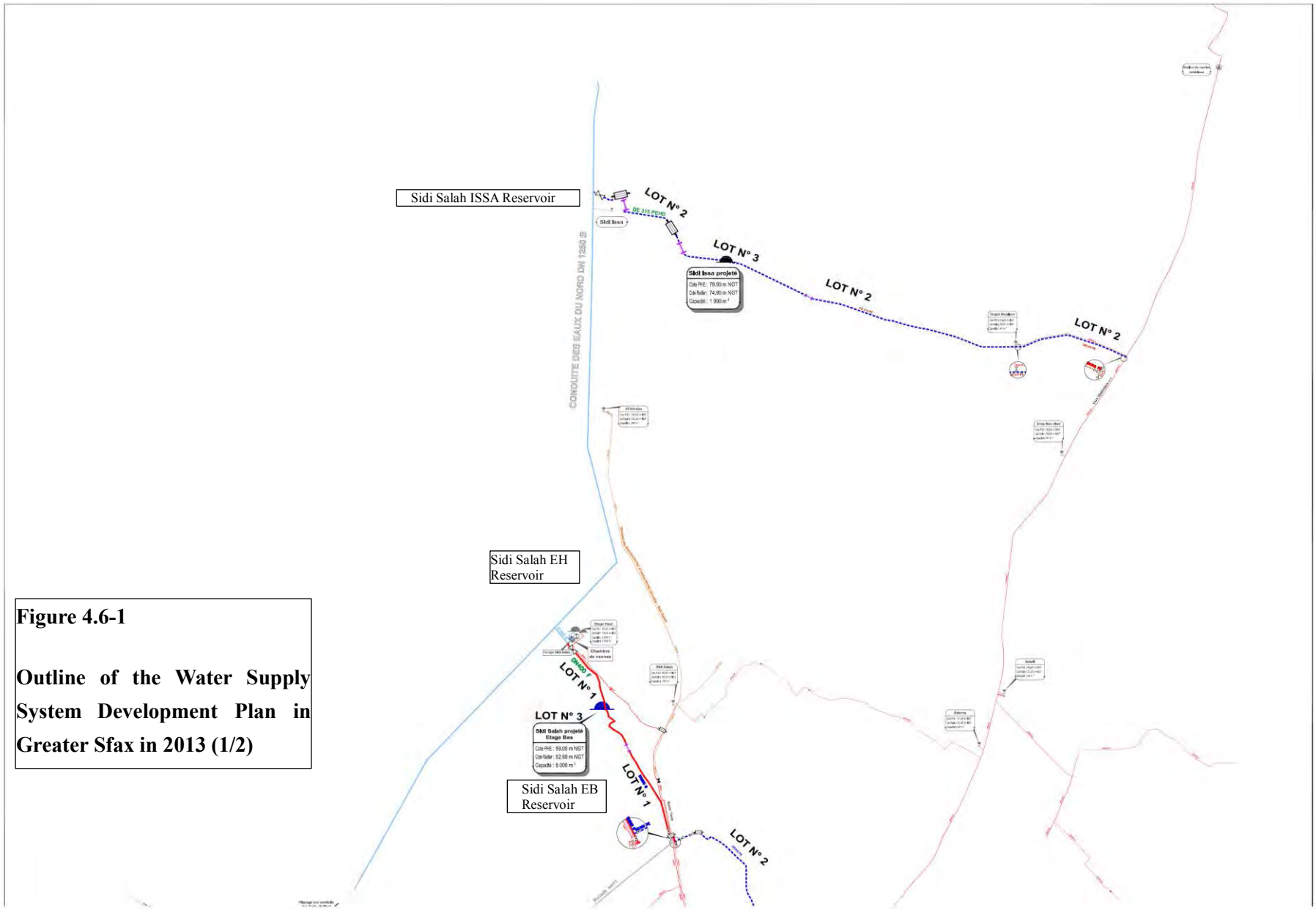


Figure 4.6-1

Outline of the Water Supply System Development Plan in Greater Sfax in 2013 (1/2)

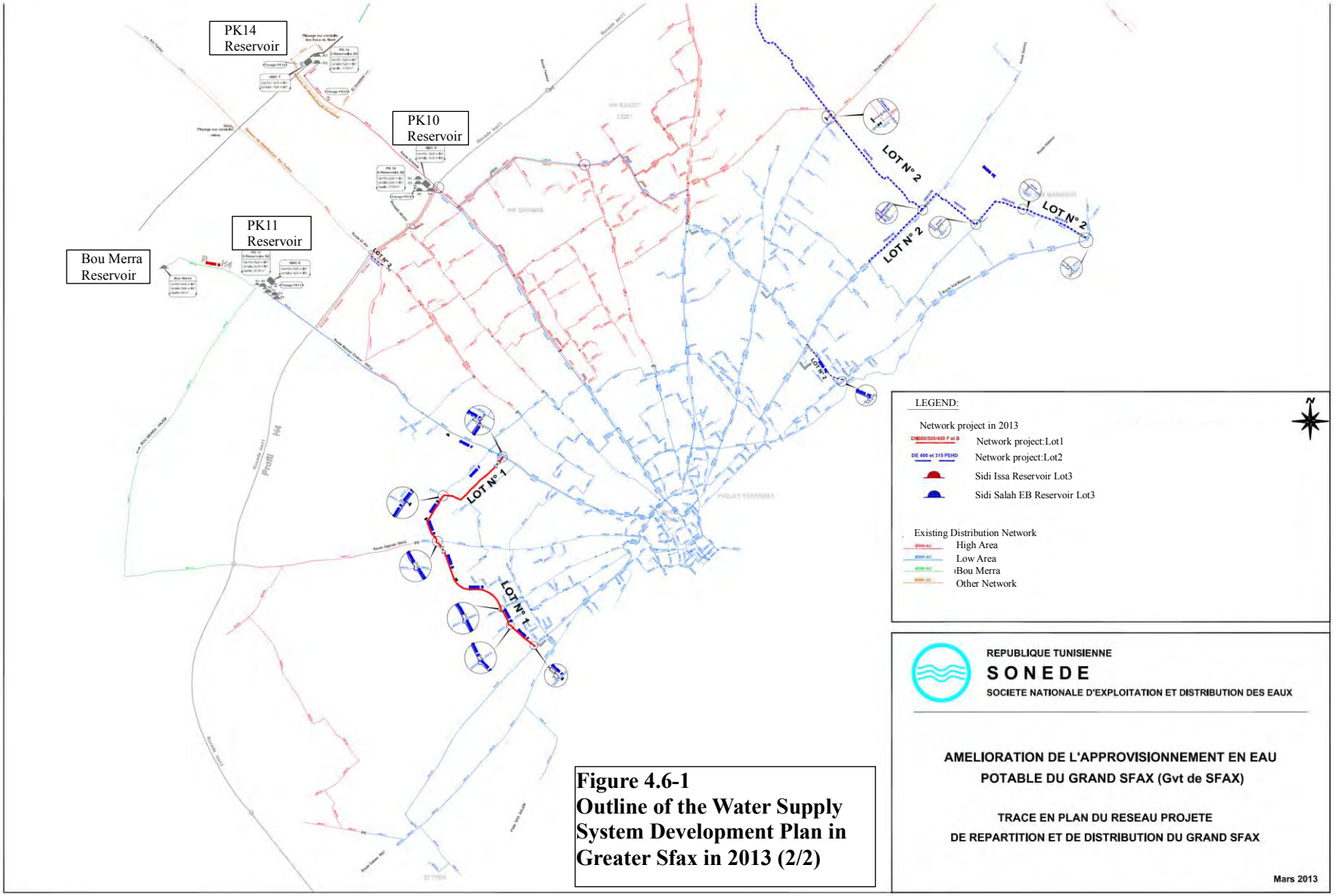


Figure 4.6-1
Outline of the Water Supply System Development Plan in Greater Sfax in 2013 (2/2)

Source: SONEDE

As shown on Table 4.6-1, more than half of the total length of distribution pipes in the Greater Sfax is occupied by asbestos cement pipe. Old pipes with more than 40 years age make up around 20% of total pipe length. Recent increasing tendency of breakage and leakage implies deterioration of said pipes. It is necessary to promote the replacement of old pipes, especially asbestos cement pipes.

Table 4.6-1 Present Status of Distribution Pipelines

Age and Materials of pipes as of September 2014														
Diameter (mm)	Length (m)	Ratio	Length by Age (m)						Length by Materials (m)					
			0-10 (yrs)	11-20 (yrs)	21-30 (yrs)	31-40 (yrs)	41-50 (yrs)	51yrs or more	Asbestos Cement	PE/PVC	Cast Iron	Ductile Cast Iron	Concrete	Others
60	11,000	0.6%					6,000	5,000	6,000			5,000		
63	18,000	0.9%	3,000	14,000	1,000					18,000				
75	0	0.0%												
80	430,000	21.8%		50,000	109,000	149,000	110,000	12,000	400,000			30,000		
90	149,000	7.6%	75,000	67,000	7,000					149,000				
100	376,000	19.1%		1,000	195,000	155,000	18,000	7,000	357,000			19,000		
110	345,400	17.5%	101,000	67,000	4,700	172,700				345,400				
150	154,587	7.8%		22,187	32,000	40,000	59,000	1,400	81,187			73,400		
160	30,000	1.5%	10,000	14,000	6,000					30,000				
200	178,100	9.0%	40,800	14,400	15,000	42,300	47,500	18,100	100,800	59,200		18,100		
250	28,391	1.4%			17,000	5,391	6,000		22,391			6,000		
300	137,065	7.0%		3,565	36,700	50,500	26,300	20,000	115,265			21,800		
315	44,000	2.2%	36,000	6,000	2,000					44,000				
350	4,314	0.2%				1,314	3,000		1,314			3,000		
400	6,094	0.3%				1,694	4,400					6,094		
500	17,561	0.9%				12,000	5,561				5,561	7,300	4,700	
600	12,606	0.6%				5,500	7,106					5,500	7,106	
800	22,604	1.1%			1,000	3,000	18,604						22,604	
1000	5,240	0.3%				3,240	2,000						5,240	
1250	810	0.0%				810							810	
Total	1,970,772	100.0%	265,800	259,152	426,400	642,449	313,471	63,500	1,083,957	645,600	5,561	195,194	40,460	0
			13%	13%	22%	33%	16%	3%	55%	33%	0%	10%	2%	0%

Statistics breaks and leaks per year from 2002												
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Network Performance per year:	84.4	84.5	87.4	87.6	87.5	86.6	86.5	84.7	80.7	79.8	79.4	84.0
Number of breakages per year:	706	791	836	881	642	679	872	845	741	789	683	711
Number of leakages per year:	9,150	8,920	9,531	8,376	8,601	8,749	11,027	11,525	13,102	10,663	10,717	14,818

Source: SONEDE (2014)

4.6.2 Water Demand and Supply in Greater Sfax

Water demand in the Greater Sfax is estimated as the population ratio between the Sfax Governorate and the Greater Sfax. Because the distribution data was not obtained, the demand was estimated with data between 2010 and 2012.

The Greater Sfax, where 2/3 of population in the Sfax Governorate lives, is mainly an urbanized area in the Sfax Governorate. In the future, the population in the Governorate is expected to increase. Basically water supply in the Greater Sfax is estimated as per conditions mentioned in Section 4.5.2. However, there are some special conditions in the Greater Sfax to be noted as follows.

1) On the way to the Greater Sfax, some amount of water from North Water Transmission System is distributed to north of the Sfax Governorate. The remaining water is conveyed to the Greater Sfax.
2) On the way to the Greater Sfax, some amount of water from Jelma-Sbeitla Groundwater Transmission System in Sidi Bouzid Governorate, the west of the Sfax Governorate is distributed to the western part of the Sfax Governorate. The remaining water is conveyed to the Greater Sfax.
3) The Greater Sfax is the main urbanized area in the Sfax Governorate. However, the water is not supplied to the Greater Sfax with the highest priority. The concept on the equal treatment to the residents is applied.

Water demand and supply were reviewed with the condition mentioned above. The result is presented in in Tables 4.6-2 to 4-6-4, and Figures 4.6-2 and 4.6-3.

Table 4.6-2 Outline of Water Supply Plan in Greater Sfax

	Present (2012)	Yr 2025	Yr 2030	Yr 2035
1) Service Area	3,069 ha	3,069 ha	3,069 ha	3,069 ha
2) Population Served	631,900	737,900	782,100	826,300
3) Maximum Daily Water Supply	117,200 m^3/d 1,356 L/s	187,900 m^3/d 2,175 L/s	224,400 m^3/d 2,597 L/s	270,900 m^3/d 3,135 L/s
4) Average Daily Supply	83,700 m^3/d 969 L/s	134,200 m^3/d 1,553 L/s	160,300 m^3/d 1,855 L/s	193,500 m^3/d 2,240 L/s
5) Average Per Capita Supply	132 L/d/person	182 L/d/person	205 L/d/person	234 L/d/person
6) Non-domestic use (%)	18	18	18	18
7) Non-revenue Water (%)	24	22	21	20
8) Per Capita Consumption	91 L/d/person	126 L/d/person	144 L/d/person	165 L/d/person

Source: JICA Survey Team

Table 4.6-3 Water Balance in Greater Sfax (existing facilities only)

(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	North Water Transmission	95,200	24,700	0	0	0	0
	Jelma-Sbeitla GW Transmission	31,000	28,900	21,700	20,600	18,300	15,200
	Local Groundwater	25,100	26,100	26,100	26,100	26,100	26,100
	Total	151,400	78,700	46,800	45,700	43,500	40,300
Daily Maximum Water Demand		133,700	157,900	169,500	187,900	224,400	270,900
Balance		17,700	▲79,200	▲112,700	▲142,200	▲180,900	▲230,500

Source: JICA Survey Team

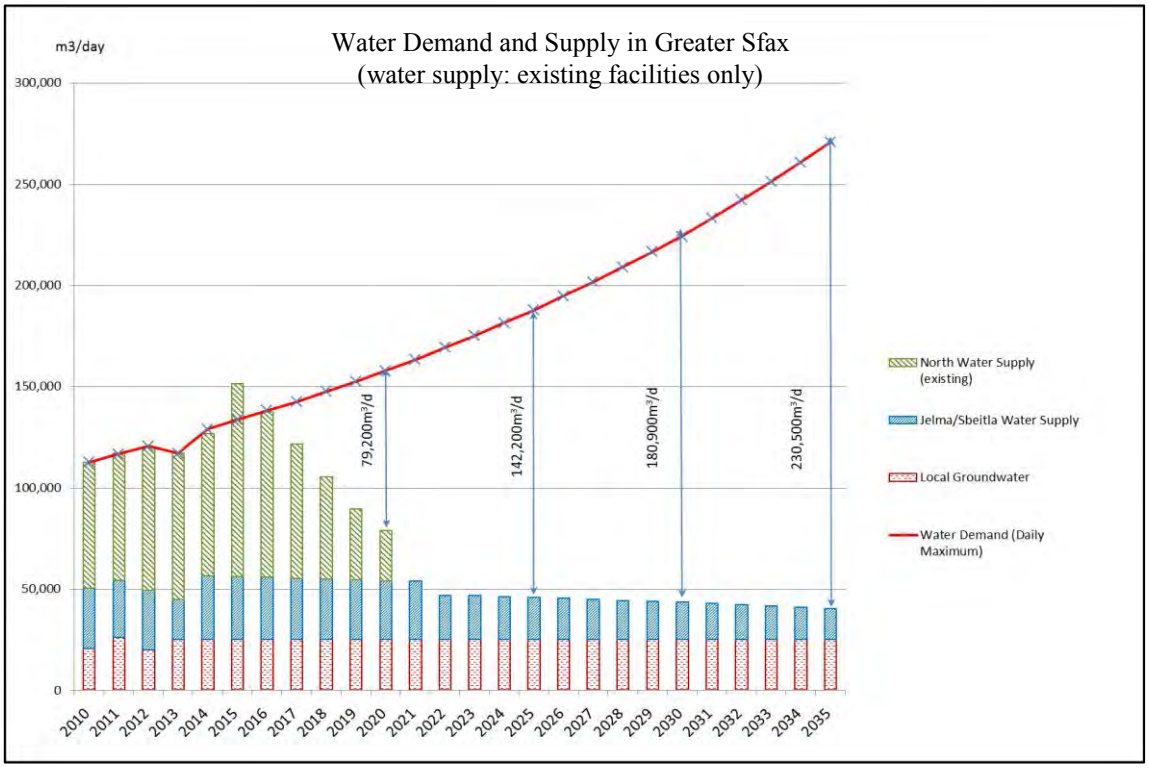
Table 4.6-4 Water Balance in Greater Sfax (existing facilities + new facilities)

(m^3/day)		2015	2020	2022	2025	2030	2035
Available Water	Sfax Desalination Plant	0	0	100,000	100,000	200,000	200,000
	North Water Transmission	95,200	128,400	65,100	75,100	29,500	67,200
	Jelma-Sbeitla GW Transmission	31,000	28,900	21,700	20,600	18,300	15,200
	Local Groundwater	25,100	26,100	26,100	26,100	26,100	26,100
	Total	151,400	182,400	211,900	220,800	272,900	307,600
Daily Maximum Water Demand		133,700	157,900	169,500	187,900	224,400	270,900
Balance		17,700	24,500	42,400	32,900	48,500	36,700

Source: JICA Survey Team

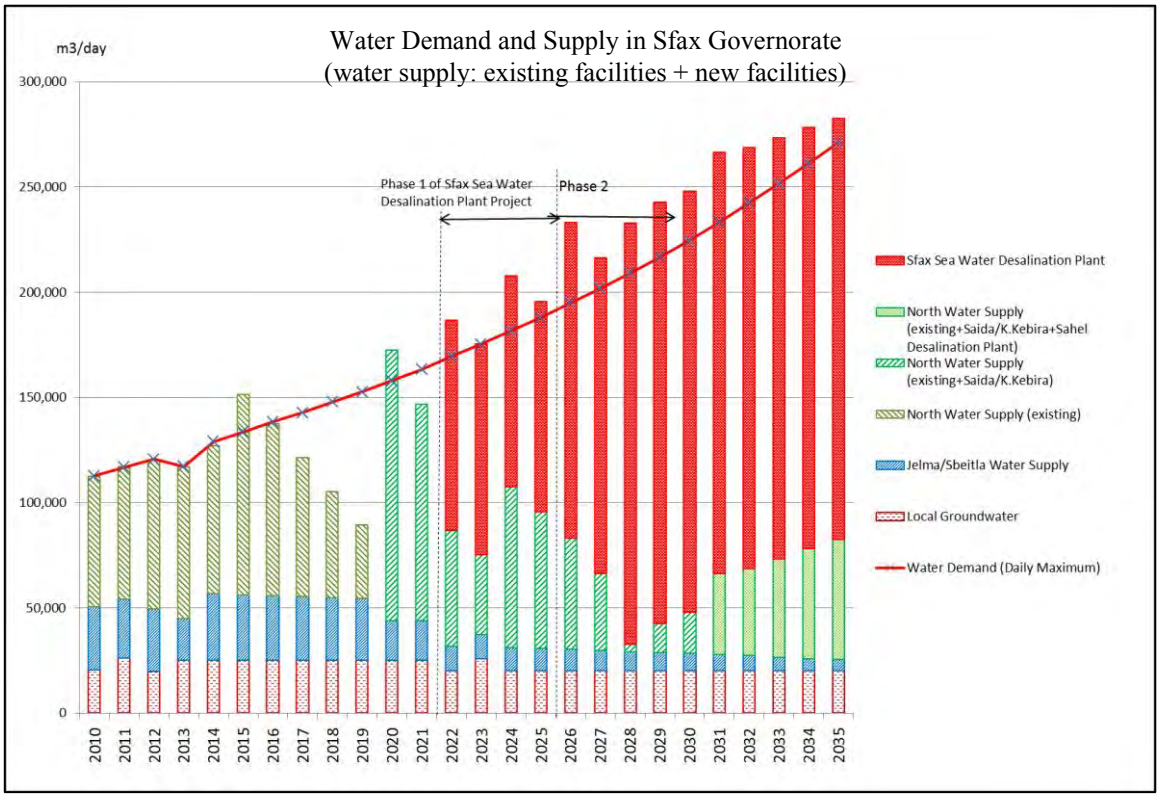
Figure 4.6-2 indicates water balance of demand and the supply in the Greater Sfax in case the new facilities or the development of new water sources formulated by the Strategic Study are not implemented. Water supply for the existing facilities is estimated under the maximum conveyance condition. Under this condition, a large amount of water shortage is confirmed. The shortage will be at an amount of 79,200 m^3/d in 2020, 142,200 m^3/d in 2025, 180,900 m^3/d in 2030, and 230,500 m^3/d in 2035, respectively.

Figure 4.6-3 indicates the balance in case the new water sources developments formulated by the Strategic Study are implemented. The water supply volume shown in Figure 4.6-3 was assumed with the conditions that water volume equivalent to half of pumpage in the Greater Sfax is reduced from water supply of the North water transmission system and the same from the Jelma-Sbeitla groundwater transmission system, As a result, water supply amount satisfies the demand by the new facilities. As mentioned in Section 4.4.4 (2), however, shortage will occur from 2017 to 2019. The issue on this water shortage is discussed in Section 4.7.



Source: JICA Survey Team

Figure 4.6-2 Water Demand and Supply in Greater Sfax (water supply: existing facilities only)



Source: JICA Survey Team

Figure 4.6-3 Water Demand and Supply in Greater Sfax (water supply: existing facilities + new facilities)

Appropriateness of water demand per capita shown on Table 4.6-2 was reviewed. As a result, the estimated value was considered to be appropriate as presented by the following reasons:

i) Served populations estimated for 2012 to 2035 show an increase of 1.3 times, while per capita water demand increases 1.8 times; i.e. 91 L/capita/day in 2012 to 165 L/capita/day in 2035. Though the increase rates are different, the estimated value of the water demand per person is considered to be appropriate because the improvement of the future living standard can be brought in by an increase in consumption.

ii) Regarding per capita consumption in 2035, the North Water Transmission System's seven governorates, the Sfax Governorate, and the Greater Sfax shows different figures. The ratio is 1.00 : 1.24 : 1.02. Table 4.6-5 presents the per capita consumption in 2012, and that of the Sfax Governorate is higher than that of seven governorates. It is appropriate because of relatively high income level of the Greater Sfax as the second largest city in Tunisia.

Table 4.6-5 Population of Seven Governorates and Per Capita Consumption (Daily Average) (2012)

	Population			SONEDE Service Population			Domestic	Total
	Urban (1000)	Rural (1000)	Total (1000)	Urban (1000)	Rural (1000)	Total (1000)	(lpcd)	(lpcd)
Nabeul	517.2	262.2	779.4	517.2	163.3	680.5	97	136
Ratio				*100.0%*	*62.3%*	*87.3%*		
Sousse	528.4	120.3	648.7	528.4	95.4	623.8	108	140
Ratio				*100.0%*	*79.3%*	*96.2%*		
Monastir	539.3	0.0	539.3	539.3	0.0	539.3	90	124
Ratio				*100.0%*	-	*100.0%*		
Mahdia	177.1	217.9	395.0	177.1	161.2	338.3	105	130
Ratio				*100.0%*	*74.0%*	*85.6%*		
Sfax	624.2	338.9	963.1	624.2	199.9	824.1	114	139
Ratio				*100.0%*	*59.0%*	*85.6%*		
Kairouan	192.0	377.4	569.4	192.0	159.3	351.3	69	82
Ratio				*100.0%*	*42.2%*	*61.7%*		
Sidi Bouzid	106.6	311.7	418.3	106.6	91.7	198.3	82	100
Ratio				*100.0%*	*29.4%*	*47.4%*		
Total	2,684.8	1,628.4	4,313.2	2,684.8	870.8	3,555.6	99	128
Ratio				*100.0%*	*53.5%*	*82.4%*		

Source: RAPPORT DES STATISTIQUES, SONEDE lpcd: Litre Per Capita Per Day

iii) Regarding per capita consumption in the Greater Sfax, however, is lower than that of Sfax governorate. The reason of this lower consumption seems to be many students in the Greater Sfax. Students consume rather lower water volume and they leave Sfax for long vacation.

iv) According to Table 4.6-6, water consumption in Tunisia is relatively not high compared to the other countries. It cannot be simply concluded that water consumption is proportional to GNI per capita. However, it is clear that the tendency between two values exists. In Tunisia, the water consumption per capita has been increasing and the trend can continue in the future, as the increase of the living standard goes hand in hand with an economic development. For these reasons, the estimated values of the water consumption are considered to be appropriate.

Table 4.6-6 Per Capita Water Demands in Various Countries

Region	Country	Year	Per Capita Annual Water Consumption (m^3/person/year)	**Per Capita Water Consumption (L/person/day)**	GNI (US$/person/yr)	Population (million)
Africa	Algeria	2000	38	103	1,540	35.42
	Egypt	2000	62	169	1,470	84.47
	Morocco	2000	39	107	1,320	32.38
	Tunisia	**2000**	36	**98**	2,310	**10.37**
North/Middle America	USA	2005	193	528	46,350	317.64
Asia	Afghanistan	2000	14	39	210	29.12
	Bangladesh	2008	25	70	560	141.82
	India	2010	46	126	1,290	1,214.46
	Iran	2004	85	232	2,170	75.08
	Israel	2004	97	265	18,790	7.29
	Japan	2000	137	375	37,150	127.00
	Malaysia	2000	54	149	3,420	27.91
	Oman	2003	45	125	8,610	2.91
	Pakistan	2008	52	143	990	184.75
	Philippine	2006	62	171	1,300	93.62
	Turkey	2003	78	**215**	3,810	75.71
Europe	France	2000	83	228	24,270	62.64
	Spain	2002	111	303	15,120	45.32

Source: Prepared by JICA Survey Team based on FAO data

4.6.3 Issues on Water Supply Plan in Greater Sfax

(1) Water supply sources in Greater Sfax

Water supply sources in the Greater Sfax are; surface water in the North Water Transmission System, and groundwater in Sidi Bouzid Governorate and in the Sfax Governorate. Detailed explanations of each source are as follows:

i) In the north of Tunisia, the surface water can be utilized from dam reservoirs by storing relatively high precipitation. After the treatment at Belli Water Treatment Plant, the water is transmitted by the North Water Transmission System from the north to seven Governorates located at the central and the south areas. The Greater Sfax is located at the lowermost area of the system. Therefore, the remaining water flows to the Greater Sfax after extracting the necessary water volume in the upper stream.

ii) Groundwater produced in Jelma and Sbeitla located in Sidi Bouzid Governorate does not contain a high concentration of salinity. The groundwater is consumed in Sidi Bouzid Governorate, then transmitted to the Greater Sfax.

iii) Groundwater in the Sfax Governorate is pumped up from deep wells owned by SONEDE. Because of fear of exhausting groundwater resource, extraction is with the special permission from the MOA. The issues are the limited amount of the extraction and a high content of salinity at around 3000 mg/L as TDS.

As stated in Sections 1.5 and 5.1.1, SONEDE has operated five brackish water desalination plants in the Gabes Governorate and the Medenine Governorate. There is no desalination plant in the Sfax

Governorate and northward except the one in Kerkenah Island.

(2) Issues on water shortage in Greater Sfax

The Greater Sfax suffered serious water shortage in summer 2012. The reasons of the shortage were; i) the functions of the transmission pumping station in the North Water Transmission System were stopped due to planned power cut for five times from July 9 to 11, 2012, ii) a decrease in water transmission volume in North Water Transmission System due to an increase in water demand in the upper stream, and iii) a decrease in water transmission volume from Sidi Bouzid Governorate due to drought. In order to avoid recurrence of such situation SONEDE and STEG agreed to exempt the transmission pumping station in the North Water Transmission System from planned power cut.

Currently SONEDE extracts groundwater at a limited rate in order to supply only the required amount. The Greater Sfax, however, is believed to have serious shortage after 2018 due to decreased water volume to be transmitted from the North Water Transmission System and the Jelma-Sbeitla Groundwater Transmission System.

(3) Water Supply

Figure 4.6-2 presents the water supply in Sfax Water Supply System. The water supplies from the North Water Transmission System and the Jelma-Sbeitla Groundwater System to the Greater Sfax are expected to decrease caused by an increase in water demand in upstream areas of the North Water Transmission System every summer after 2021. As a result, the Greater Sfax will not receive any water from the North Water Transmission System from the said period onward.

(4) Water balance of demand and supply

As shown in Figure 4.6-2, the Greater Sfax will have the water shortage of 79,200 m^3/d in 2020 if new water resources will not be developed. It is obvious that the shortage will increase without new water sources.

4.7 Appropriateness of Capacity and Location of Sfax Seawater Desalination Plant

4.7.1 Capacity of Facility

As formulated in Strategic Study, the water demand in the seven governorates can be fulfilled by the Kalaa Kebira Water Treatment Plant and the Sfax Seawater Desalination Plant.

As mentioned in Section 4.4.2, the capacity of the facilities is planned to be increased by phases. Capacity of the Kalaa Kebira Water Treatment Plant will be increased to 4,000L/sec or 345,600 m^3/day through phased development.

For the Sfax Seawater Desalination Plant, phased development was planned by in the Strategic Study. As a result of examination, it was found that augmentation of the plant with a capacity of 100,000 m^3/d will meet to the demand till 2026. Only in 2023, however, water shortage requires temporary excessive pumpage of groundwater. If the phase 2 project with a total capacity of 200,000 m^3/d is completed in 2026, water supply capacity will meet the water demand up to 2035 as presented in Figure 4.4-3, provided the Sahel desalination Plant will be completed in 2031. Therefore, total capacity of the Sfax Desalination

Plant shall be 200,000 m^3/d when the target year is set as 2035. In this survey it is assumed that the capacity of the plant to be augmented is 100,000 m^3/d. Required augmentation capacity of the plant, however, is 35,000 m^3/d in 2026, 50,000 m^3/d in 2027, and 80,000 m^3/d in 2028. Therefore, it is possible to construct the plant with further sub-phases. It shall be judged based on the increase of demand and water supply capacity in the future.

However, there is water shortage in the seven governorates in the North Water Transmission System, especially four governorates including Sousse and southward, if the Kalaa Kebira water treatment plant is not constructed. In that case, the construction of the Sfax Seawater Desalination Plant with a full capacity of 200,000 m^3/d in Phase 1 should be considered, but be constructed and operated at 100,000 m^3/d at first for the following reasons.

- The construction cost of sea water desalination plant at 200,000 m^3/d is relatively high.
- SONEDE does not have any operational experience for the sea water desalination plant. Therefore, it is more practical to obtain the O&M technique of the sea water desalination plant through a smaller capacity of 100,000 m^3/d. After obtaining the technique and experience, the facility can be expanded.
- If the construction of the Kalaa Kebira water treatment plant is delayed and operated until 2023, the water supply will exceed 100,000 m^3/d. As a result, the Sfax Seawater Desalination Plant will not be operated because the production cost of water is more expensive than the Kalaa Kebira water treatment plant. At present, it has potential for being over financed if the Sfax Seawater Desalination Plant at 200,000 m^3/d is constructed in Phase 1.

4.7.2 Appropriateness of Location

The Sfax Governorate is located in the most down stream's tail end of the North Water Transmission System and the Jelma-Sbeitla Groundwater System. As a result, the water supply volume in the Sfax Governorate affects the water demand in the upstream areas. If the water demand in the upper stream increases, the supply flow to the Sfax Governorate decreases. Therefore, it is relevant to install a sea water desalination plant in the Greater Sfax, a largest urban area in the Sfax Governorate.

4.7.3 Measures against Water Shortage

Sfax seawater desalination plant is planned commence operations from October 2022 (see Chapter 10). While, commissioning of the Kalaa Kebira water treatment plant is expected in 2020. Before its operation, the water shortage is expected in the Greater Sfax from 2017 to 2019. There is no fundamental solution against this water shortage. However, there are some mitigation measures as described in the following.

(1) Countermeasure by supplier

1) Reduction of NRW

SONEDE has been making effort continuously for reducing NRW. This continuous effort can still increase transmission and distribution amount of water. Although NRW in the Greater Sfax is not relatively high at 16% in 2013, it is possible to utilize the limited resource as much as possible with

continuous effort to reduce leakage.

2) Formulation of action plan on water shortage

Customer complaints due to water shortage will be more serious if the water supply is cut off for a number of hours without prior notice. For mitigating this aspect, Water Shortage Contingency Plan (WSCP) should be formulated. This plan shall consist of controlling water demand during the shortage and other necessary actions by SONEDE including a public information campaign to inform customers of strategies and actions to mitigate the negative impacts of the shortage. to national life, public property, industries, and tourism together with securing necessary public health. In general, WSCP will be prepared in stages.

Ex. Phased water demand reduction plan

This plan presents the countermeasures in four stages in a severity of the water shortage. The stages include various communication, internal operation, and demand control.

(i) Stage on advice: The customers shall be informed for the potential date when the shortage occurs.
(ii) Stage on self-action: When the water supply is not sufficient, the plan moves to the stage on self-action. In this stage, the mitigation amount until the target is dependent on voluntary cooperation by customers. The self-action by customers shall be proposed in this stage.
(iii) Stage on obligation: The plan moves to the stage on obligation if the stage on self-action does not achieve the target. The stage on obligation is to prohibit specific actions. Avoiding the difference in areas, the water stoppage shall be applied after the plan is disseminated.
(iv) Stage on emergency reduction: The stage on emergency reduction shall be applied with a combination of stage on obligation and the additional charge when the most serious situation occurs. This is the final stage, only applicable when severe shortage and emergency situation in facilities are observed.

3) Temporary use of groundwater

The further utilization of groundwater in the Greater Sfax is practically prohibited. If groundwater extraction is temporarily permitted for the five years between 2017 and 2021,water may contain high salinity. In order to utilize such water, the package type desalination plant will be required, which is explained below:

4) Installation of package-type sea water desalination plant

If the budget is available, it is proposed that a number of small package type sea water desalination plants are to be installed. In case this plant is installed, intake and discharge facilities shall be of temporary type because of emergency use. This type of the plant can be operated from place to place.

(2) Measures by customers

1) Public awareness program for water conservation

SONEDE has started the public awareness program directed to costumers in order to raise the water

savings by distributing water saving stickers. It is recommended that the activities by CM on TV and the initiatives with the other organization be conducted in order to transform awareness to action of water saving in national wide.

The water demand in the seven governorates in the North Water Transmission System will reach to 865,900 m^3/d in 2019. The shortage is 75,300 m^3/d. If the water supply in the area of the upper stream satisfies the consumption, the shortage in the region will be equal to the shortage in the Greater Sfax. On the other hand, if the water consumption in the seven governorates is reduced at 9% by the efforts on the saving, the shortage in the Greater Sfax will not occur. In addition, no serious water shortage will also occur if the water consumption in Tunis, a capital of Tunisia, is reduced. In order to achieve the reduction, it is suggested that the public awareness of water conservation in Tunis be conducted.

a) CM on TV

CM on TV introduces the reduction of shower time, washing dishes by using basins, and installation of water saving apparatus at a tap and a shower head.

b) Water volunteer groups

Volunteers have important roles in the regions. Water volunteer groups consisted of volunteers and students who shall visit household. After observing the actual water utilization, they will introduce the procedure of water savings. The activities of the group are explained as an example:

At first, SONEDE or local government establishes community-based water volunteer groups. The groups will cooperate with SONEDE or schools to promote water conservation methods through public awareness programs. As a next step, the groups shall educate households not only focusing the water conservation procedure but also on simple water consumption monitoring. If the water consumption is monitored, leakage or water utilization issue may be predicted by comparing actual water consumption to the average.

If leakage is observed at taps, the taps should be repaired immediately in order to reduce the loss. The water savings in daily life will be possible by carrying out by shortening shower time, recovery of rinse water from washing machine for utilization for toilet flushing or floor cleaning, reduction of toilet flush water.

2) Installation of water saving equipment

Water conservation devices stated below are effective to reduce daily water consumption.

- Water will be saved as much as 30 % if a small apparatus, made of O ring and mesh-type gauze, is inserted to a tap. This apparatus could contribute a significant water savings if household, schools, governmental buildings, and commercial buildings are installed. In 2010, 76,494 devices were provided by the environmental agency of Abu Dhabi government to tourist club area to reduce their

water consumption[4].

- In Japan, it is recommended to use a water saving packing, alias washer, at a tap. The bottom part of the packing is bigger than that of normal packing as shown in Figure 4.7-1. This bottom shape of the packing enable reduction of water flow of a tap by 0 to 50% in middle-open condition.

Source: Waterworks Bureau, Tokyo

Figure 4.7-1 Water Saving Packing

[4] http://gulfnews.com/news/uae/environment/saving-75b-litres-of-water-using-a-dh7-device-1.677234

CHAPTER 5

STUDY ON SEAWATER DESALINATION PLANT

CHAPTER 5 STUDY ON SEAWATER DESALINATION PLANT

Non-Disclosure Information

CHAPTER 6

PLAN OF WATER SUPPLY FACILITIES

CHAPTER 6 PLAN OF WATER SUPPLY FACILITIES

Non-Disclosure Information

CHAPTER 7

ELECTRIC FACILITY PLAN

CHAPTER 7 ELECTRIC FACILITY PLAN

Non-Disclosure Information

CHAPTER 8

SOCIO-ENVIRONMENTAL CONSIDERATIONS

CHAPTER 8 SOCIO-ENVIRONMENTAL CONSIDERATIONS

8.1 Objectives of Socio-environmental Considerations

Socio-environmental considerations have been examined in accordance with the JICA guidelines issued in April 2010 (hereafter referred to as "JICA Guidelines") as well as from Tunisian legislation currently in force, with the following objectives:

1) Identify elements having negative impacts on the natural and social environment;
2) Suggest mitigation measures to be implemented;
3) Draft recommendations about tasks, schedules and staff needed to undertake the Environmental and Social Impact Studies to be implemented by the Tunisian Government through SONEDE.

8.2 Project Category

JICA classifies this project as falling into the B category from among the four categories stated below:

- A Category; includes projects likely to have a considerable impact on the environment and projects with complex, unprecedented or hard to assess impacts are classified in this category;
- B Category; includes projects with a limited impact on the environment that is specific to the site, that is irreversible but can be mitigated by adopting normal mitigation measures;
- C Category; includes projects with minimal negative impacts or no negative environmental impact;
- FI Category; includes sub-projects classified in the FI Category. These sub-projects will be selected once JICA funding is approved (or the project evaluation) and cannot be specified before approval, consequently, they may have an impact on the environment.

The following environment review was carried out in accordance with procedures required for the B Category projects. During the selection process, JICA classified the project in terms of possible environmental impact taking in consideration factors such as: (1) the project's sector and scope, (2) its foundation (3) the level of uncertainty in terms of possible environmental impact and (4) the environmental and social impact on the site suggested for the project.

The following criteria have been taken into account to confirm that the project belongs with the B Category:

1) For elements that may have an impact on the environment, the project does not involve;
   - The large scale involuntary displacement of people;
   - Large scale extraction of underground water;
   - Polders, soil restoration or large scale clearing operations;

- Large scale deforestation.

2) Sensitive areas that may be affected by the project do not include;

- Wetland areas of international importance (RAMSAR Convention)
- National parks

3) With respect to the natural environment:

- The project has no considerable and large scale impact on the marine environment and on *Posidonia oceanica*, a protected species within the framework of the Barcelona Convention.

4) With regard to cultural and historical heritage:

- The project has no considerable impact on the Thyna Roman archaeological site.

According to Tunisian regulations, the scope of this project requires the execution of an Environmental and Social Impact study. Presently, SONEDE is conducting the said study by hiring a local consultant.

8.3 Project Components and Main Impacts

The project components for Phase 1 are summarized in the following table:

Table 8.3-1 Project Components for Phase 1

Non-Disclosure Information

The project site stretches from the south of Sfax (Agareb) to the north-west as shown on the map below:

Figure 8.3–1 Project Location

The illustrated sections of the transmission pipeline, the intake and discharge pipes in the sea are shown in the following figure:

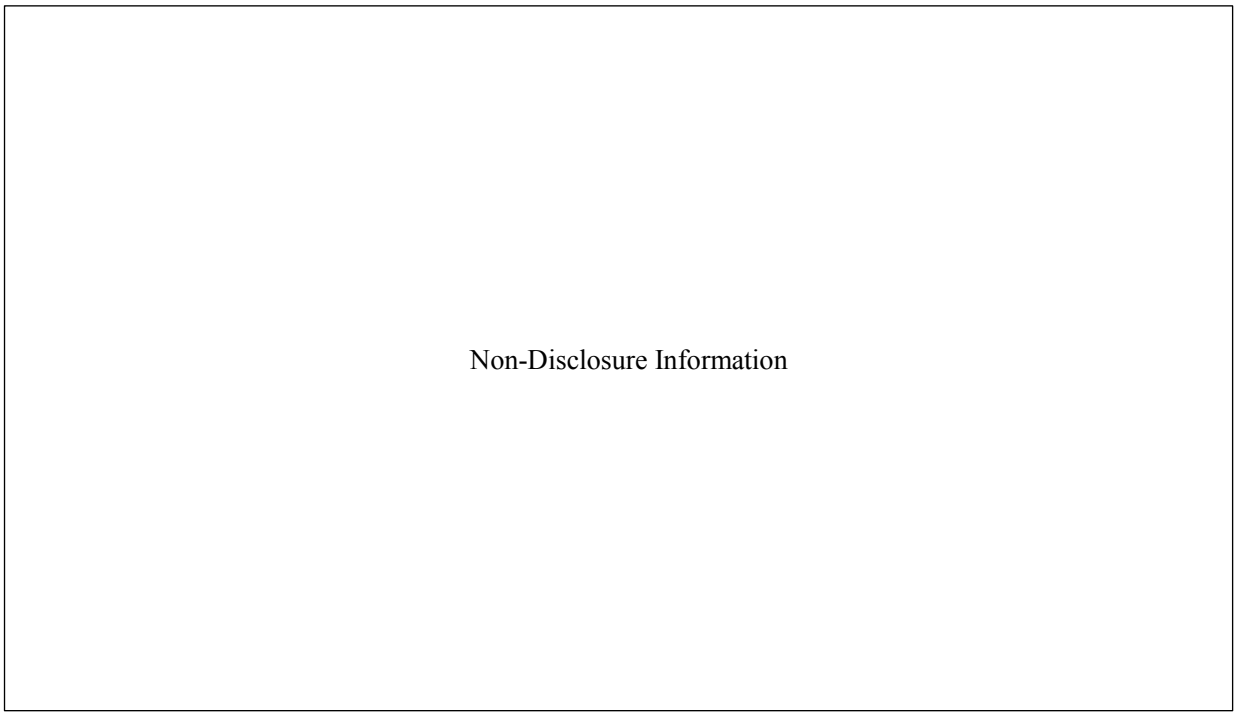


Figure 8.3–2 Illustrated Sections of Pipes (Upper: transmission, Lower: intake and discharge)

The location of intake and discharge pipes is shown on the plan below:

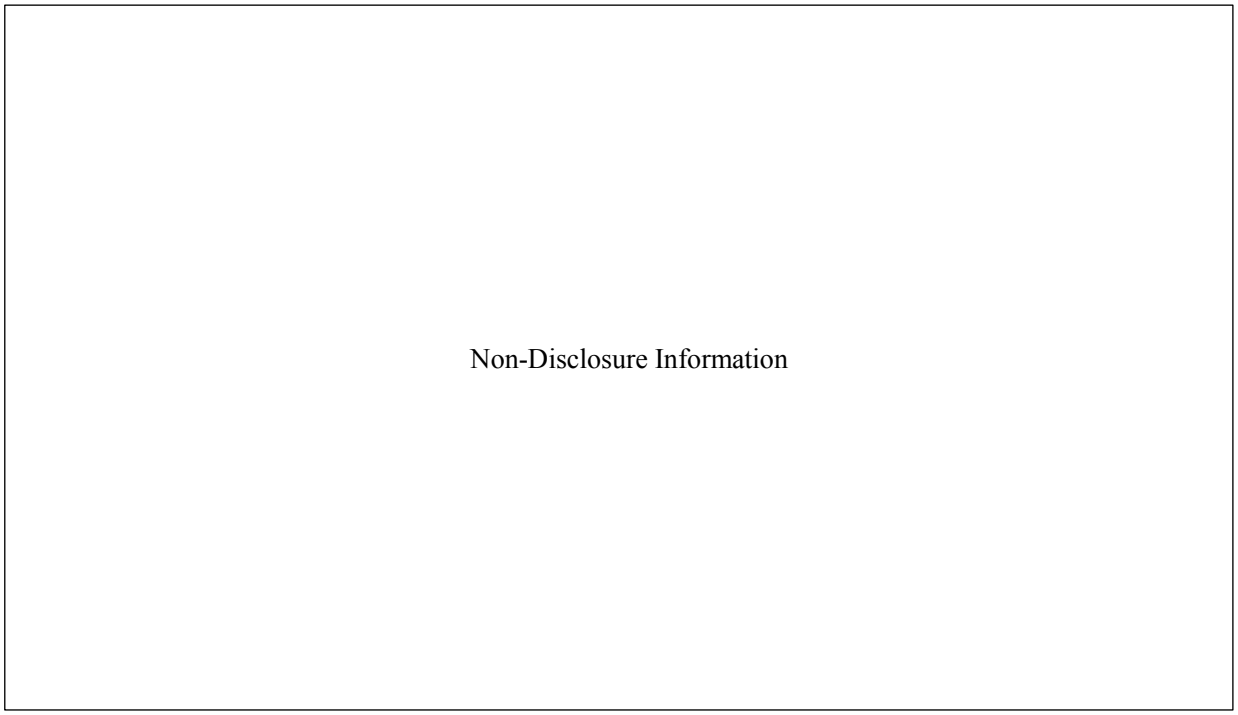
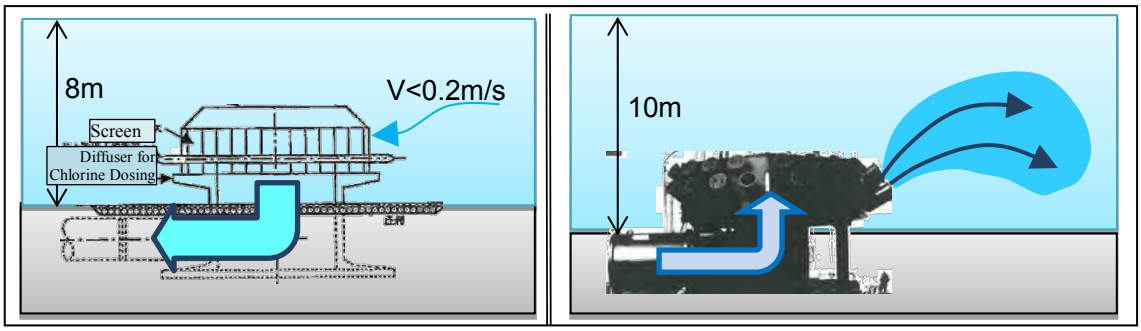


Figure 8.3–3 Plan of Intake and Discharge Pipes

Intake and discharge towers in the sea are shown below:



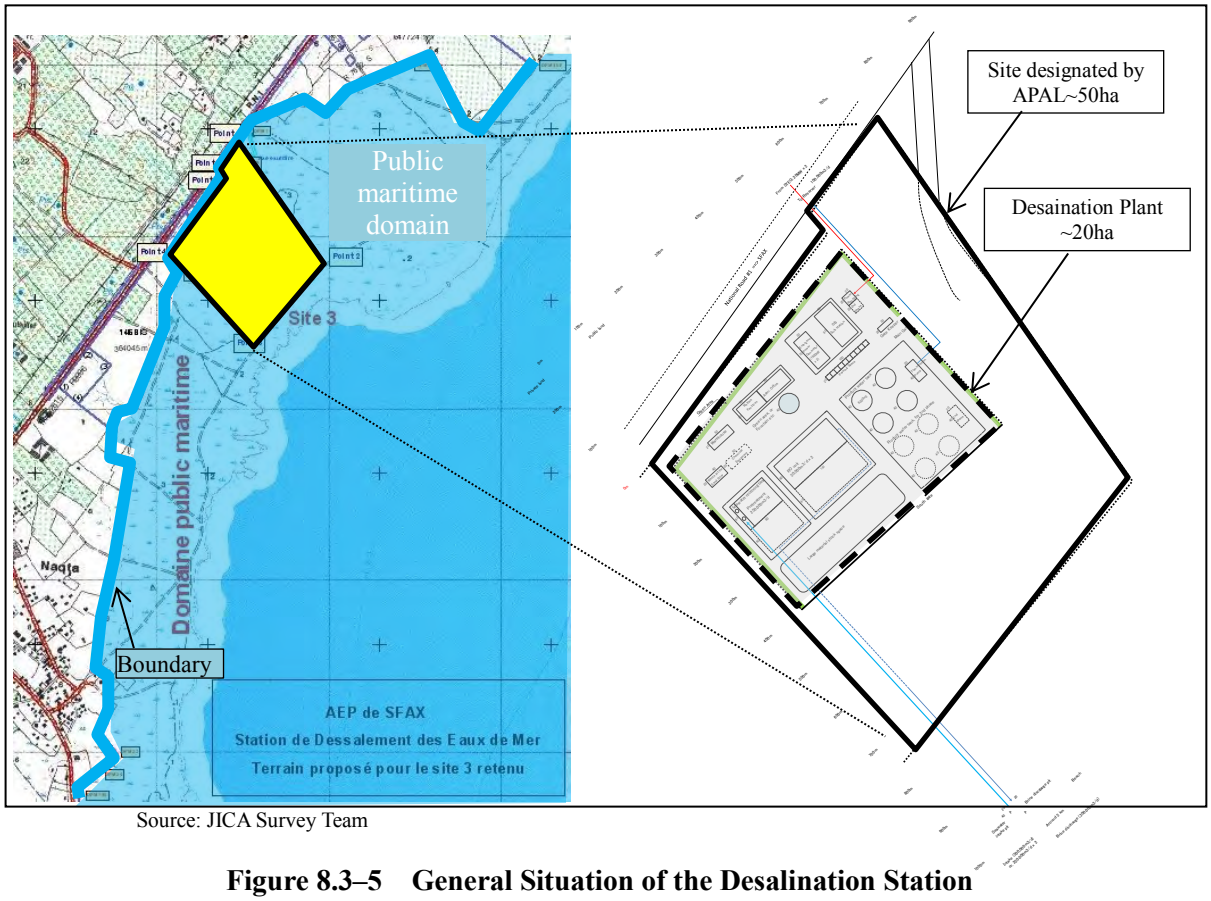
Source: Tokyo Kyuei

Figure 8.3–4 Intake and Discharge Towers in the Sea (image)

Based on sections shown above, it is possible to estimate excavated quantities：

- Onshore excavations (transmission)：((4+2)/2x2.5)m^2 ×45,000m → about 338,000m^3 （7.5=(4+2)/2×2.5）
- Offshore excavations (intake and discharge)：(34+10.2)/2x4)m^2 ×4,000m → about 354,000m^3 （110=(38+10.6)/2×4.5）

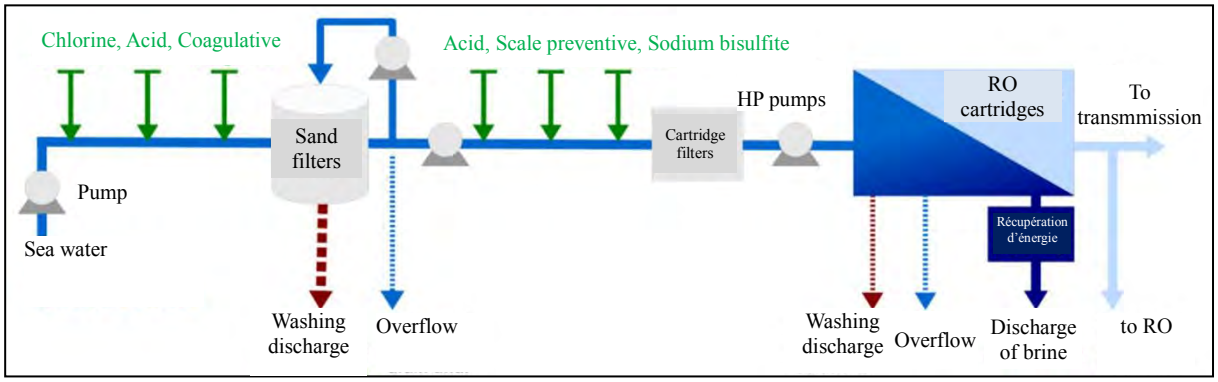
Installation of the desalination station is described in section 5.3. As shown in Figure 8.3-5, the desalination station is entirely located within the public maritime domain.



Source: JICA Survey Team

Figure 8.3–5 General Situation of the Desalination Station

This project uses reverse osmosis as the desalination technique as shown in the Figure 8.3-6:



Source : UNEP (United Nations Environment Program), Directives about desalination projects' impact studies

Figure 8.3–6 Reverse Osmosis Desalination Process (inputs in straight lines, discharges in dotted lines)

The consumption of chemicals will depend on the size of the desalination plant as well as the operating hours, sea water quality and the target water quality. The majority of the chemicals will be used for filtration and adjustment of pH.

The annual consumption of RO membranes also depends on the capacity of the station and its operating pace, but it is estimated that 20% of all membranes will be replaced every year. For example, in Phase 1, 8,624 RO unit×20% = 1,725 unit/year, which represents about 55 m^3/year in terms of volume and in Phase 2, 110 m^3/year. This product is generally considered to be waste that can be incinerated.

The power transmission line for the seawater desalination plant will be constructed, owned[1] and maintained by STEG. As stated in Chapter 7, a power supply of 40MW is planned from two lines of 150kV high-tension voltage line. In this case, it is assumed that about 40m high power transmission towers with a base of 8m x 8m will be constructed with average intervals of 400m. The actual route will be planned by STEG. Presently the route length is planned to be 15km and the required number of towers is about 40 (=15000/400).

Regarding components, the main impacts of the project are the following:

The project is being designed in order to respond to concerns related to water supply in Sfax. It is expected this project to have considerable positive impacts on the population in Sfax by improving the water supply system. In addition, this project will reduce environmental pressure by stabilizing and even reducing demands on existing resources (underground waters).

As the outline of the transmission pipeline and the location of reservoirs may be adjusted, there is no current plan to displace any population. As for the acquisition of lands, it will be very limited as most

[1] The transmission towers and power cable will be owned by STEG. Sites for transmission towers will be owned by SONEDE.

new structures will be built in the right of way areas of existing roads or within the sites of reservoirs, with the exception of some specific points of the transmission pipeline, sites for one-way surge tanks, i.e. 20m x 30m x 2 sites. As for the sites for the power transmission towers, which will be owned by SONEDE, STEG will select the transmission route such that it will be easy for land acquisition and with minimal social and environment disruptions. The sites for the transmission towers will be selected along the route.

The biggest portion of the transmission pipeline will be laid along the existing express road at a good distance from the roadway. Consequently, traffic will not necessarily be disturbed during construction. The entire area of the desalination station is located within the public maritime domain and no private lands will therefore need to be acquired. The intake and discharge structures will be entirely buried and their location will be officially beyond trawler fishing areas, which means that the project will not have any significant direct impact on fishing activities.

The connection rate to the drainage and sanitation system is high in Sfax. There is currently an ongoing project to renew and modernize the waste water processing station in Sfax. The possible impact of the additional 200,000 m^3/day on rivers (wadis) and the aquifer system is considered to be minimal.

Works for the transmission pipeline will be mainly conducted along the existing express road in an urban environment. Works will not concern any special environmental area or a culturally valuable site, which means that the project will have limited negative impacts on the natural land environment. Though it is not decided as yet, STEG is expected to select the power transmission route so that works have no negative impacts on the environment.

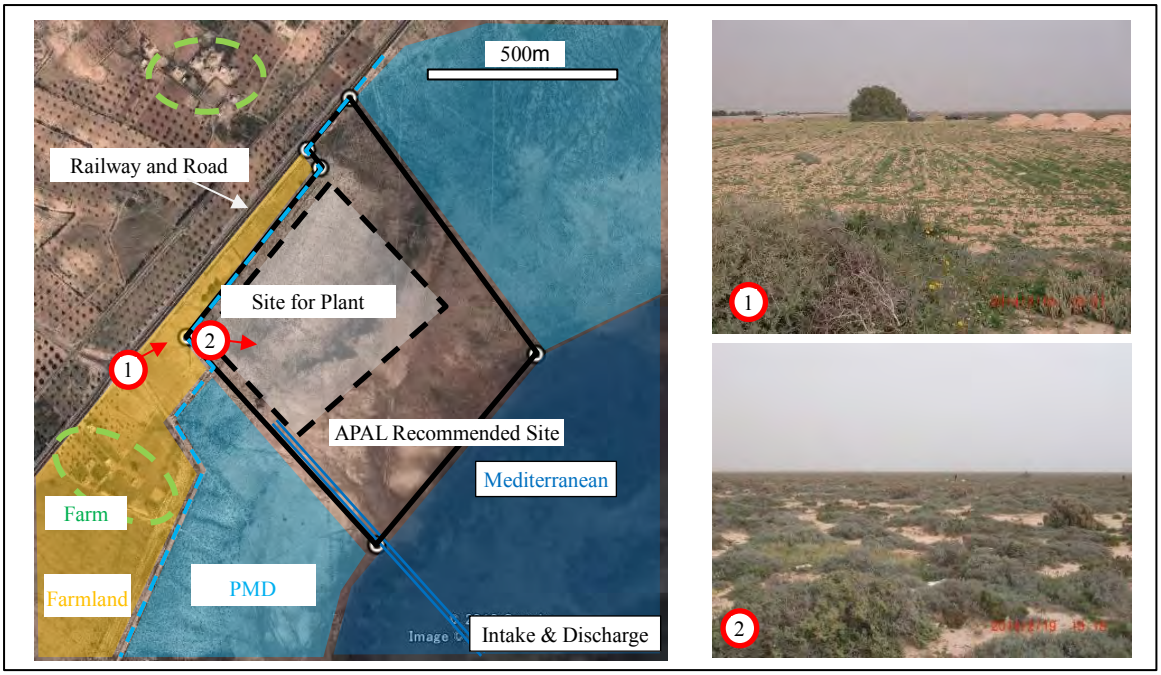
During construction activities, intake and discharge structures will have some impact on the marine environment (destruction of the marine ecosystem along the outline of pipes' layout), but as the pipes will be entirely buried, the existing systems will regenerate with time. Burying all pipes under the seabed also means that the project will have minimal or no adverse impacts on marine currents.

The intake and discharge towers are emerging structures above sea level but since their area is limited, their impact on the exiting marine currents is believed to be very minimal. The permanent impact of brine discharge (Phase 1: 122,222m^3/day, Phase 2: 244,444m^3/day) with high salinity (about TDS 73,000mg/L) will be quite considerable (high salinity is hazardous to marine grasses when TDS exceeds 50,000mg/L). However, the impact would be limited to the area around the discharge head. The area impacted by hazardous salinity resulting from brine discharge is estimated as stated in Section 8.8.

8.4 Natural and Social Environment of the Project Site

As shown in the image below, the desalination station will be built on coastal salty swamps. The entire area belongs to the public maritime domain bordered on the south east by a farming land, and on the west by the express road and the railways. According to satellite imagery, the closest housings are

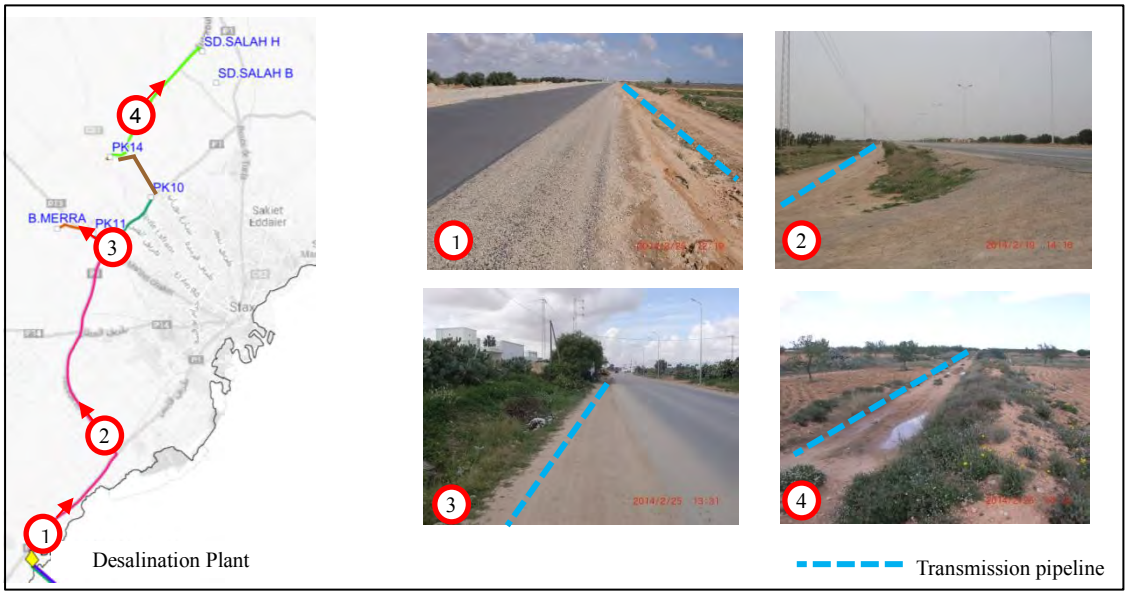
located about 250 m from the proposed project site.



Source ; Google 2013 (satellite view), JICA Survey Team

Figure 8.4–1 Present Conditions and Land Occupation at the Level of the Desalination Plant

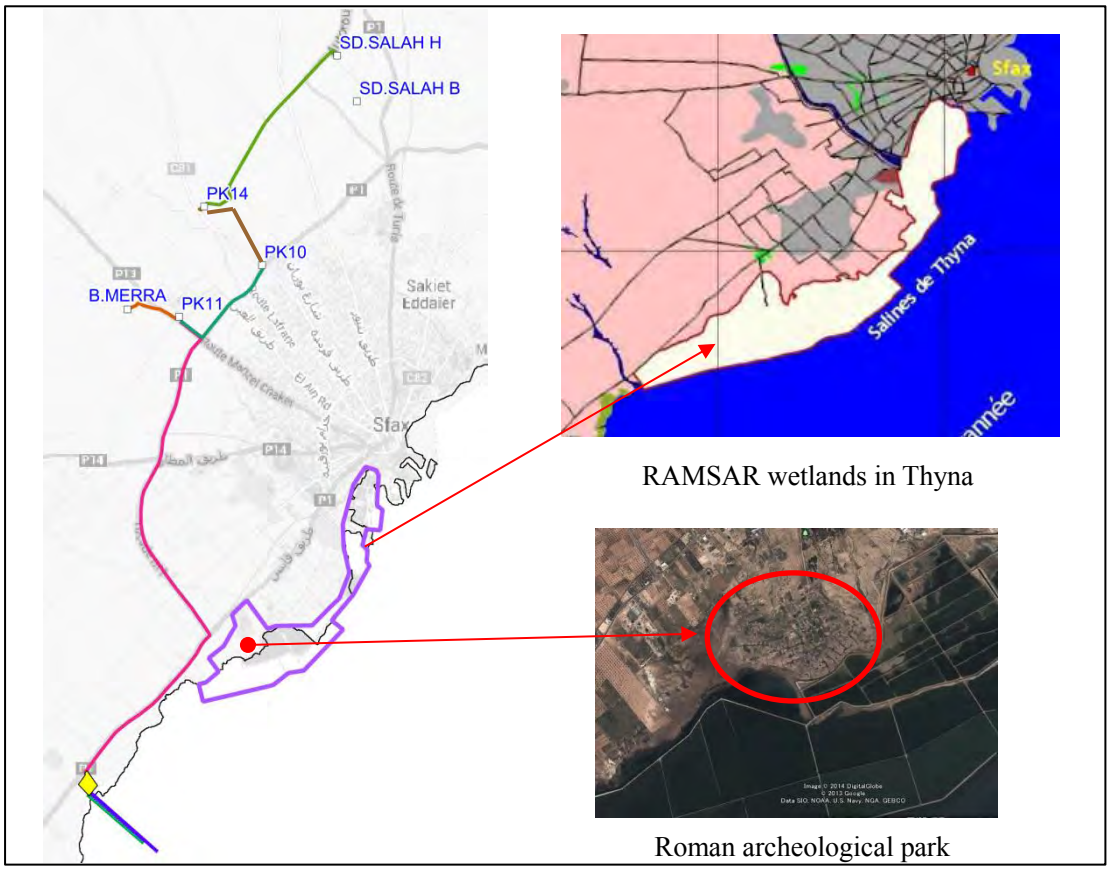
The environment along the transmission pipeline is an urban road landscape as shown in Figure 8.4-2.



Source: JICA Survey Team

Figure 8.4–2 Environment along the Transmission Pipeline

The transmission pipeline will be laid near Thyna, also hosting the RAMSAR wetlands and the Thyna Roman archaeological site, but the pipeline will not cross any of them as shown in Figure 8.4-3:



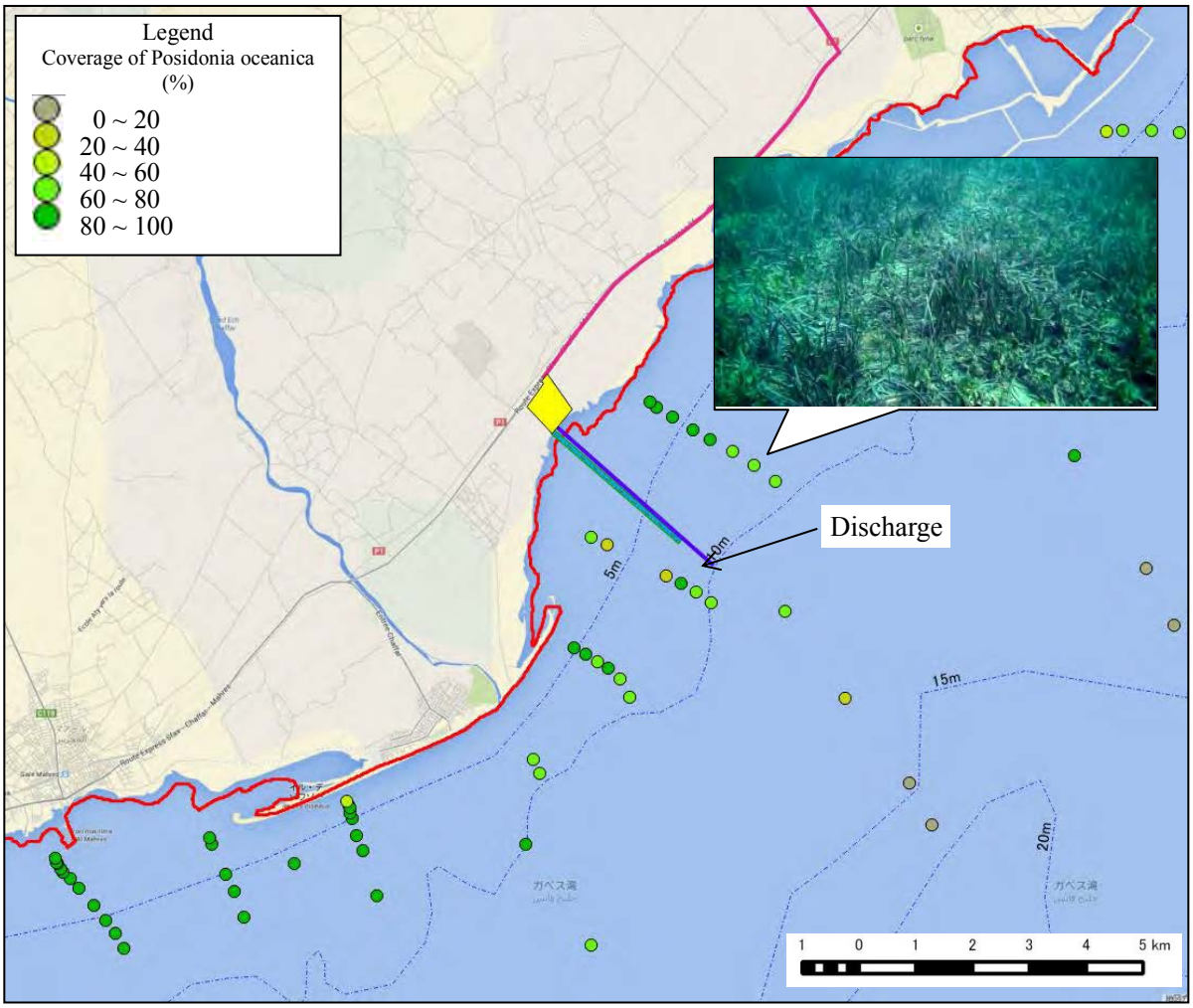
Source : http://ramsar.wetlands.org, JICA Survey Team

Figure 8.4–3 Thyna Area and Route of the Transmission Pipeline

It should be noted that important marine grasses have been identified as growing in the areas outlined for the intake and discharge pipes. According to the Protocol relating to Specially Protected Areas and Biological Diversity in the Mediterranean, "SPA/BD Protocol, 1995" refers to special protected areas and the conservation of biological diversity in the Mediterranean Sea. This was issued by the Barcelona Conference, joined by Tunisia in 1976. A list of SPAMI (Special Protected Areas of Mediterranean Importance) was designed to implement and monitor protection policies. In Tunisia, sites on SPAMI's list are as follows:

- La Galite Archipelago
- Kneiss Islands
- Zembra and Zembretta National Park

Among the three sites, the Kneiss Islands are located in the Sfax area but are at about 35 km from the project site. Even if the project was not located in the SPAMI area, *Posidonia oceanica* growing in the project area is considered by the SPA/BD protocol as endangered species. The JICA Survey Team collected data and information from INSTM about sea-grasses growing around the project area. According to the obtained data, coverage by *Posidonia oceanica* around the project site and the discharge point is about 60 to 80%. The project's impact on *Posidonia oceanica* is being assessed and mitigation measures are being suggested (see Sections 8.8 and 8.10).



Source : INSTM, Ben Mustapha – World Bank 2008, JICA Survey Team

Figure 8.4–4 Coverage of *Posidonia oceanica* around the Project Area

On the other hand, *Posidonia oceanica* also hosts "sea horse" *Hippocampus ramulosus* which is a protected species (see Table 8.4.1). As shown in the following table, the Gulf of Gabes offers the most abundant marine biodiversity in Tunisia:

Table 8.4-1 Marine Biodiversity in Tunisia in Number of Species

Species (family)	Examples (near Sfax)	Gulf of Tunis (North)	Gulf of Hammamet (Center)	Gulf of Gabes (South)
Echinoderms (sea stars)	 *Asterina gibbosa*	48	29	46
Cnidaries (jelly fish)	-	23	17	6

Species (family)	Examples (near Sfax)	Gulf of Tunis (North)	Gulf of Hammamet (Center)	Gulf of Gabes (South)
Bryozoairis	-	57	12	57
Annelidaes (worms)	 *Serpulidae*	10	8	11
Crustacean	 *Liocarcinus vernalis*	120	27	24
Sea squirts	-	7	25	17
Sponges	-	80	51	108
Mollusca	 *Cerithium vulgatum*	416	10	171
Fish	 *Hippocampus ramulosus*	106	113	227

Source : INSTM « Marine biodiversity in Tunisia », Afli, 2005 ; Examples : SMAPIII Report, City of Sfax, 2008

8.5 System and Organization of the Socioeconomic Considerations in Tunisia

(1) Legislation related to studies of impact

According to the National Agency for Environment Protection (ANPE), and with reference to Decree issued on July 11, 2005, execution of an Environment Impact Assessment (EIA) is necessary for approval of the Project.

- EIA Decree: Decree 2005-1991 dated July 11, 2005 defines subject of EIA and required terms of reference for EIA

The EIA decree defines projects for which a study of impact on the environment is required. The list of projects concerned by this requirement is attached in the Annex of the Decree. For this type of project, the Project Leader must submit a study of impact (A and B categories of Annex 1 of the Decree) or a tender Document (projects covered by Annex 2 of the Decree). The Tender Document is a preliminary list of measures and conditions specific to the type of project that the contractor shall submit to the

ANPE's approval. The study of impact on the environment in Tunisia is a procedure through which ANPE expresses its rejection or approval of the project. ANPE's approval is a prerequisite to have all necessary administrative authorizations for the execution of the Project (by SONEDE for this project).

The EIA decree covers impacts that may affect the physical and natural environment. However, the text does not explicitly mention the obligation to take into due consideration the social environment in the region.

Comparison between the Tunisian legislation regarding the environment and JICA guidelines shows the following:

Table 8.5-1 Tunisian Legislation and JICA Guidelines

JICA Guidelines	Tunisian legal framework	Gaps between JICA guidelines and Tunisian legal framework	Policy for this project
Regulation related to the study of impact on the environment	Decree 2005-1991.	None	Following decree 2005-1991
EIA Evaluation	The EIA carried out in the framework of the project must be examined by ANPE	None	EIA is implemented by SONEDE and approved by ANPE
Scope of EIA : from the natural environment to the social environment	The natural environment is covered by Decree 2005-1991. Land acquisition and resettlement of the population are covered by Law n° 26 dated April 14, 2003.	Decree 2005-1991 does not cover social considerations	The EIA shall cover both the environmental and social aspects of the project
Meeting of stakeholders and public information about EIA	-	This aspect is not considered in Decree 2005-1991	Considering the size of the project, it will be necessary to hold public consultations with stakeholders during the EIA
Follow up	Follow up is mentioned in Decree 2005-1991 The team in charge of the environment component in this project at SONEDE has an extensive experience in terms of EIA execution and follow-up.	None	The monitoring is done following the decree 2005-1991.There is a person in charge of environment in the Central Department of Research of SONEDE

Source: JICA Survey Team

According to Table 8.5-1, the Tunisian legislation seems to comply with JICA Guidelines in terms of the environment. Nevertheless, due to the scope of the project, it is necessary to consult with stakeholders during the execution of the EIA. It is also necessary to hold public information sessions whenever necessary.

(2) Institutions concerned with socio-environmental aspects in Tunisia

- The Ministry of Environment and Sustainable Development: Started operation in 1991 as the Ministry of Environment. It defines the country policy in the field of environment and pilots activities for the protection and improvement of the living spaces. According to the 11th Development Plan and Agenda 21, the Ministry is working on the formulation of the state sustainable development policy in the middle and short terms, following the Mediterranean Sustainable Development Strategy, with the support of the United Nations Environment Program (Action Plan for the Mediterranean: UNEP/PAM);
- The Environmental Protection Agency (ANPE): This agency was established in 1988 under the authority of the Ministry of Environment and Sustainable Development. The Agency implements policies to prevent pollution and to protect the environment;
- The Protection and Development of Coast Agency (APAL), was established in 1995 under the authority of the Ministry of Environment and Sustainable Development. The Agency implements policies related to the management and protection of coastal areas and the littoral.

As this project relates to water supply and is located on a coastal area, its socio-environmental aspects will be treated in cooperation with SONEDE, ANPE and APAL. The National Commission for Sustainable Development (CNDD), the National Agency for Waste Management (ANGED) and the National Sanitation Office (ONAS) are also involved in environmental management but are not directly concerned with the project. However, they are involved as stakeholders.

8.6 Alternatives to the Project (including no-project or zero option)

The following points have been considered in the project design:

1. Necessity for the project: zero option, supply from remote areas, sea water desalination. Due to the lack of water resources in Sfax, the further development of the existing water supply network appears to be a non-realistic option. In the case of a zero option or supply from a distant area, water needs in the future cannot be fulfilled and the social impacts on the population in Sfax will be very severe.
2. Site of the desalination station: seven candidate sites have been evaluated and the socio-environmental aspects have been taken in consideration along with other criteria (see section 5.2);
3. Desalination process: RO process, thermal evaporation, electrolysis. These three processes have been evaluated taking in consideration energy use (see Table 5.1-1).

8.7 Scoping and Terms of Reference of the EIA

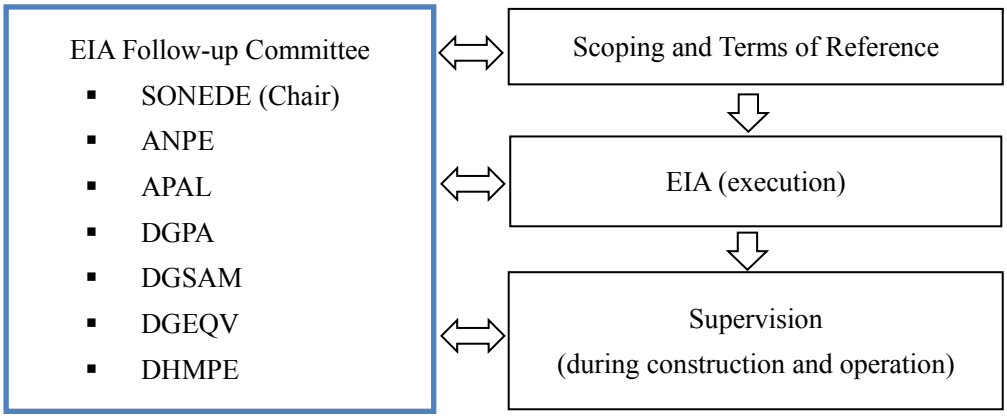
The scoping and terms of reference of EIA (Environmental Impact Assessment for environmental and social impacts) for this project have been conducted based on the following conditions:

- Decree 2005-1991 about protection of the environment and study of impact on the environment;
- JICA Guidelines (2010 version) about the socio-environmental considerations;
- Resource and Guidance Manual for Environmental Impact Assessments: Desalination – UNEP/ROWA, 2008;
- Guidelines for Impact Assessment on Seagrass Meadows, C. Pergent-Martini, C. Le Ravallec, UNEP, 2007;
- Environmental, sanitary and security guidelines – International Financial Corporation (IFC) of the World Bank Group;
- Specially protected areas and biological diversity in the Mediterranean (Barcelona Convention).

JICA Survey Team drafted an initial scoping report and EIA Terms of Reference in consultation with the EIA Follow-up Committee and the participation of a marine environment expert from INSTM (National Institute for Sea Sciences and Technologies). This report has been submitted to SONEDE. Organizations participating in the EIA Follow-up Committee are the following:

- SONEDE：Execution Agency of the project
- ANPE：Environment Protection Agency, Ministry of Environment and Sustainable Development (MESD)
- APAL：Protection and Development of Coast Agency, MESD
- DGPA：General Fishing and Aquaculture Department ,Ministry of Agriculture, Water Resources and Fisheries
- DGSAM：General Department for Air and Maritime Services, MESD
- DGEQV：General Department for the Environment and Life Quality, MESD
- DHMPE：Department of Public Hygiene and Protection of the Environment, Ministry of Healthcare.

The EIA Follow-up Committee was created at the recommendation of ANPE in order to compensate for the lack of experience of various institutions concerned by such a large-scope project in Tunisia. The committee was created at the initiative of SONEDE, which is in charge of the execution of the Project, the follow up and approval of the Terms of Reference and different EIA phases (the first session of the EIA Follow-up Committee was held on April 29, 2014 in order to examine the first version of the EIA Terms of Reference). The EIA Follow-up Committee must monitor the EIA's various phases including the follow-up of the project in operation. It is shown in the following Figure 8.7-1:



Source: JICA Survey Team

Figure 8.7–1 Activities of EIA Follow-Up Committee

Scoping results have shown that the project's positive aspects related to improving drinking water supply and water quality, while negative aspects were mainly related to the discharge of brine in the marine environment (TDS 73,000 mg/L). Therefore, the EIA's main components are the following:

- The receiving natural environment and the marine environment must be sufficiently and accurately characterized before execution of the project in order to serve as a baseline for subsequent supervision activities;
- Impacts of intake and discharge operations on the marine environment must be identified during construction and operation including any impacts on fishing activities;
- Depending on the intensity of the various impacts, appropriate mitigation and compensation measures must be implemented;
- Consultation with institutions concerned and with the population living around the project will be necessary;
- Mitigation measures will be adjusted according to the results generated by the supervision of the project whilst in operation.

The scoping study's detailed results are shown in the following Table 8.7-1 for the following evaluation components:

- Evaluation component 1: Desalination Plant (desalination factory, intake and discharge structures);
- Evaluation component 2 : Transmission pipeline (transmission pipeline, pumping stations, water-hammer structures -surge tanks-, reservoirs)
- Evaluation component 3: Power Transmission Line (power transmission line, power transmission towers)

Table 8.7-1 Scoping : Seawater Desalination Plant

Categories		Impact criteria	Evaluation		Justification
			Construction phase	Operation phase	
Pollution	1	Air pollution / Dust	C-	D	**During construction:** - The operation of worksite vehicles during construction will generate dust and gasses (NOx, SOx, etc.). Since large-scale earth works and pavement works are not planned in the project, this impact will not be serious. - Areas surrounding the plant site are mainly farmlands, road and beach, and dust will be generated anyway from the existing natural environment. No significant impact is therefore expected. **During operation:** - Power consumption by the station will generate the emission of greenhouse gasses (As Tunisian power production is based on fossil energies), but not to the extent to produce pollution affecting all of Tunisia.
	2	Water pollution	C-	C-	**During construction:** - Increase of sea water turbidity during dredging operations to lay pipes. **During operation:** - The increase of supplied drinking water quantities will increase volumes of wastewater with a possible contamination of groundwater depending on the extent of development of the sewerage system. - Brine discharge (Phase 1: 122 200 m^3/day at 73,000 mg/L) will locally increase sea water salinity.
	3	Waste	D	D	**During operation:** - The renewal of RO membranes will produce waste (about 200 m^3/year), however this waste is inert and combustible.
	4	Soil contamination	D	D	**During construction, and During operation:** - No specific waste treatment is planned; in addition main materials carried are drinking water, so even in the case of leaks, no soil contamination is expected
	5	Noise; Vibrations	D	D	**During construction:** - There is no population in the vicinity of the factory site and no living organisms sensitive to vibrations, therefore impact of noise and vibrations will be minimal. **During operation:** - Desalination is performed indoors; there are no consistent emissions of noise or vibrations outdoors.
	6	Land subsidence	D	D	**During operation:** - As this is a sea water desalination station, underground water will not be used. Similarly no large underground works will be done.
	7	Odour nuisance	D	D	**During operation:** - No open-air process producing strong odour is planned.

Categories		Impact criteria	Evaluation		Justification
			Construction phase	Operation phase	
	8	Sediments	D	D	**During construction:** – Excavated sand quantities for the laying of intake and discharge pipes are about 110m^2×4000m = 440,000m^3. - This includes the surplus soil generated corresponding to volume of pipes of about (2.3m^2/2+2.1m^2/4) × 3.14 × 4000m = 47092m^3, armor stones, and gravel pipe beds which will be disposed in the deep sea. The remaining quantity will be stored and backfilled into the excavated trenches. - As this concerns existing sediments, no specific additional pollution is expected.
Natural environment and natural risks	9	Protected natural areas	D	D	**During construction, and During operation:** - Protected areas (RAMSAR site of the salt factories in Sfax and ASPIM in the Kneiss islands) are not impacted upon by the Project.
	10	Natural habitats	B-	C-	**During construction :** - The factory is built within the maritime public domain. - The construction of the factory and mainly of the intake and discharge pipes will partially damage existing natural habitats. Concerned areas cover about 20 ha for the factory and 4000m×34m=14ha for the pipes. - The deposit of 101,600 m^3 excavated materials may have some impact according to characteristics of the natural environment at the level of deposit areas. **During operation :** – The discharge of brine (phase I : 73000mg/L×122,200m^3/day) will induce an impact on the local natural environment; – The seawater intake (Phase I : 222,200m^3/day) will be made at about 3 m above the seabed and the intake speed will be limited at 0.2 m/s; no major impact is expected on the marine environment.
	11	Hydrology	C-	D	**During construction :** - The laying of intake and discharge pipelines may temporarily modify currents. **During operation :** - Intake and discharge pipes are entirely buried; there will be no significant impact on marine currents.
	12	Morphology and geology	D	D	**During construction, and During operation:** - No major excavation works are planned
Human and social environment	13	Unwilling displacement of the population	D	D	**Design:** - The site of the plant is located within the public maritime domain and no housing facility exists in the project site.
	14	Subsidence means, poverty, vulnerability	C-	D	**During construction:** - As the site of the plan will be located within the public maritime domain, no cultivated land will be impacted. - The construction of intake and discharge pipes may temporarily disturb fishing activities.

Categories		Impact criteria	Evaluation		Justification
			Construction phase	Operation phase	
					- Since, the project will be implemented in the site next to farming and fishery areas, individuals possibly receiving impact are poor farmers and fishermen. Especially, construction work has the possibility to cause temporary impacts on fishermen. **During operation:** - Intake and discharge towers are located outside trawl fishing areas, thus, there will be no impact on fishing activities.
	15	Ethnic minorities	D	D	**During construction, and During operation:** - There are no minorities living in the site of the plant - The construction of the plant will not disrupt the shoreline continuity and will always enable nomadic pasturage activities to take place.
	16	Local economy/ employment	B+	B+	**During construction :** - Offer for local employment will increase; - Possibility to sub-contract services with local providers **During operation :** - Possibility to offer operators' positions at the plant - Possibility to sub-contract services with local providers
	17	Use of land and local resources	D	D	**During construction, and During operation:** - As the plant is located within the maritime public domain, no land acquisition needs to be planned.
	18	Water resources	D	B+/C+	**During operation :** - The over-exploitation of underground aquifers will be reduced by the use of desalinated seawater (B+) - The improvement of water supply should have a positive impact on resident's health (C+)
	19	Public infrastructures and social services	D	B+	**During operation :** - The project will improve the quantities and quality of drinking water supplied.
	20	Social capital and organization	D	D	**During construction, and During operation:** - As this is a sea-water desalination project, we do not expect any impact on social capital and organization.
	21	Distribution of profits and social equity	D	D	**During construction, and During operation:** - The project will be supported by the Greater Sfax population and will not create any regional disparity.
	22	Local conflicts of interest	D	B+	**During operation:** - The project will be developed in the Greater Sfax area for the benefit of the Greater Sfax region. - The project will re-balance the distribution of water resources by reducing the Sfax region's dependence on the transfer of water from the North.
	23	Historical and cultural heritage	C-	D	**During construction :** - The project currently avoids impacting the archaeological park of Thyna but the construction of the station might reveal new ruins.
	24	Landscape	D	D	**During construction, and During operation:** - The height of installations and of embankments will not be expected to modify the landscape.

Categories		Impact criteria	Evaluation		Justification
			Construction phase	Operation phase	
	25	Gender	D	C+	**During operation :** - In the area without water supply, women and children usually have to work to get water. The increase of water supply volume by the project will result in the possibility of extension of the water supply area. This improvement of water supply service may have a significant positive impact on women's conditions
	26	Children's rights	D	D	**During operation :** - Not applicable.
	27	AIDS, TD, hygiene and healthcare	D	D	**During construction :** - The project is implemented in the Greater Sfax area, local manpower expected and they are not likely to modify existing sanitary conditions.
	28	Professional health/security on the worksite	D	C-	**During construction :** - Desalination Plant: Safety management is needed with other ordinary construction works. Since there will be no work with explosives, dangerous substances, etc., special consideration about them will not be needed. - Marine works: Mmarine work will be needed for intake and discharge pipelines, transportation, lifting, and installation of pipes, intake head, and discharge head, but these are not different from other ordinary construction works. Therefore, there is no fear for the safety of workers, provided general safety management is carried out. Marine works, however, will be influenced by weather condition. Therefore, appropriate work schedules will have to be established. Submarine work will be conducted in depths of less than 10m by specialists in such type of work. Because of this reason, there will be a low possibility of the bends affecting workers. **During operation :** - At the desalination plant, chemicals will be used for water treatment. However, there is no need to fear dangerous accidents, because these chemicals are already in use at existing facilities and the quantities used will be small. High-pressure vessels and rotating equipment will be manufactured with designs which specifically consider safety. -Maintenance work will be conducted for marine facilities. Low concerns of accidents are anticipated because experienced divers will conduct such work.
Others	29	Accidents	D	D	**During construction, and During operation :** - No dangerous facilities are being planned and chemical products used in the process are stable (even in the unlikely instances of power failures).
	30	Trans-border effects or climatic changes	D	C-	**During operation :** - The power consumption of the desalination station is about 175GWh/year for Phase 1. This will increase the overall emission of greenhouse gas levels of Tunisia

A+/-: A major positive/negative impact is expected

B+/-: A positive / negative impact is expected to a certain extent
C+/-: Impact is unknown (Additional studies must be conducted to finalize the evaluation)
D: No impact is considered

Table 8.7-2 Scoping : Transmission Pipeline

Categories		Impact criteria	Evaluation		Justification
			Construction Phase	Operation Phase	
Pollution	1	Air pollution / dust	C-	D	**During construction:** - The operation of worksite vehicles during construction will generate dust and gas (NOx, SOx, etc.) Since large-scale earth works and pavement works are not planned in the project, the impacts will not be serious. - Areas surrounding the factory site are mainly farmlands and dust will normally come from the existing natural environments. No additional specific impacts are therefore expected. **During operation:** Power consumption by the station will generate emission of greenhouse gasses (As Tunisian power production is based on fossil energies), but not to the point to produce pollution affecting all of Tunisia.
	2	Water pollution	D	D	**During construction:** - The transmission pipeline is buried at about 3 m deep. The risk for the pollution of underground aquifers is very minimal. **During operation:** - As the transmission pipeline carries water, leaks will not induce any pollution of underground aquifers
	3	Wastes	D	D	**During operation:** - Spare parts for pumps and water hammer balloons represent common waste.
	4	Soil contamination	D	D	**During construction:** - Of the 230,000 m^3 to be excavated for the laying of the transmission pipelines, about 60,000 m^3 will be deposited. Excavated materials are mainly existing soils, so no added contamination is expected.
	5	Noise; Vibrations	D	D	**During construction:** - There are very few homes along the pipeline and no organism that may be sensitive to vibrations has been identified. Therefore no impact is expected. **During operation:** - Pumping stations are located in existing reservoirs' sites so no impact are to be expected (Surge tanks usually do not cause noise and vibration. When it is working, water flow sounds will be generated only for a limited time.)
	6	Land subsidence	D	D	**During operation:** - No use of underground aquifers is expected and no large scale soil excavations are planned
	7	Odour nuisance	D	D	**During operation:** - Only drinking water is transmitted with no emission of unpleasant odours.
	8	Sediments	D	D	**During construction, and During operation:** - Not applicable.

Categories		Impact criteria	Evaluation		Justification
			Construction Phase	Operation Phase	
Natural environment and natural risks	9	Protected natural areas	D	D	**During construction, and During operation:** - Protected areas (RAMSAR salt factory site in Sfax and ASPIM of the Kneiss islands) will not be affected by the Project.
	10	Natural habitats	D	D	**During construction :** - The natural environment along the transmission pipeline corresponds to an already developed urban area so no additional impacts are to be expected.
	11	Hydrology	D	D	**During construction :** - The crossing of rivers (wadis) by the pipeline will be underground with no impact on the river beds
	12	Morphology and geology	C-	D	**During construction:** - Of the 230,000m^3 excavated to lay and bury transmission pipes, about 60,000 m^3 will be deposited; it is therefore possible that some to modification of the local constituents of the soil (e.g. 60,000m^3 = height 2m × 3ha) may occur.
Human and social environment	13	Unwilling displacement of the population	D	D	**Design:** - Since the outline of the transmission pipeline can be adjusted to avoid existing housings, the project does not expect any unwilling displacement of people to occur.
	14	Subsidence means, poverty, vulnerability	D	D	**During construction, and During operation:** - Not applicable.
	15	Ethnic minorities	D	D	**During construction, and During operation:** - Not applicable.
	16	Local economy / employment	B+	B+	**During construction :** - Employment opportunities will increase. - Possible sub-contracting opportunities with local service providers **During operation :** - Possibility to work as operators in the plant - Possible sub-contracting opportunities with local service providers
	17	Use of soils and local resources	C-	D	**During construction :** - In general, the transmission pipeline will be laid within the existing road's right of way area. Very limited land acquisitions are expected.
	18	Water resources	D	D	**During construction, and During operation:** - Not applicable.
	19	Public infrastructures and social services	D	B+	**During operation :** - The project will improve the quantity and quality of drinking water supplied.
	20	Social capital and organization	D	D	**During construction, and During operation:** - As this is a sea-water desalination project, we do not expect any impact on social capital and organization.
	21	Profit distribution, social equity	B+	B+	**During construction, and During operation:** - The project will be supported by the Greater Sfax population and thus will not create any regional disparity.
	22	Local conflict of interests	D	B+	**During operation:** - The project is developed in the Greater Sfax area for the

Categories		Impact criteria	Evaluation		Justification
			Construction Phase	Operation Phase	
					benefit of the Greater Sfax. - The project will re-balance the distribution of water resources by reducing the Sfax region's dependence on the transfer of water from the North region.
	23	Historical and cultural heritage	D	D	**During construction :** - The project avoids the archaeological park of Thyna but the construction activities involved in laying of transmission pipes might reveal new ruins.
	24	Landscape	D	D	**During construction, and During operation:** - The height of transmission pipes and of embankments is not expected to modify the landscape.
	25	Gender	D	D	**During operation :** - Discussed in the evaluation component 1
	26	Children's rights	D	D	**During operation :** - Discussed in the evaluation component 1.
	27	AIDS, STDs, health and hygiene	D	D	**During construction :** - As the project is to be implemented in the Greater Sfax area, we expect manpower to be local and will not be expected to modify existing sanitary conditions.
	28	Professional health/safety on the worksite	D	D	**During construction :** - Safety management will be needed similar to any other ordinary construction work. Since there will be, however, no work with explosive, dangerous substances, etc., special consideration about them will not be needed. - The work along roads will require traffic control to avoid traffic accident. Further, deep excavation have to be conducted with earth retaining work in place to avoid collapses caused by heavy traffic loads. - Railway crossing work requires special consideration to avoid collapse. Though it will be carried out by a trenchless method, the work shall be stopped when train pass by the work site. Special request to the railway operation authority will be needed to slow down the speed of trains in the vicinity of the work site. With such considerations, no specific dangers are to be expected. **During operation :** - No specific impact will therefore be expected.
Others	29	Accidents	D	D	**During construction, and During operation :** - No dangerous facilities are being planned.
	30	Trans-border effects and climatic changes	D	D	**During operation :** - Discussed in the evaluation component 1

A+/-: A major positive/negative impact is expected
B+/-: A positive/negative impact is expected to a certain extent
C+/-: Impact is unknown (Additional studies must be conducted to finalize the evaluation)
D: No impact is considered

Table 8.7-3 Scoping: Power Transmission Line

Categories		Impact criteria	Evaluation		Justification
			Construction Phase	Operation Phase	
Pollution	1	Air pollution / dust	C-	D	**During construction:** - The operation of worksite vehicles during construction will generate dust and gasses (NOx, SOx, etc.) Since large-scale earth works and pavement works are not planned for the project, the impact will not be serious. - Areas surrounding the power transmission route are mainly farmlands and normally dust will be expected to come from the existing natural environments. No significant specific impacts are therefore expected. **During operation :** - Not applicable.
	2	Water pollution	D	D	**During construction, and During operation :** - Not applicable.
	3	Wastes	D	D	**During construction, and During operation :** - Not applicable.
	4	Soil contamination	D	D	**During construction, and During operation :** - Not applicable.
	5	Noise; Vibrations	D	D	**During construction, and During operation :** - Not applicable.
	6	Land subsidence	D	D	**During construction, and During operation :** - Not applicable.
	7	Odour nuisance	D	D	**During construction, and During operation :** - Not applicable.
	8	Sediments	D	D	**During construction, and During operation :** - Not applicable.
Natural environment and natural risks	9	Protected natural areas	D	D	**During construction, and During operation :** - The transmission line is not expected to pass over the Thyna area (RAMSAR) shown on Figure 8.4-3.
	10	Natural habitats	D	D	**During operation :** - Mostly olive farming field. No fragile ecosystem present
	11	Hydrology	D	D	**During construction, and During operation :** - Not applicable.
	12	Morphology and geology	D	D	**During construction, and During operation :** - Not applicable.
Human and social environment	13	Unwilling displacement of the population	D	D	**Planning:** - The transmission route is expected to be selected to avoid involuntary resettlement
	14	Subsidence means, poverty, vulnerability	C-	D	**During construction:** - Fear of possible impact on farmland where land acquisition will be conducted for power transmission towers. **During operation:** - Not applicable
	15	Ethnic minorities	D	D	**During construction, and During operation :** - Not applicable.
	16	Local economy / employment	D	D	**During construction, and During operation :** - Not applicable.
	17	Use of land and local resources	C-	D	**During construction:** - there will be land acquisition for construction of power transmission towers

Categories		Impact criteria	Evaluation		Justification
			Construction Phase	Operation Phase	
					During operation: - Not applicable
	18	Water resources	D	D	**During construction, and During operation :** - Not applicable.
	19	Public infrastructures and social services	D	D	**During construction・During operation :** - Not applicable.
	20	Social capital and organization	D	D	**During construction, and During operation :** - Not applicable.
	21	Profit distribution, social equity	D	D	**During construction, and During operation :** - Not applicable.
	22	Local conflict of interests	D	D	**During construction, and During operation :** - Not applicable.
	23	Historical and cultural heritage	D	D	**During construction, and During operation :** - Not applicable.
	24	Landscape	D	C-	**During construction:** - Same to below. **During operation:** - Fear of impact of landscape by 40m high towers
	25	Gender	D	D	**During construction, and During operation :** - Not applicable.
	26	Children's rights	D	D	**During construction, and During operation :** - Not applicable.
	27	HIV/AIDS, health and hygiene	D	D	**During construction, and During operation :** - Not applicable.
	28	Professional health/safety on the worksite	D	D	**During construction, and During operation :** - STEG will plan, construct and maintain the power transmission facilities. No impact is expected on work site condition.
Others	29	Accidents	D	D	**During construction, and During operation :** - STEG will plan, construct and maintain the power transmission facility. Based on their past experiences, no accidents are expected.
	30	Trans-border effects and climatic changes	D	D	**During operation :** - Evaluated in sea water desalination plant.

A+/-: A major positive/negative impact is expected
B+/-: A positive/negative impact is expected to a certain extent
C+/-: Impact is unknown (Additional studies must be conducted to finalize the evaluation)
D: No impact is considered

Based on the results of the scoping exercise, the JICA Survey Team prepared and submitted a draft of the Terms of Reference (TOR) for the EIA to be conducted by local consultant. SONEDE discussed the matter with APAL and ANPE based on the draft and agreed with them to finalize the TOR based on the draft. The JICA Survey Team compiled and submitted the TOR to SONEDE and SONEDE made a

contract with a local consultant to carry out the services of the EIA after bidding. The EIA is being conducted as of June 2015.

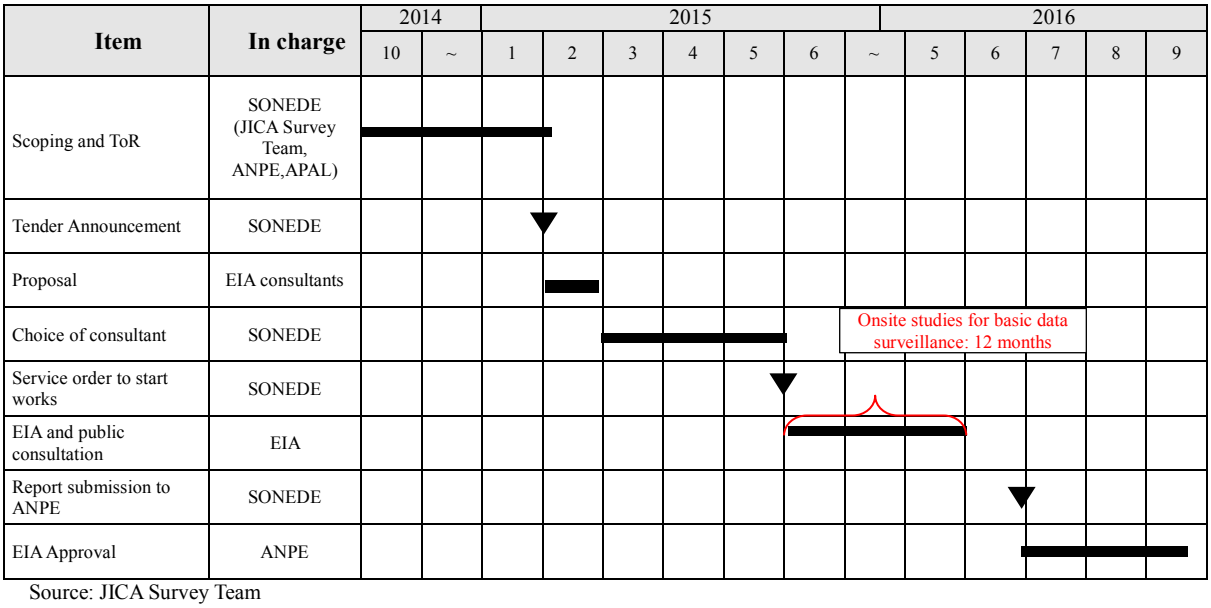
The summary of the EIA's TOR developed based on the scoping study is given in the following table:

Table 8.7-4 Summary of the EIA's Main Terms of Reference

Objective	Point to study	Study Method
Approach and framework of EIA study	① legal and institutional framework of EIA ① EIA methodology, approach, planning, and personnel	1-Refer to EIA scoping report 2-refer to EIA Terms of reference
Define the baseline of the natural and social environment	① Description of the receiving environment : Project area, land and marine physical and biological natural environment, ②Description of the society: population, healthcare, gender effects.	1-Collect and summarize available data and reports 2-Additional studies on site of the marine environment: ➢ Water quality (including plankton) ➢ Description of marine grasses ➢ Description of the ecosystem ➢ 4 sampling points. 2 points at the level of the project (A and B on the figure) and 2 points on pilot areas (C and D).  ➢ Sampling in summer and in winter
Project description	①Description of the project's components ②Project's materials inventory (input/output) ③Construction and operation methods	1- Refer to the report of the project's preparatory study (This report)
Evaluation of the project's variants and the project site	①Project variants ①Project site options	1- Refer to the report of the project's preparatory study (This report) 2-Conduct site visits
Evaluation of impacts on the natural and social environments	①Evaluate impacts with regard to the project's components (during construction and during operation) ①Areas impacted by the discharge of brine and impact on the marine environment	1-Consult reference documents, check each item. 2- Calculate the area affected by the brine discharge 3-Consult documents concerning the relation between salinity and toxicity in the marine environment
Mitigation measures and compensation of related costs	①Suggest appropriate mitigation and compensation measures for each impact	1-Based on the evaluation of site conditions and impact characteristics, elaborate appropriate mitigation measures.

Objective	Point to study	Study Method
	②Evaluate costs and suggest an organization for the implementation of measures	2-Design compensation measures complying with the relevant laws and regulations in force. 3-Jointly with SONEDE, define costs and organization to implement and enforce compensation measures.
Monitoring plan	①Design of a monitoring plan: items to monitor, applicable standards, concerned institutions, costs, implementation organization	1-Definition of supervision modes for each item to monitor 2- Jointly with SONEDE, design a monitoring plan
Consultation with stakeholders and with the population	①Consultation with stakeholders reflecting the results of the project ②Information of the local populations	1- Hold meetings with stakeholders in Sfax in order to explain the characteristics and the impacts of the project. Refer to the stakeholders meeting already held during the preparatory study. Evaluate different proposals and reflect them in the project implementation. 2- Hold information meetings with the local population in order to explain the project characteristics and impacts.

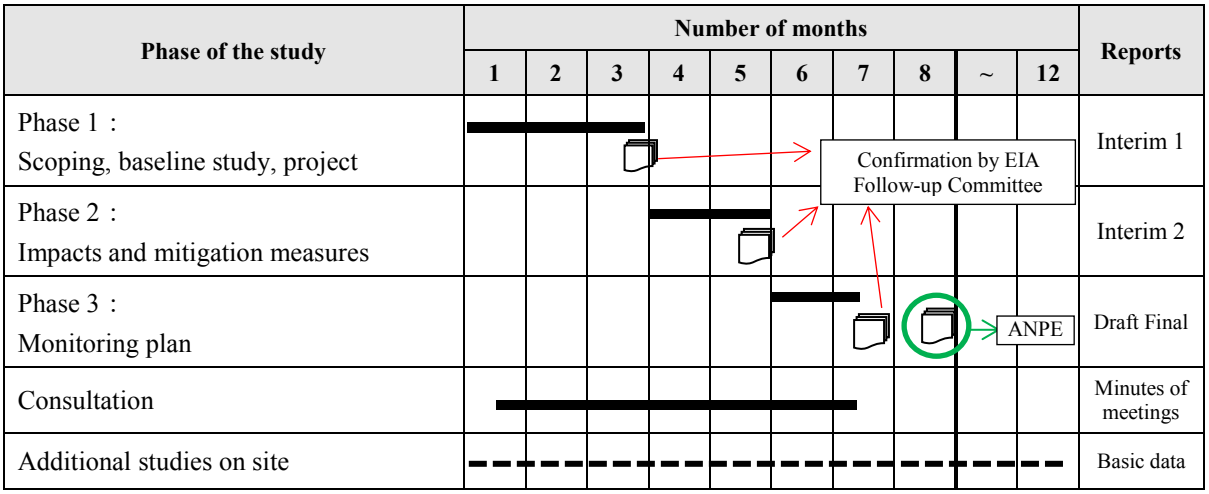
The provisional schedule for the execution of the scoping study, preparation of the terms of reference and the EIA is shown in Figures 8.7-2:



Source: JICA Survey Team

Figure 8.7–2 Provisional Schedule for Scoping, TOR and EIA

The execution of EIA is detailed in Figure 8.7-3:



Source: JICA Survey Team

Figure 8.7–3 EIA Execution Plan (proposal)

Since every phase and intermediate report will be checked by the EIA Follow-up Committee, it may be expected that the final approval by ANPE will raise a few additional comments or reservations.

8.8 Results of Socio-Environmental Investigations

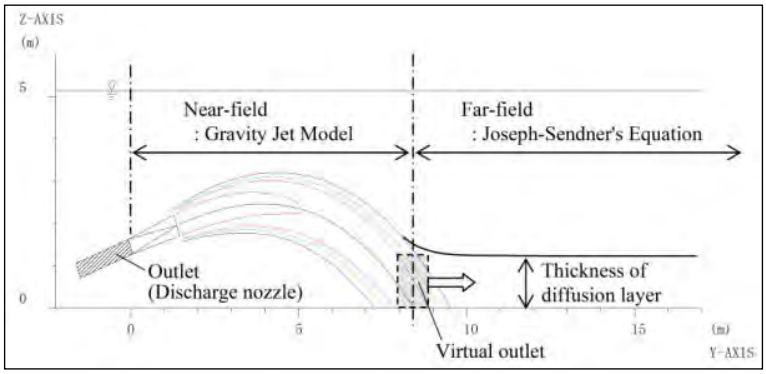
Further to the scoping results, characterizing impacts related to brine discharge was subject to a simulation exercise. Data related to marine grass, *Posidonia oceanica,* in the project's surrounding areas have also been collected and analysed.

A social survey was conducted in order to assess the satisfaction rate in terms of drinking water service and impacts on society.The final meeting with the representatives of the British Gas company (hereafter referred to as BG) was organized in order to identify possible impacts of this project on fishing activities. Results are collected in Table 8.8-1:

Table 8.8-1 Results of Socio-Environmental Investigations

Criteria	Investigations Results
Water pollution	**Simulation of brine dispersion** In order to assess the impact of brine discharge into the natural environment, amounting to about 73000 mg/L TDS at the level of the discharge head, the JICA Survey Team studied the dispersion of brine in surrounding sea water. To do this, we use a two-layer model: 1. First a gravitational jet model at the level of the nearby field (ten meters around the discharge tower): this model takes into consideration the immediate dilution at the level of the circulating jet mixed with surrounding water. It gives information about the form of the jet, the falling point and the evolution of concentration in the jet. It also takes in consideration the form, the inclination of the nozzle, the number of nozzles and the speed of discharge. 2. Then a model for dissemination in remote areas at 2 dimensions following the equation developed by Joseph Sendner : the model is based on the concentration of the jet at the level of the falling point calculated by the nearby field model, and calculates the progressive dilution of salinity through dispersion throughout a plane area. It takes in consideration the total quantity of water discharged as well as the water height and the shape of the dispersion area. This two-layer model is shown in the figure below:

Criteria	Investigations Results
Water pollution	



Source: JICA Survey Team

Figure 8.8–1 Two-Layer Simulation Model

This type of simulation is largely used at the level of the pre-project preparatory studies for conventional or nuclear thermal power plants (floating jet), and for desalination stations (falling jet), and is based on several references. The model was also applied by research laboratories, and suitability and accuracy of it was confirmed.

Calculation conditions for this project

Simulation was based on unfavourable conditions in the summer period (highest salinity of the environment) as shown in Table 8.8.2.

Discharge quantity : :244 ;400 m^3/day (maximal capacity, Phase 2)

Discharge speed :3m/s

Number of nozzles: :4

Diameter of the nozzle : :0.55m

Angle of the nozzle from horizontal line :45deg

Height of discharge from the ground (nozzle centre):1.3m

Current : 0.01m/s (*1)

*(*1) in the absence of more accurate data, we used the pejorative hypothesis of minimal current.*

Discharge angle :180deg (*2)

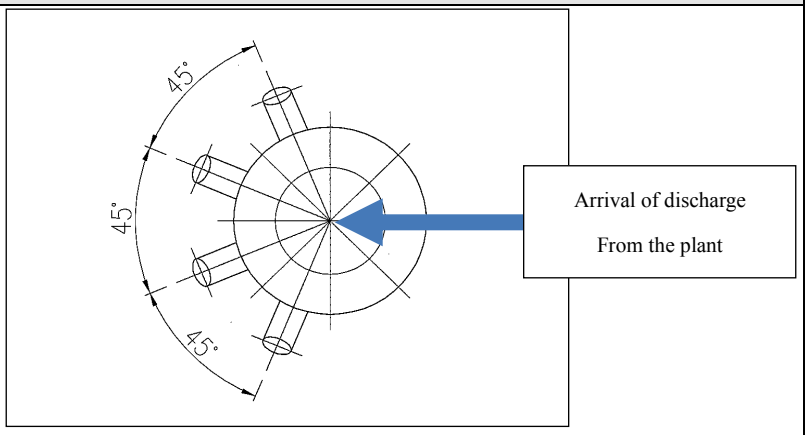
*(*2) Since discharge is slightly heavier than sea water, it tends to flow on the highest slope. Based on this phenomenon, a discharge tower of 180deg is adopted, see Figure 8.8.2.*

Table 8.8-2 Temperature and Salinity

Month		Jan - Mar	April - June	July August	Sep.-Nov.	December
		Winter	Spring	Summer	Fall	Winter
Sea water temper.	C	15	25	30	25	15
Discharge temper	C	15	25	30	25	15
Sea water salinity	mg/L	39,000	40,000	41,000	40,000	39,000
Discharge salinity	mg/L	70,800	72,500	74,300	72,500	70,800
Difference	psu	31.8	32.5	33.3	32.5	31.8

Source: JICA Survey Team

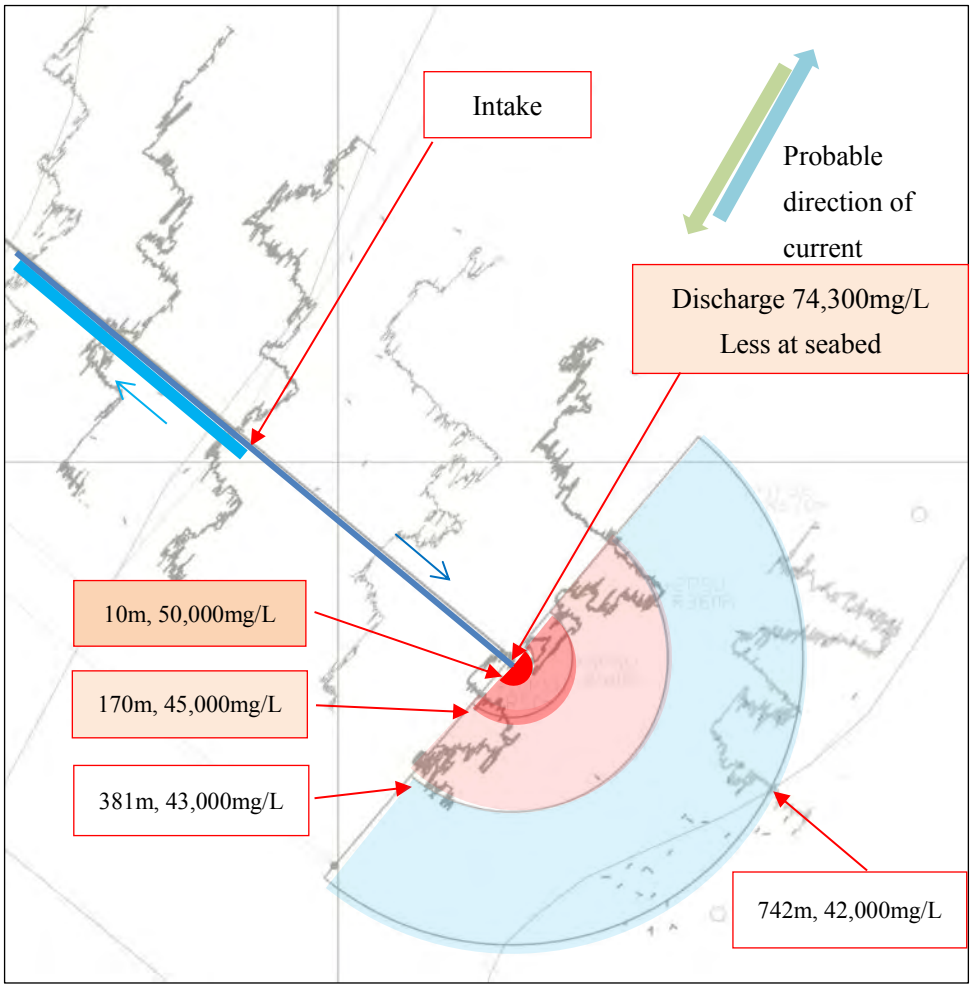
Criteria	Investigations Results



Source: JICA Survey Team

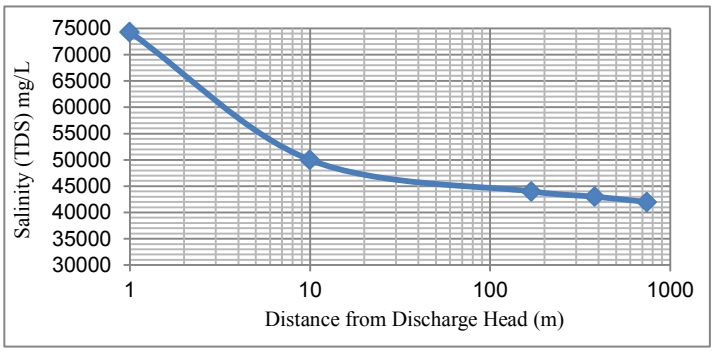
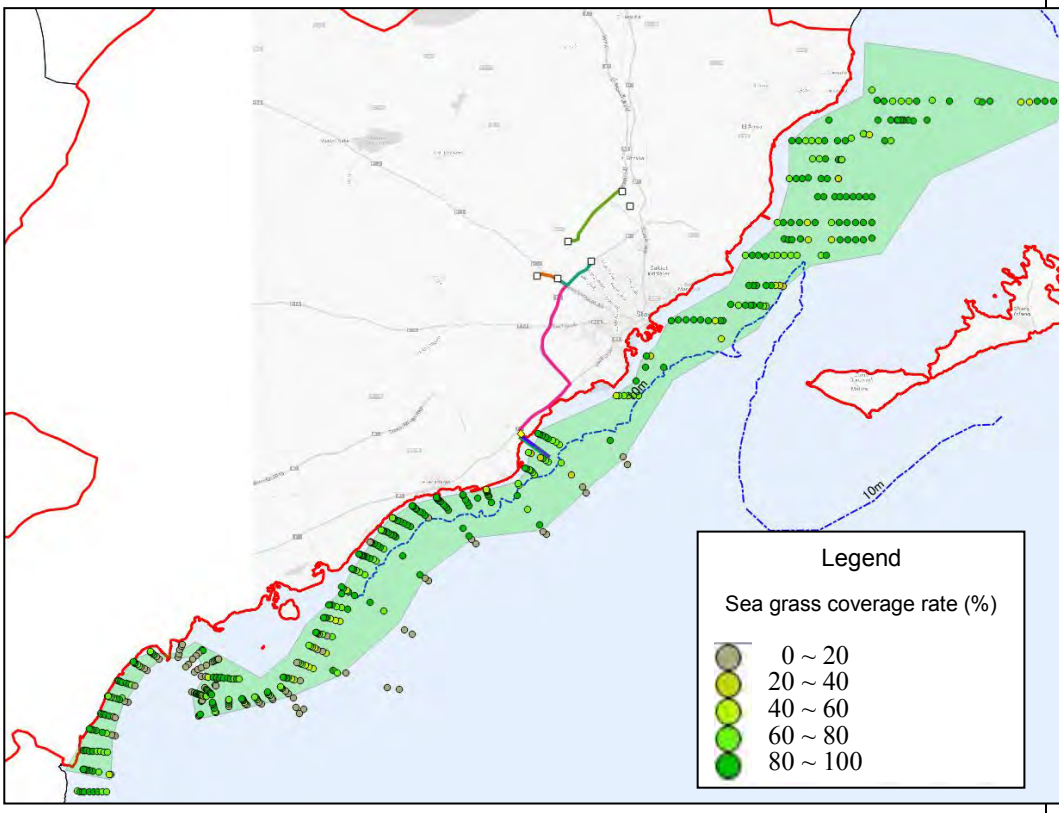
Figure 8.8-2 Plan of the Discharge Tower

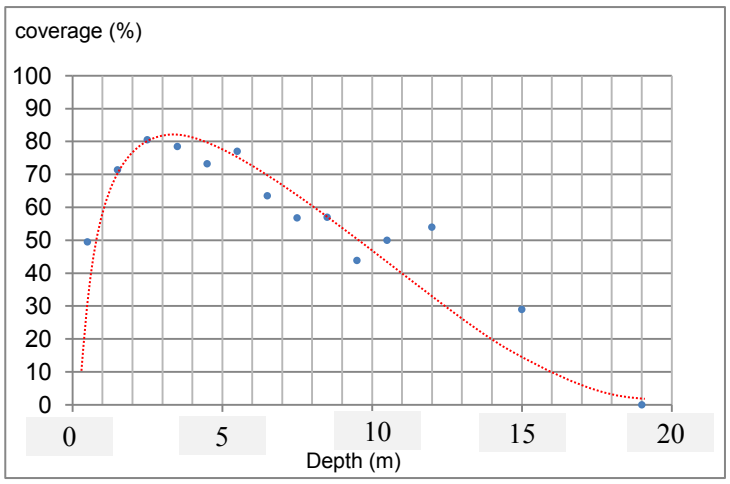
Results are shown in figure below on the following figure:



Source: JICA Survey Team

Figure 8.8–3 Results of the Brine Dispersion Simulation

Criteria	Investigations Results
	Salinity according to distance from the discharge tower is shown in the graph below:  Source: JICA Survey Team **Figure 8.8–4 Salinity according to Distance to the Discharge Head**
Natural habitats	**Baseline of *Posidonia oceanica*** Data concerning the state of *Posidonia oceanica* and *Cymodocae* in the governorate of Sfax were kindly provided by INSTM (L. Ben Mustapha) based on a 2008 World Bank Study. The SIG Analysis of these data shows the following facts:  Source : : INSTM (Ben Mustapha), JICA Study Team **Figure 8.8–5 Current State of *Posidonia oceanica* and *Cymodocea* in Sfax Governorate (excluding Kerkennah)** In the Governorate of Sfax, the current conditions of *Posidonia oceanica* is as follows : ▪ Coverage area : about 130,000 ha (green area above, including surveyed areas) ▪ Average coverage rate (low hypothesis) : 40% => sea grass area = 0.4x130,000 = 52 000 ha ▪ Average coverage rate (high hypothesis) : 60% => sea grass area = 0.6x130,000 = 78,000 ha In the Governorate of Sfax, excluding Kerkennah, the total area of sea grass is then estimated at about 52,000ha.

Criteria	Investigations Results
	The correlation between the depth of the water and the average coverage rate observed is represented on the following figure:  Source : JICA Survey team **Figure 8.8–6 Coverage Rate of Sea Grass vs. Water Depth** **Relation between the salinity rate and *Posidonia oceanica* survival** The relationship between the salinity rate and the survival of *Posidonia oceanica* was studied in Fernandez-Torquemada, Y., Sanchez-Lizaso "Effects of salinity on leaf growth and survival of the Mediterranean sea-grass *Posidonia oceanica*", 2005. According to this source, survival of this sea grass is not possible when salinity exceeds 50000 mg/L in TDS. However, we may consider that as of 45000 mg/L in TDS, the environment would have long term damage. This shows the impact of the project on sea grasses, *Posidonia oceanica*: ▪ Impact due to the construction of the intake and discharge pipes: 34 m (width of excavation) x 4000 m (average length of pipeline) x 80% (sea grass coverage rate at the level of the pipeline) = 11.2 ha (note: partial recovery is possible above the pipeline in coming years) ▪ Impact due to the discharge of salinity: salinity (TDS)< 45000mg/L => radius > 200m => impacted area : 3.1416×200^2 / 2×80%= 5ha (the choice of the coverage rate at 80% is pejorative for this calculation as it increases the impacted area) <u>Desalination effects in the Gulf of Gabes</u> In the Gulf of Gabes, 4 sea water desalination projects are in progress : ▪ Sfax (this project) : 200,000m^3/day at the end of the project ▪ Djerba : 75,000m^3/day at the end of the project ▪ Zarat : 100,000m^3/day at the end of the project ▪ Kerkennah : 6,000m^3/day at the end of the project This represents therefore a total of 381,000m^3/day at the level of the Gulf of Gabes by horizon year 2030. If we consider that the Gulf of Gabes covers a total area of about 12,000km² and if we also consider an average annual evaporation of 1788m/year (ref. National Meteorology Institute), then the daily evaporated water volume would be 12,000,000,000 m² x 1.788 m / 365 days = 58,800,000 m^3/day. Water desalination would then represent at the end of projects about 381,000 / 58,800,000 = 0.6% of the evaporation all over the Gulf of Gabes (by deliberately not calculating additional inputs of soft water discharged by purification stations). Therefore, except the influences at discharge point, the influence on ecology system in the Gulf of Gabes is quite small. The nearest seawater desalination plant planned is the Kerkennah plant 40km from the Sfax plant, Therefore, discharge water from both plants will not be merged and their combined influence on ecology system is negligible because of sufficient dilution effects.
Subsidence means, poverty, vulnerability	**Coastal fishing activities in the vicinity of the desalination station's site** In 2004, fishing in the Governorate of Sfax represented 47% of the national overall activity, while the port of Sfax represents the largest fishing port in Tunisia (with an annual production of about 15,000 tons). Fishing methods used in Sfax are shown in the following table:

Criteria	Investigations Results

Table 8.8-3 Fishing Methods in the Sfax Region

Method	Boats	Target	Area	Status
Coastal shell collection	-	Crustaceans, molluscks	Beach, littoral	Authorized
Line fishing	Sail boats or with engines (1 to 2 fishermen)	cuttlefish, sea bream	*Posidonia oceanica* (depth 2 to 10m) Sfax-Kerkennah Channel (depth +10m)	Authorized
Net fishing (static)	Sail boats or with engines (2 to 5 fishermen)	Octopus, cuttlefish, shrimps, sea bream, flounder		Authorized
Trapping	Sail boats or with engines (1 to 2 fishermen)	Octopus, mullet		Authorized
Fishing with turning seine	Motor boats (6 to 8 fishermen)	Tuna, sardine		Authorized (depth.+20m)
Mini-trawl fishing (« kiss »)	Sail boats or with engines (1 to 6 fishermen)	Octopus, cuttlefish, shrimps, sea bream, flounder		forbidden

Source : SMAPIII report, City of Sfax (Impact study : report on marine environment)

Source : SMAPIII report, City of Sfax (Impact study : report on marine environment)

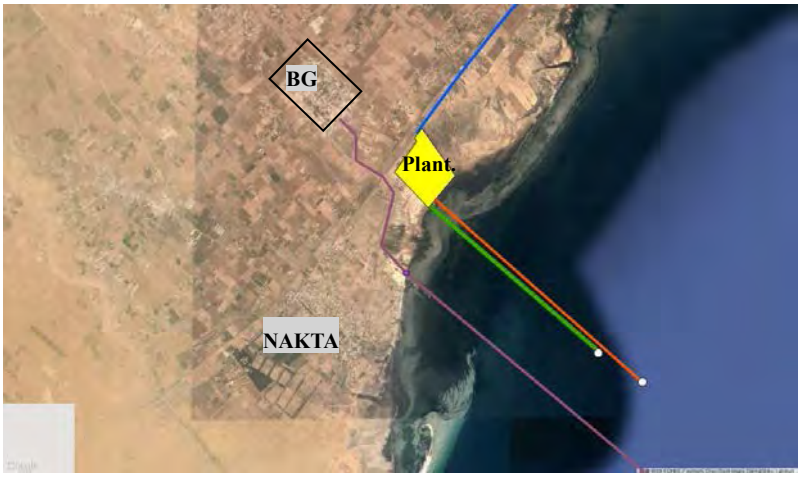
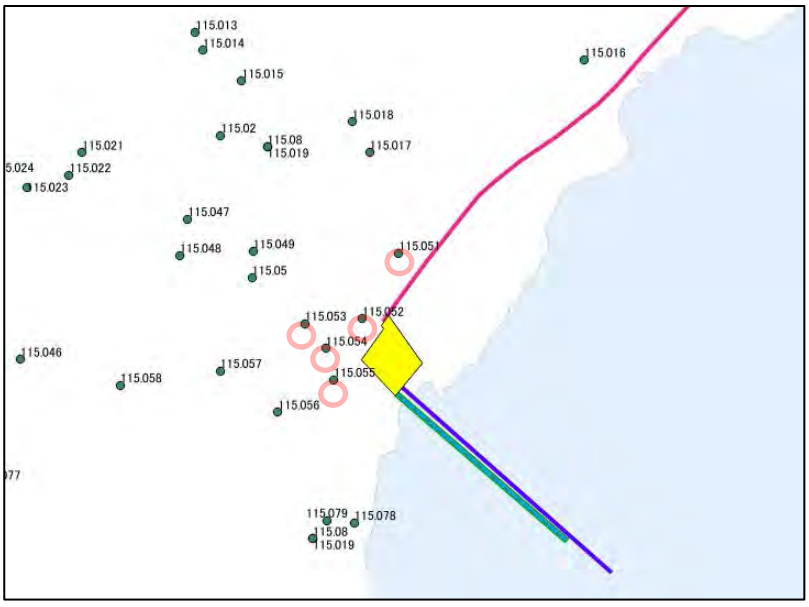
Figure 8.8–7 Fishing Boats in the Sfax Region (sail boat on the left and motor boat on the right)

Impact of the construction of intake and discharge pipes on fishing activities, the example of British Gas (referred to as BG):

The gas plant of British Gas is located in the vicinity of the project site.

The following observations can be made about gas pipelines linking offshore extraction platforms to the plant:

1) According to the pipelines' coordinates, they neither cross the desalination station's proposed site nor sea pipelines:

Criteria	Investigations Results
	 Source : BG (pipelines' coordinates) ; JICA Study Team **Figure 8.8–8 Position of the Project and BG Pipelines** 2) When laying a new pipeline in 2008, the following problems emerged: 1. Since the orientation of sail boats is conditioned by the wind, the limit set for the construction of the pipeline will no longer allow access to a certain fishing areas; 2. Collection of shells is practiced in the project area by local women. As turbidity increased during excavation works offshore, the quality of the shells dramatically dropped reducing sales; 3) In order to act on these issues, BG set up a compensation system summarized as follows: 1. During the construction phase of the initial five kilometres of the pipeline, payment of a monthly compensation to populations affected by the project; 2. For boats or vessels: NDI TND for the captain and NDI TND for crew members; 3. About NDI TND for women shell collectors. 4) Four staff members of BG devoted 30% of their time for 6 months to settle these issues. We expect similar works for the construction of intake and discharge pipes. In order to prevent these issues, it is necessary to consult with fishermen and with the local population, explain to them the construction method and define an appropriate compensation programme.
Historical and cultural heritage	The location of archaeological ruins around the site of the desalination plant based on the information of the National Institute of Ruins (Institut National du Patrimoine, INP) is shown in Figure 8.8-9.  Source: : INP, JICA Survey Team **Figure 8.8–9 Location of Archaeological Ruins around the Desalination Plant Site**

Criteria	Investigations Results
	The archaeological ruins close to the plant site are as shown in the following table. The nearest archaeological ruins No. 115.052 is 290m from the site. **Table 8.8-4 List of Archaeological Ruins near the Plant Site** ID / Name / Longitude* / Latitude 115.051 / Sidi Ghrib / 647127.10 / 3830084.99 115.052 / Jeh el Hr. / 646600.63 / 3829107.43 115.053 / Hr. Farhat / 645748.46 / 3829025.98 115.054 / - / 646063.70 / 3828661.98 115.055 / - / 646191.77 / 3828202.80 Source：INP (http://www.inp.rnrt.tn/Carte_archeo/html/115)、*UTM32N Carthage Datum The law related to conservation of ruins is No. 94-35 (24.2.1994). Clause 69 of the law enables stopping construction work for six months in case new ruins are discovered to enable survey of any newly discovered archaeological ruins.

Source: JICA Study Team

8.9 Evaluation of Impacts

Based on results of Section 8.8 above, the different impacts of the project were evaluated for each evaluation component as described in Table 8.9-1:

Table 8.9-1 Evaluation of Impacts : Seawater Desalination Plant

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
Pollution	1	Air pollution / dust	C	D	D	D	**During construction:** - Large-scale earth works and pavement works are not being planned, and areas surrounding the plant site are mainly farmlands, road and beach. Since only dust will be produced, no significant specific impact is therefore expected.
	2	Water pollution	C-	C-	D	D	**During construction :** - Turbidity will temporarily increase due to offshore excavation works, however since turbidity is generated by existing sediments, there is no additional pollution of sea water (impacts on fishing activities are described below) **During operation:** - Since discharges are diluted, salinity drops to +1000mg/L（or +2%）of the natural salinity at about 750m from the discharge head, the situation is therefore not dangerous for human activities. (Concentrations of Na and Cl in Tunisian Standards for Water discharge to Sea, NT106-002,

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
							shown in Table 8.11-1, are "No Limit"). (Impacts on natural habitats are described below). - Taking in consideration the nominal capacity of the 4 sea water desalination stations planned in the Gulf of Gabes, the accumulated water intake volume will be 0.6% of water losses through evaporation at the level of the Gulf. There is therefore no significant impact at this level.
Natural environment and natural risks	10	Natural habitats	B-	C-	B-	B-	**During construction :** - Due to excavation works in the sea, 11.2 ha of *Posidonia oceanica* will be lost, which will have an impact on the marine environment. However, when compared with the 52,000 ha of sea grasses living along the Sfax coast, this impact is rather limited and partial recovery will be possible in the long term above the pipelines. - The coverage rate of sea grasses in the pipelines area ranges between 60% and 80%. The deposit of excavated materials in the area may generate additional loss of sea grasse, this is why the impact depends on the choice of the deposit site for the 101,600 m^3 excess excavated material. **During operation :** - The final impact area of discharged water is estimated at about 5.0 ha, however, compared to the 52,000 ha of sea grasses living along the coast of Sfax, the impact is relatively limited.
	11	Hydrology	C-	D	D	D	**During construction :** - After excavation, pipes will be taken to the site by floating them and then they will be laid at the bottom of the sea trench and buried, so there will be no impact on marine currents.
Human and social environment	14	Means of subsidence, poverty, vulnerability	C-	D	B-	D	**During construction :** - Based on the British Gas experience, it is possible that the construction of pipelines impacts fishing activities.
	16	Local economy/Empl	B+	B+	B+	B+	**During construction :** - Local employment will increase;

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
		oyment					- Possibility for sub-contracting services with local providers **During operation :** - Possibility for operators' positions at the plant - Possibility for sub-contracting services with local providers
	18	Water resources	D	B+/C+	D	B+/D	**During operation :** - No impact on health by change of water supply system because no relationship between the water supply and diseases has definitely been proved.
	19	Public infrastructures and public services	D	B+	D	B+	**During operation :** - The project will improve the quantities and quality of drinking water
	22	Local conflicts of interest	D	B+	D	B+	**During operation:** - The project facility will be located in the Greater Sfax area. The subject area of the project is the whole Greater Sfax. - As this seawater desalination project will ease the water supply situation in the central area of Tunisia, it will have a positive effect on any impacts of any local conflicts.
	23	Historical and cultural heritage	C-	D	D	D	**During construction :** - As shown on Figure 8.8-9, there are currently no archaeological ruins at the desalination plant site. The route for the transmission pipeline was once excavated for road construction, and therefore, the possibility of discovery of new archaeological ruins is very low. Areas for foundation works of power transmission towers are small, i.e. four piles which are 0.8m in diameters, In addition, it is possible to change the route to avoid any archaeological ruins if they exist. - The results of geotechnical drilling works have shown no hard stratum in the project area, therefore, the probability of archaeological ruins is very limited.
	25	Gender	D	C+	D	D	**During operation :** - Though the increase of water supply volume by the project will allow create the possibility of an extension of the water supply area; as the rate of connection to

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
							drinking water supply in Sfax is already very high, the improvement of the water supply service may have only little positive impacts on existing women's conditions.
	28	Professional health /safety on the worksite	D	C-	D	D	**During operation :** - SONEDE's operating stations already use similar chemical products, so the staff has good and appropriate experience in managing any leaks and related hazards.
Others	30	Trans-border effects and climatic changes	D	C-	D	D	**During operation :** - Power consumption in Tunisia for the year 2013 was 14,379GWh (https://www.steg.com.tn), the power consumption by the station: 143GWh will therefore represent 1% or less of the national consumption figures, the increase of CO_2 emissions will then be very limited at the national level.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 8.9-2 Evaluation of Impacts : Transmission Pipeline

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
Pollution	1	Air pollution/dust	C	D	D	D	**During construction:** -Large-scale earth works and pavement works are not being planned, and the pipeline route is mainly surrounded by farmland and roads. Since only dust will be produced, no significant specific impacts therefore are expected.
Natural environment and natural risks	12	Morphology and geology	C-	D	D	D	**During construction :** - The construction and laying of transmission pipes will generate 60,000m^3 of excess excavated material. However a large part can be reused on the site of the desalination station, which requires backfilling. On the other hand, several deposit sites nearby Sfax are also available; and there will be no big impact on existing soils.

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct . phase	Operation phase	
Human environment and society	16	Local economy / Employment	B+	B+	B+	B+	**During construction :** - Local employment will increase; - Possibility for sub-contracting services with local providers **During operation :** - Possibility for sub-contracting services with local providers
	17	Use of soils and local resources	C-	D	B-	D	**During construction :** - In general, pipes will be laid in the right of way areas of existing roads. However, some land acquisition will be necessary in several areas and for surge tank areas.
	19	Public infrastructures and social services	D	B+	D	B+	**During operation :** - The project will improve the quantities and quality of drinking water
	21	Repair of benefits, social equity	B+	B+	B+	B+	**During construction, and During operation:** - - The project facility will be located in the Greater Sfax area. The subject area of the project is the whole Greater Sfax.
	22	Local conflicts of interest	D	B+	D	B+	**During operation:** - The project facility will be located in the Greater Sfax area. The subject area of the project is the whole Greater Sfax. - As this seawater desalination project will ease the water supply situation in the central area of Tunisia, it will only positively affect the impacts of any local conflicts.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 8.9-3 Evaluation of Impacts : Power Transmission Line

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
Pollution	1	Air pollution/dust	C-	D	D	D	**During construction:** - Large-scale earth works and pavement works are not being planned, and the pipeline route is mainly surrounded by farmland and roads. Since only dust will be produced, no significant specific impacts are expected.
Human and social	14	Subsidence means, poverty,	C-	D	B-	D	**During construction:** - Land acquisition of 10 m x 10m

Categories		Impact criteria	Evaluation		Confirmation		Justification
			Construct. phase	Operation phase	Construct. phase	Operation phase	
environment		vulnerability					each for power transmission pylons. Including additional space for construction work, there is a high possibility of impacts on farmlands. Cutting of olive trees will need to be done.
	17	Use of soils and local resources	C-	D	B-	D	**During construction:** - Land acquisition of 10 m x 10m each for power transmission towers. Including construction work space, there is a high possibility of impacts on farmlands.
	24	Landscape	D	C-	D	D	**During operation:** - The seawater desalination plant site is 10km from the Thyna archaeological park, and also far from the Medina located in Sfax city. Therefore, no impact is expected on landscape of tourist spots. It is expected that the power transmission route will be located in areas surrounded by farmland, and therefore no serious impact on landscape is expected.

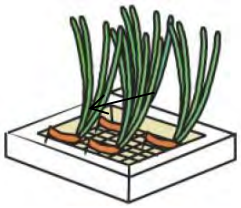
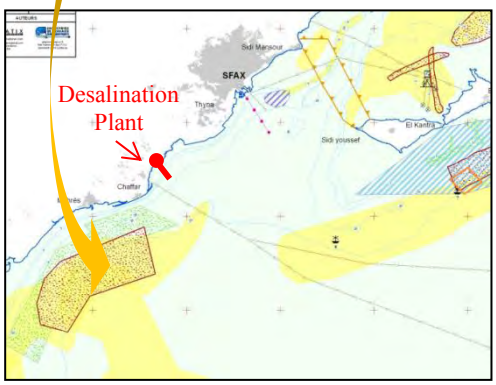
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

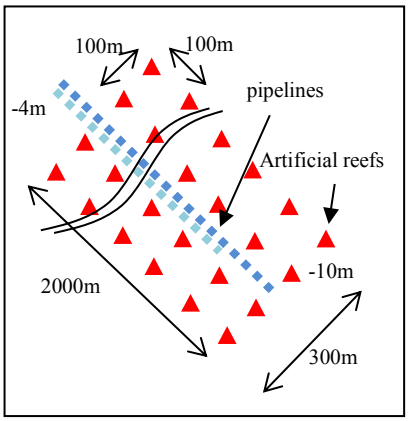
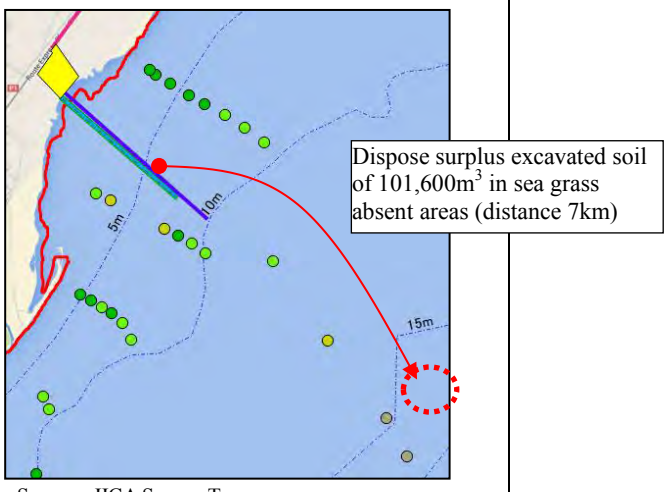
8.10 Mitigation Measures and Implementation Costs

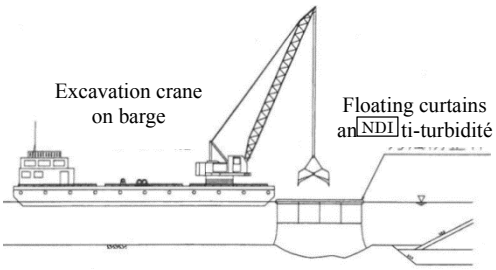
For each impact identified and evaluated in Section 8.9 above, the following mitigation measures are suggested:

Table 8.10-1 Suggestion of Mitigation Measures

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
During construction					
1	Loss of sea grass during excavation of intake and discharge pipes (~12ha)	Sea grass may grow again on buried pipelines, but the growth rate of *Posidonia oceanica* is estimated at 3 to 4 cm/year (*Protection and Conservation of Posidonia oceanica, RAMOGE, 2006*). To cover 38 m-large excavations, time required will be 38m / 2 sides / 3.5cm = 543 years. Recovery being very slow, it is therefore necessary to suggest additional mitigation measures. We may first consider the artificial planting of sea grass. Images showing experiments made in the Mediterranean sea on *Posidonia oceanica* are shown below. According to them, the success rate after four years was 84%. Costs amount to 500 man-hours per hectare or about NDI USD or JPY NDI per ha (*Protection and Conservation of Posidonia oceanica, RAMOGE, 2006*).	Construction company	SONEDE / INSTM / ANPE	Non-Disclosure Information

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
		  Source : RAMOGE, ONG "Sea Gardens" **Figure 8.10–1 Replanting of *Posidonia oceanica*** However, compared to the 52,000ha of sea grass made up of *Posidonia oceanica* and *cymodocea* of the Sfax coast, replanting some hectares seems not to be an efficient solution (See *Protection and Conservation of Posidonia oceanica, RAMOGE, 2006, p. 139*). In order to efficiently protect sea grasses and related ecosystems, it is possible to lay out artificial reefs all over the project area. Reefs will also protect against mini-trawl fishing. This technique to valorise resources is already implemented by the DGPA in the Gulf of Gabes.   Source : Conservation of fish resources with artificial reefs (DGPA, 2014) **Figure 8.10–2 Installation Plan of Artificial Reefs in the Gulf of Gabes** An example of the installation of reefs along pipelines in this project is suggested below :			

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
		 Source : JICA Survey Team **Figure 8.10–3 Artificial Reefs Installation Plan (example)** There will be 4x21=84 reefs, and each reef will be made up of eight concrete blocks each weighing one ton for a total of 84×8ton＝672ton or 280m^3 of concrete. Reinforcement bar weighs about 100kg/m^3 or 28ton. The cost of 1m^3 of concrete is NDI USD and installed reinforcement bar costs NDI USD/ton. The total estimated cost is about 280xNDI + 28xNDI= NDI USD for a protected area of 60ha. **Examination results :** Mitigation measures against the negative influences to sea grasses meadows are; 1) artificial planting, and 2) artificial reef installation. Based on the experience in Gabes Bay Artificial Reefs Project, implementation of 2) is judged to be practical, thus it was selected as the mitigation measure of choice by the project against negative influences on sea grass meadows.			
2	Impact of the deposit of excess excavated materials (~50,000m^3)	Excavated material in excess should be deposited in areas with no sea grasses growing as shown on the map below.  Source : JICA Survey Team **Figure 8.10–4 Sea Deposit Plan (example)** Transportation and depositing costs will be about NDIUSD/m^3, total costs will then amount to	Construction company	SONEDE / INSTM / ANPE	Non-Disclosure Information

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
		101,600m^3 × NDI USD/m^3 = NDI USD. Note : A detailed study about sea weed coverage in the area may suggest further reducing this distance.			
3	Impact of the construction of pipelines works on fishing activities	After explaining in detail the construction methods of pipelines to the local fishermen, anti-turbidity measures may be implemented and where required a suitable financial compensation plan put in place. An example of an anti-turbidity protection system is shown below. Considering unitary costs practiced in Japan, a protection along the pipeline would amount to about JPY NDI million.  Source : Equipe d'enquête JICA **Figure 8.10–5 Anti-Turbidity Protection (example)** The closest fishing port to the project area is Mahres at about 10 km to the project's south-west (photo below).  Source : Conservation of fish resources with artificial reefs (DGPA, 2014) **Figure 8.10–6 Mahres Port** It can be considered that 20 boats and 100 women collectors are going to be impacted by fishing activities in the pipeline area. If the period required for excavations in the coastal area would be about six months, and about one year for the laying of pipes, then based on the BG example, the following is the compensation estimate: 12 months × 20 boats × NDI TND + 2 × NDI TND) + 6 months × 100 individuals × ND TND = NDI TND.	Explanations of anti-turbidity methods and measures: Construction company Compen -sation : SONEDE	SONEDE / UTAP	Non-Disclosure Information
4	Land acquisitions for transmission pipeline and power transmission line	The acquisition of lands and compensations will be made according to Tunisian Law n. 2003-26.	Legal and acquisitions department at SONEDE and STEG	SONEDE / Ministry of Agriculture	See Chapter 9

No.	Impact	Mitigation measures	Implementation entity	Monitoring entity	Costs
During operation					
5	Permanent impact of discharge on sea grass	As shown in Figure 5.4-10, salinity concentration of discharged water is reduced to 48,400 mg/L at the seabed through the use of multi-discharge nozzle. This idea is already employed in the design, and is not considered as the mitigation measure, but the dilution of discharge water allows reducing the impact. Further, there are two measures to dilute or reduce the discharge water as explained below to this table; 1) discharge to Thyna Salt-works, and 2) dilution with treated sewage. Both ideas, however, were considered to be not applicable to the Project. Therefore, the impact on sea grass meadows is not avoidable around the discharge head. As an off-set measure, it is recommended to apply mitigation measures at a place different from the discharge head location. The measures are; 1) artificial plantation of sea grass, and 2) installation of artificial reefs. Due to the same reasons as those stated above, installation of artificial reefs is recommended. The installation plan is shown in Figure 8.10-3. Required cost is USD NDI . In addition, due to the permanent character of impacts, it is necessary to regularly monitor sea grasses. A monitoring plan is suggested in Section 8.11.	-	-	Included in No.1

Source : JICA Survey Team

Mitigation measures suggested above represent an investment of about JPY NDI million excluding land acquisitions as shown in Table 8.10-2. This cost is considered as a part of the project cost. Assuming the total project cost to be JPY NDI billion, the said mitigation cost will be equivalent to 0.6% of the total cost.

Table 8.10-2 Cost for Mitigation Measures

Mitigation Measures	Cost	Cost (equivalent Yen) (USD1=JPY119.6) (TND1=JPY61.02)	Item
Artificial Reef	Non-Disclosure Information		Construction Cost
Deposit of Surplus Material			Construction Cost
Turbidity Prevention			Construction Cost
Compensation to Fisheries			Compensation

In addition to these measures, the two following measures should also be studied:

1) Connection to Thyna salt-works and reuse of discharge to produce salt

As shown on the following map, the Thyna salt-works stretch from the Port of Sfax to the southern suburbs and are subject of the protection of the international RAMSAR convention (protection of wetlands). The daily harvesting of sea water amounts to about 82,000 m^3/day

for an annual salt production of 330,000 ton/year. Salt is exported to America and to northern Europe to be used as antifreeze for roads in the winter seasons. The salt-works are located 10 km from the desalination plant site, and discussions with the salt-works operator (COTUSAL) have revealed that they have an interest in the technical opportunity to reuse discharges (73,000 mg/L) to increase the salt production in the same area.

Source : JICA Survey Team

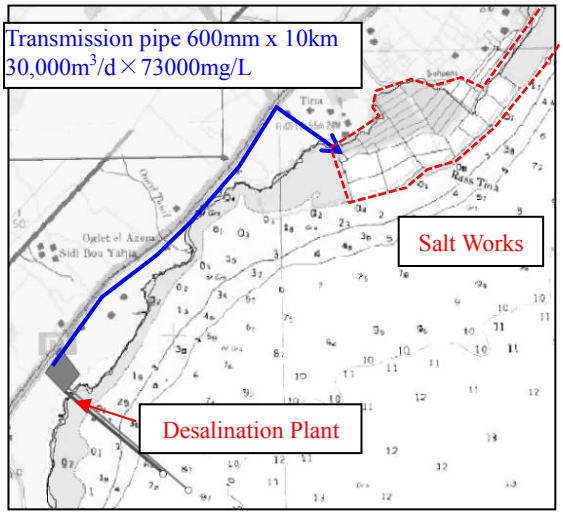
Figure 8.10–7 Scope of Thyna Salt-Works (COTUSAL) and Current Conditions

According to COTUSAL, considering daily variations, the volume of discharge that can be received by the salt-works would be about 30,000 m^3/d. While the technical feasibility has been confirmed, the economic feasibility still needs to be studied. But, the absence of any similar experience worldwide may put this solution into question.

If this solution can be implemented, the volume of brine discharged in the sea will be reduced, which will constitute a mitigation measure. The preliminary plan of this solution is shown in Figure 8.10-8.

Assuming 30,000m^3/day of transmission to the salt-works, discharge from the desalination plant will be about 92,200 m^3/day (= 100,000/0.45 - 100,000 - 30,000) or 76% of the discharge volume in the case without this option. This option requires a 10km long 600mm diameter pipeline and a pumping facility with a pumping head of 35m.

While, as the salt-works are protected as a RAMSAR area, it is necessary to clearly identify the impact on avifauna induced by modification of the basins water composition due to the discharge of brine, and this will take a long time to identify. Considering the urgency of this project, it is judged that its execution shall be considered during Phase 2.



Source : JICA Survey Team

Figure 8.10–8 Thyna Salt-Works Mitigation Measure (COTUSAL) (example)

2) Reuse of the discharge of South Sfax Sewage Treatment Plant to dilute brine discharge

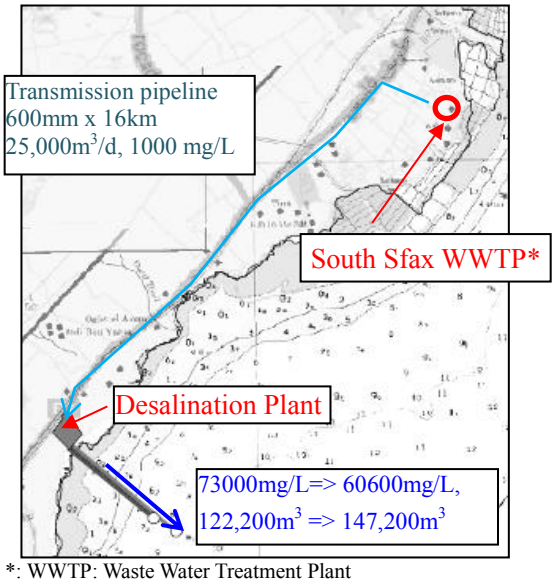
The use of the discharge from the South Sfax waste Water Treatment Plant, it would be possible to dilute brine before it is discharged into the sea. This solution is shown in Figure 8.10-9, and the distance between the two plants is about 16km.

Assuming salinity of treated sewage is 1000mg/L, salinity of discharge from the desalination plant will be as follows:

Discharge in Phase 1 : 122,200m^3/d × 73000mg/L + 25,000m^3/d × 1000mg/L

= 147,200m^3/d ×60,600mg/L.

This concentration is 83% of the case without said option. But, discharge volume will increase by 20%. This option requires a 16km long 600mm diameter pipeline and a pumping facility with a pumping head of 30m.



*: WWTP: Waste Water Treatment Plant

Source : JICA Survey Team

Figure 8.10–9 Mitigation Measure by Using WWTP Discharges (example)

The South Sfax waste water treatment plant (WWTP) currently discharges about 35,000 m^3/day, of which 10,000 m^3/day (or 40%) are already reused in agriculture, and this rate tends to increase. Since the STP discharge is already used in irrigation, this mitigation measure cannot be considered.

As stated above, both mitigation measures cannot be employed in Phase 1. Even though said measures are employed, it is not possible to eliminate the impact on sea grasses by discharge from the desalination plant. Therefore, as a mitigation measure, an off-set measure, the installation of artificial reefs, shall be employed as presented in Table 8.10-1 item 5.

8.11 Monitoring Plan

This project mainly impacts the marine environment, it is therefore necessary to monitor the state of sea grass and sea water quality. In Tunisia, standard NT106-002 regulates discharges within the natural environment. Table 8.11-1 shows the NT106-002 standard concerning sea discharges.

Table 8.11-1 NT106-002 Water Quality Standard concerning Discharges to Sea

Item	Limit value	Unit	Item	Limit value	Unit
Discharge temperature	35	°C	Chlorine compounds	0.05	mg/L
pH	6.5 - 8.5		ABS	2	mg/L
Suspended solids	30	mg/L	B	20	mg/L
Settlable solid	0.3	mg/L	F	1	mg/L
COD	90 (average in 24h)	mgO_2/L	Cu	1.5	mg/L
BOD_5	30	mgO_2/L	Sn	2	mg/L
Cl	No limit	mg/L	Mn	1	mg/L
Cl_2	0.05	mg/L	Zn	10	mg/L
ClO_2	0.05	mg/L	Mo	5	mg/L
SO_4	1000	mg/L	Co	0.5	mg/L
Mg	2000	mg/L	Br_2	0.1	mg/L
K	1000	mg/L	Ba	10	mg/L
Na	No limit	mg/L	Ag	0.1	mg/L
Ca	No limit	mg/L	As	0.1	mg/L
Al	5	mg/L	Be	0.05	mg/L
Color (PtCo scale)	100		Cd	0.005	mg/L
S	2	mg/L	CN	0.05	mg/L
F	5	mg/L	Cr^{6+}	0.5	mg/L
NO_3	90	mg/L	Cr^{3+}	2	mg/L
NO_2	5	mg/L	Sb	0.1	mg/L
N	30	mg/L	Ni	2	mg/L
PO_4	0.1	mg/L	Si	0.5	mg/L
Phenols	0.05	mg/L	Hg	0.001	mg/L
Mineral oils	20	mg/L	Pb	0.5	mg/L
Hydrocarbons	10	mg/L	Ti	0.001	mg/L

Source : INNORPI, 1989

Monitoring water quality during the construction of pipelines will be based on the monthly measurement of turbidity (as well as pH, temperature and electric conductivity) along the pipelines (one location) and at the level of the beach (one location). Once operation starts, water quality will be measured at the level of the discharge site to check items of the standard cited above (twice a year for the first year and once a year in the two following years at one location).

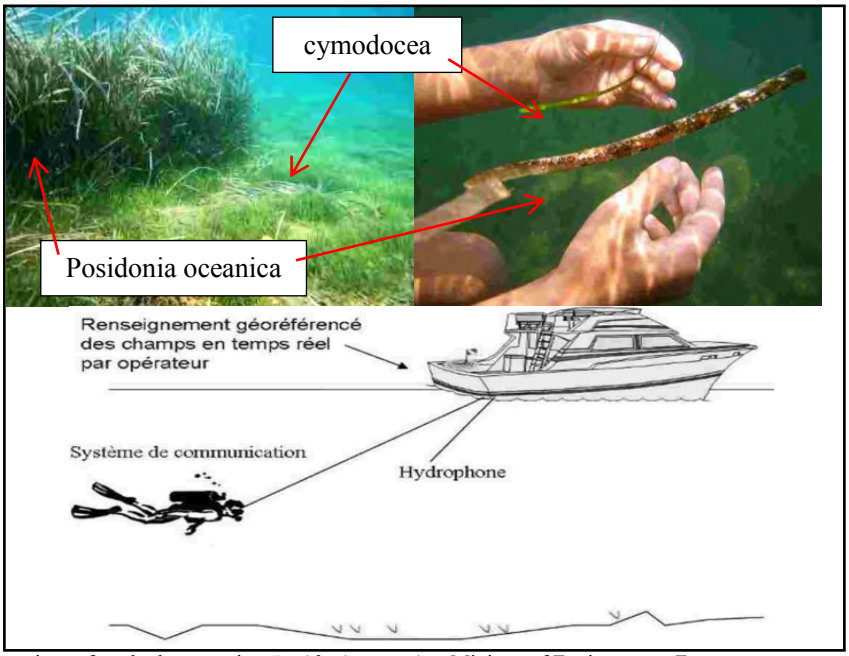
The EIA terms of reference, parameters used to monitor *Posidonia oceanica* are given in the following table:

Table 8.11-2 Monitoring Parameters of Posidonia oceanica

Parameter	Observation
Sea grass pressure (Grass)	L: % of leafs with herbivores
Coverage by invasive algae	T: % cover of algae such as *C. racemosa* on 3 transects along 20 m
Sea grass covering (Cover)	T: % spots of live sea grass over 3
Dead mat cover	T: % dead mats on 3 transects over 20 m
Density of transect beams	T: Number of live beams per quadrant of 40x40 cm taken randomly
Plagiotrope rhizomes (Pl rhi)	T: % per quadrant (3) of 40x40 cm taken randomly
Beam biomass	Dry weight of leaves without epiphytes (gr/beams)
Surface of leafs by beam (Shoot FS)	L: (LAI) surface area of leaves (cm^2 shoot21)
Length and width of leafs (Leaf L)	L: average per type of leaves and by beam (cm)
Others	

Source : INSTM, Ben Mustapha

It should be noted that a diver with a boat is required to monitor *Posidonia oceanica*. It can be considered that SONEDE does not have this know how in-house and that monitoring will be carried out by INSTM (National Institute for Sea Science and Technologies). The method used to monitor *Posidonia oceanica* is shown in Figure 8.11-1 below.



Source : Comparison of methods to monitor *Posidonia oceanica*, Ministry of Environment, France

Figure 8.11–1 Photos of *Posidonia oceanica* and *Cymodocea*, and Monitoring Methods

In order to monitor soil dredging works and the deposit of excess material, monitoring the seabed around the pipes installation site (two locations) and the deposit site (one location) will be carried out twice a year during the construction phase. Before starting operation, monitoring will be carried out in four areas; namely at the artificial reef area, at the discharge point, and at 200 m and 1000 m from the discharge point in order to constitute a baseline reference. Once operation starts, monitoring will be carried out in the same areas, four times on the first year and twice in the two following years. This is summarized in Table 8.11-3.

Table 8.11-3 Monitoring Plan

Environmental aspect	Criteria	Site	Frequency	Entity in charge
Construction phase				
Water quality	Turbidity, pH, Temperature, electric conductivity	Along the pipeline and along the coast Total 2 locations	Every month	SONEDE
Natural habitats (*Posidonia* oceanica)	Criteria of table 8.11-2	2 sites near the pipeline and 1 site near deposit area Total 3 locations	Twice a year	SONEDE (+INSTM)
Operation phase				
Water quality	Criteria of Table 8.11-1	Near discharge tower 1 location	Twice in the first year, once a year in the two following years	SONEDE
Natural habitats (*Posidonia oceanica*)	Criteria of table 8.11-2	Artificial Reef, Water discharge point, 200m from discharge, 1000m from discharge Total 4 locations	Four times in the first year, and twice a year in the two following years	SONEDE (+INSTM)

Source : JICA Survey Team

The Monitoring Form may be used for efficient submission of monitoring results. As shown on the Table 8.11-4, evaluation of monitoring results and preventive action shall be carried out. An example of such action is as follows;

Example:

- Monitoring Item: reduction of sea grass leaf numbers in the area at a distance of more than 170 m from the discharge head.
- Evaluation: There should not be any influence in the area more than 170 m from the discharge tower. Any cause of the phenomenon shall then be investigated and suitable preventive actions shall be taken.
- Preventive actions; 1) Confirm the reason why sea grasses are depleted, 2) If the reason found is related to the salt concentration, check the operation records for salinity concentration at the discharge head, 3) If the salinity of the discharge water has been higher than the designed value, examine the operational status and method, and adjust them appropriately as far as possible, 4) If it is judged that the impact area under the designed normal operational condition is wider than the one predicted, mitigation measures defined for the area shall accordingly be applied to a wider area.

Table 8.11-4 Monitoring Form

1.Comments of national organizations and of Private Sector

Monitoring Criteria	During construction	During operation
Comments of national organizations (ANPE,APAL, etc.)	(Comments and measures)	(Comments and measures)
Comments of Private Sector (UTAP, NGO etc.)	(Comments and measures)	(Comments and measures)

2.Seawater quality

Criteria for the quality of sea water	Reference value	Contract value	During construction						During operation			
			Near the coast			Near the pipeline			Near the discharge tower			
			Month 1	Month 2	…	Month 1	Month 2	…	1st time	2nd time	3 rd time	4th time
Turbidity												
pH												
Water temperature												
Conductivity												
Results and preventive actions												
Criteria of Table 8.11-1												
	…	…										
Results and preventive actions												

3.Natural environment : State of submarine *Posidonia oceanica*

Criteria	During construction									During operation											
	Near the pipeline 1			Near the pipeline 2			Site of soil deposit			Art. Reef			Discharge tower			At 200m from the tower			At 1000m from the tower		
	1st time	2nd time	…	1st time	2nd time	…	1st time	2nd time	…	1st time	…	8th time	1st time	…	8th time	1st time	…	8th time	1st time	…	8th time
Criteria of Table 8.11-2																					
Results and preventive actions																					

Source : JICA Survey Team

8.12 Stakeholders Meeting

The Tunisian legislation does not formally state the need and obligation of consultations with stakeholders in the execution of projects. This practice is already common and it is also recommended in the JICA Guidelines. To take into consideration the opinions of all parties concerned by the project, a meeting with stakeholders was suggested by the project's steering committee.

This meeting was held once the projects components were defined. The purpose was to explain the project's outlines as well as the scoping works related to the EIA. Participants represented concerned organizations (ANPE, APAL, ONAS, ANGED, etc.), local authorities (the City of Sfax, the Governorate, Fisheries related groups, Farming related group) as well as nongovernmental organizations. The policy regarding land acquisition and compensation were also explained verbally. An advance announcement was previously carried out by posting a printed poster on the notice boards of SONEDE, the universities, and governorate offices.

The summary of this meeting is provided below:

Announcement: The public announcement for the meeting was made in Sfax one week in advance. (SONEDE Sfax, the Universities, the Governorate offices, etc.) with the poster shown in Figure 8.12-1 (Original format: A3).

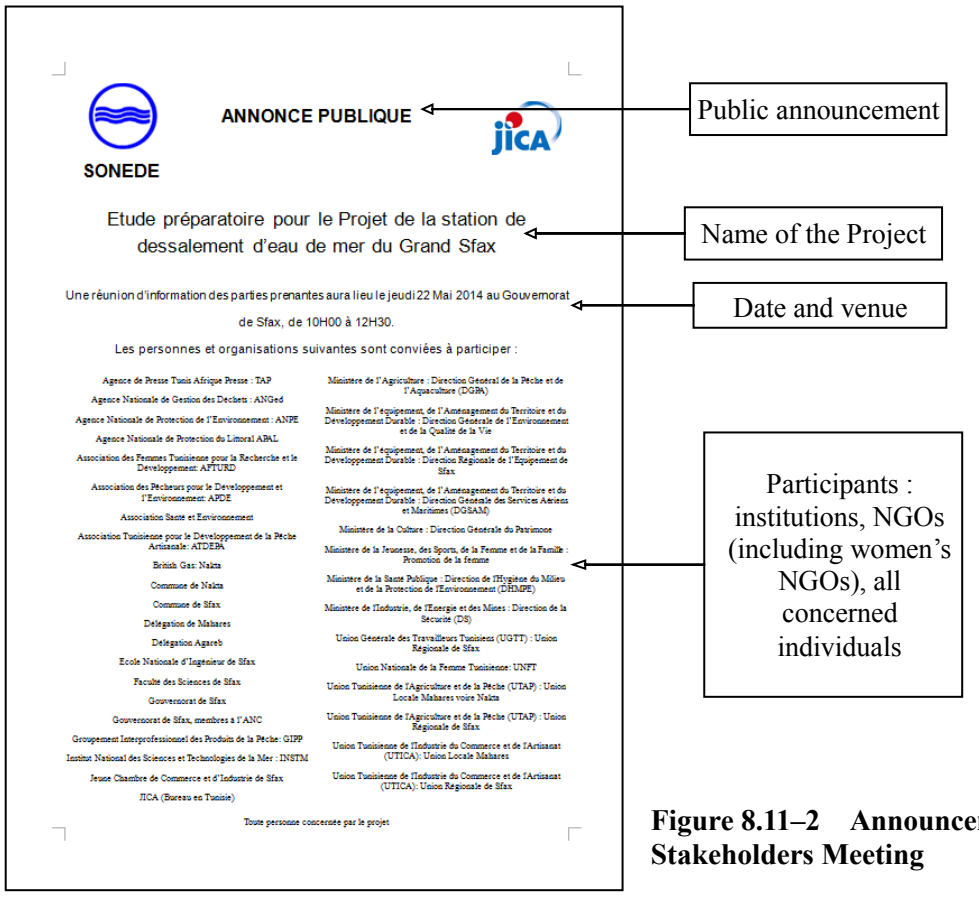


Figure 8.11–2 Announcement for the Stakeholders Meeting

Venue: May 22, 2014, Syphax Hotel

Registration: Registration of participants was conducted at the entrance and there was no limit to the participation of all the applicants.

Participants : There were 79 people in total including: the Governor, ANC representatives, delegations with Mahres, Agareb, Sakkiet Eddaier, Ministry of Infrastructures, Ministry of Health, the University of Sfax, ANPE, APAL, INSTM, STEG, ANGED, UTAP, INP, representatives of each delegation, private people. Minutes of the meeting and the list of participants are attached to this report.

Meeting:

Table 8.11-5 Meeting Agenda

Agenda	Content and photos
10:40~10:45 : Governor's welcoming speech	
10:45~11:00 : A. Boubaker, Director of Studies, SONEDE, Presentation : "Execution of the Sea Water Desalination Project in Sfax"	 Table of Content 1. Project Target Area 2. Water Supply conditions 3. Project Context 4. JICA Study Schedule
11:00~11:30 : Presentation by JICA Survey Team of the project and scoping works	 Table of Content 1. Water needs 2. Candidate sites 3. Summary of the Project 4. Scoping study 5. (Provisional) schedule

11:30~12:30: Q & A session	   

Source : JICA Survey Team

Questions & Answers :

Questions and comments	Answers and orientations
ENIS: Sfax National Engineering Institute, Lecturer 1- Renewable energies for the project? 2- Connection with salt production units in Sfax to reinforce project benefits and reduce discharge impacts? 3- Involvement of the Sfax University in the project	(SONEDE, Boubaker) 1- Energy concerns were thoroughly examined and contacts with STEG to connect the station have already been made (JICA Survey Team, Arnaud). 2- Connection to salt production facilities is a possible idea. Contacts have been made with the company in charge of operating subject facilities. This company showed some interest but was very cautious about quality. The impact on birds and the RAMSAR reserve must still be confirmed. Due to the urgency of the project, the policy of SONEDE is not to consider this alternative in this phase. This can be discussed in the framework of future developments. 3- Several institutions have been involved in the project and an EIA steering committee was set up with representatives of ANPE, APAL, and several ministries. Sfax University may be contacted during the execution of the EIA.
National Heritage Institute, Archaeologist: Impact of the project on archaeological sites?	(Arnaud) The Thyna archaeological site is not impacted upon by the Project's components
Ministry of Health (Sfax representative): 1- The British Gas pipeline is in the vicinity of the station and associated risks? 2- Problem related to deballasting vessels and distribution reserves in tanks in case operation is interrupted? 3- Warning system if distributed water is contaminated? 4- Water aggressiveness for metal pipes, corrosion of the distribution system?	(Arnaud) 1- The Survey team met with BG. The pipeline mainly conveys gas which evaporates in case of leak. As for the liquid fraction, we believe it floats on the water surface. The intake tower of the project is designed to take water at a depth of 2 to 3 meters above seabed in an 8 m high water column. Therefore, surface water is not absorbed which reduced contamination risks. 2- Vessels navigate at about 8.5 km from the intake tower. Nevertheless, in case of small oil discharge induced by ballast, risks are limited due to the design of the intake tower for the reason mentioned above. In case of an urgent interruption of operations, water reserves represent approximately eight supply hours. 3- Standard equipment includes real time monitoring (conductivity meter, pH, etc.) and will be installed in the

Questions and comments	Answers and orientations
	station with a centralized monitoring and control system. As for the detection of contamination, no particular system is designed but the risk that bacteria or even viruses can penetrate through reverse osmosis membranes is very limited. 4- (Nouicer) Before reaching the distribution network, water is mixed with mineral additives in the post-processing phase, so that desalinated water is not more aggressive than standard running water.
INSTM Sfax branch: 1-Involvement of INSTM in the project? 2-Live organisms other than *Posidonia* oceanica such as phyto and zoo plankton? 3-Pilot sites? 4-Is the distance of 800 m between intake and discharge towers sufficient?	(SONEDE, Nouicer) 1-SONEDE is very keen on involving INSTM in the project, and JICA Survey Team met several times with INSTM experts in Tunis. An invitation was also sent to INSTM-Tunis to join the EIA follow up committee. Unfortunately no reply was received. (Arnaud) 2- During the EIA, the study of water quality and sediments, including biological characteristics and several points will be made. 3- Our sampling areas were defined: Two samples in the project area and two other samples at the pilot sites. 4- The 800 m distance between the aspiration and discharge towers is enough for discharge water salinity to be sufficiently diluted before being aspirated again. In addition, the main current direction is almost perpendicular to the alignment of intake and discharge towers, which prevents the risk of feeding intake with discharged water.
UTAP, member: 1-Compensations to fishermen for impacts on fishing during construction and operation 2-Water turbidity caused by illegal fishing such as kiss and danger for water intake?	(Arnaud) 1- Considerations about projects' social impacts represent a key component of the donor, and public consultations represent one major mission of the EIA. There is an experience on compensations provided to fishermen of Nakta carried out by BG. This experience may be considered within the framework of the desalination project. 2- The intake tower is designed to take water at 2 to 3 m from the seabed which reduces the risk of absorbing water with high turbidity. Absorbed water is then conveyed through sand filters in the pre-treatment phase which will eliminate water turbidity.
Sfax Engineering Association, Chairman: Problem of leaks in the distribution system of Sfax and cost of produced water?	(Boubaker, Noucier) There are currently several programs carried out by SONEDE to reduce leaks at the national level. The leakage rate in the region of Sfax is about 20% which is reasonable and represents one of the best rates in Tunisia. However, due to the high cost of desalinated water, SONEDE will make all efforts to reduce water leakage.
APAL Office, Sfax: Modification of currents around the intake tower and consecutive impact on the ecosystem?	(Arnaud) The intake tower is designed to take water at a speed of 0,2m/s, which is close to the average current of water around the aspiration nozzle head (0,1m/s). Besides, the intake head is concentrated in a local area so no substantial modification of the current can be expected.
ANPE Office, Sfax: Q: 1- Project sustainability? 2- Involvement of Sfax University? 3-Relation with Nakta fishermen due to the current concerns related to the construction of the British Gas pipeline?	(Arnaud) 1- The presentation is just a summary of the orientation report. Sustainable development is JICA's basic policy and environmental and social aspects represent the EIA's objectives for the project to be viable. 2- Several institutions have been involved in EIA follow up committee: ANPE, APAL, Ministry of Agriculture, Ministry of Equipment and Environment, and Ministry of Health. Besides several INSTM persons were consulted. The involvement of the University may take place when implementing the EIA. 3- During the EIA implementation, public consultations, including those with Nakta fishermen will be held to listen to their opinions and suggest appropriate measures. The

Questions and comments	Answers and orientations
	experience of providing compensations for Nakta fishermen made by British Gas may be considered as applicable for compensations to be eventually granted within the framework of this project.

Source : JICA Survey Team

The following comments are reflected in the project as follows:

- Several institutions are already involved in the EIA preparation (ANPE, APAL, INSTM, etc.), but during the EIA implementation phase, the Sfax University and the local branches of ANPE, APAL and INSTM may be involved.
- The BG experience implies the launch during construction of collaboration channels with local fishermen and UTAP to explain construction methods and eventually define a compensation plan.
- The project development is supported by measures to improve the present system while evaluating it in a global and integrated way.

During the EIA implementation phase (in 2015), meetings with stakeholders will be held, together with meetings to inform the general population to be held in different communities affected by the project. It is appropriate to hold the explanatory meetings at the places where land acquisition will be conducted or construction affected area, i.e. Mahres (on place), Agareb (two places), and Sfax South (two places). At the explanatory meetings, it is required to explain and discuss about the contents of the project, such as the power transmission line, implementation schedule, land acquisition procedure, compensation plan, and cut-off-date regarding compensation.

CHAPTER 9

LAND ACQUISITION AND RESETTLEMENT

CHAPTER 9 LAND ACQUISITION AND RESETTLEMENT

9.1 Needs for Land Acquisition and Resettlement

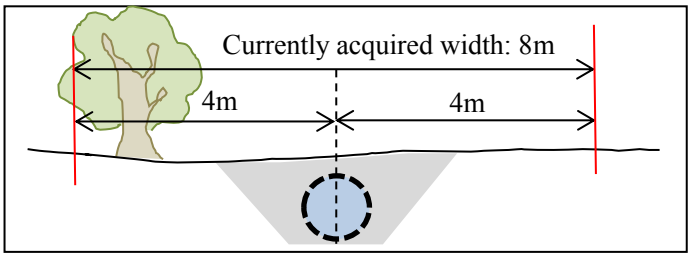
The need for land acquisition and resettlement for the Project is summarized in Table 9.1-1. This Project will not require the displacement of people and will not require large scale land acquisition.

Table 9.1-1 Needs for Land Acquisition and Resettlement

Component	Use	Land acquisition and procedure requirements	Resettlement requirements
Intake pipe Discharge pipe Desalination plant (RO Process)	Maritime public domain (public land)	The use of the maritime public domain is conditioned by a special authorization	None
Transmission pipeline	Generally in the right of way areas of existing roads (public lands) with the possibility to acquire some private lands (underground)	Normal procedure with the permission of the authority in charge of road networks or the road operators. Possibility of having to acquire lands in some areas	This Project was designed so as to avoid the resettlement of people by adjusting the outline of pipes and the location of structures where necessary.
Pumping station	Within the desalination plant area or in current reservoirs sites (public or SONEDE's lands)	None	
Water hammer/surge tank	According to the final choice of sites, possibility of having to acquire some private land	Possibility of having to acquire lands	
Distribution reservoirs	Within sites of existing reservoirs	None	
Power transmission line	Farmland (Private)	Possibility of having to acquire lands. SONEDE will possess the lands.	

Source: JICA Study Team

Acquisition operations conducted by SONEDE concern agricultural lands and mainly for the laying of transmission pipes. As shown in the following figure, SONEDE will acquire the corresponding lands, 8 m wide or 4 m on both sides of the pipe. Agricultural activities are allowed around the pipeline with the exception of olive trees and arboriculture.



Source: JICA Survey Team

Figure 9.1–1 Plan of Current Land Acquisitions being conducted by SONEDE

9.2 Tunisian Legal Framework for Land Acquisition and Resettlement

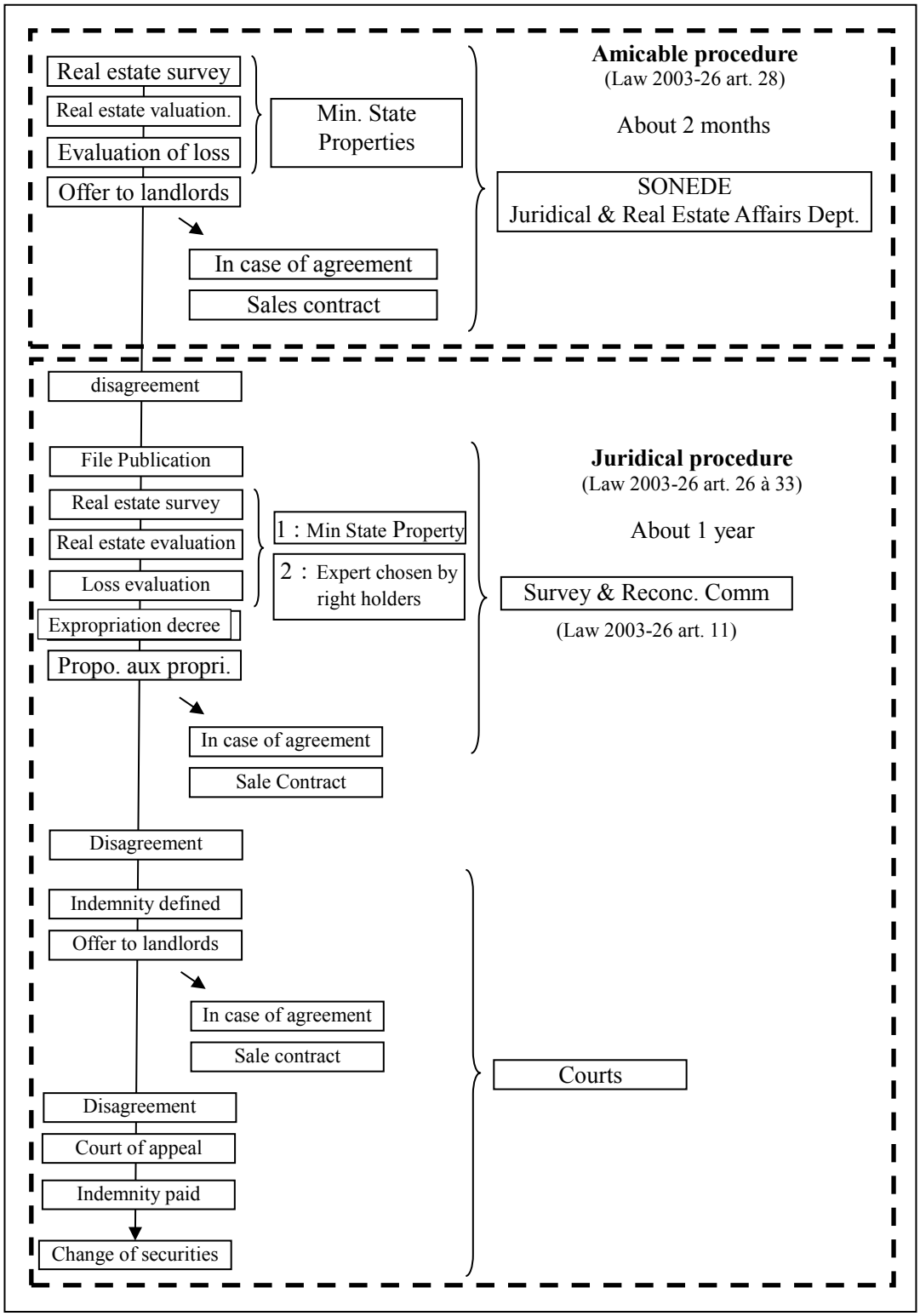
(1) Outline of the Tunisian legal framework for the acquisition of land and resettlement

The most pertinent legislative framework is Law 1976-85 dated August 11, 1976 as amended by Law 2003-26 dated April 14, 2003 related to resettlement activities for public use and utility (hereafter referred to as "Law 2003-26") and decree 2003-1551 dated July 2, 2003 defining the composition, attributions and modalities of the Survey and Reconciliation Commission in charge of expropriation.

According to Article 1 (first paragraph) of Law 2003-26 "Involuntary resettlement can be made only exceptionally after exhausting all reconciliation measures stated in Article 11 (note: related to the Survey and Reconciliation Commission) of this Law, where land acquisition must first be done in an amicable way while legal methods shall be employed only as a last resort". In addition, according to Article 2 (paragraphs 2 and 3) "The expropriator can take hold of expropriated facilities only after paying or offering as a mortgage a fair compensation paid in advance. All rights held on all or part of the expropriated facility, including ENZEL leases, assets in settlement or subject to claims and any other real assets shall be transferred on the expropriation indemnity", acquisition shall be valid only after payment of a compensation to owners and to landlords. This is shown in the Figure 9.2-2.

SONEDE has conducted the land acquisition procedure through its department of juridical and real estate affairs. SONEDE manages between 60 and 100 acquisition files a year of which only two or three files are not amicably settled. These cases are handled by the MOA. The main reasons for the failure of amicable settlement are the following: 1) unidentified landlord; and 2) too low price to compensate the land. The position of transmission pipes and pumping stations can usually be adjusted so that the resettlement of people can be avoided in the majority of the cases. This is why SONEDE has no specific experience in the resettlement of people.

The land acquisition procedure implemented by SONEDE as shown in Figure 9.2-2 offers three opportunities of appeal to land rights holders. When the amicable procedure fails, the expropriation file is made public so that all different parties are able to examine it. In addition as shown in Figure 9.2-3, documents related to the procedure are drafted in Arabic and so that these can be understood by all concerned parties.



Source: JICA Survey Team

Figure 9.2–1 Land Acquisition Procedure of SONEDE

لجنة الاستقصاء والمصالحة في مادة
الانتزاع للمصلحة العامة
بولاية المنستير
=***=

محضر جلسة لجنة الاستقصاء والمصالحة في مادة الانتزاع
للمصلحة العامة بولاية المنستير يتعلق بتقرير ختم أعمال اللجنة
بخصوص ملف مشروع اقتناء قطعتي أرض لازمتين لإنجاز خزان
مياه بمنطقة زبيد من معتمدية البقالطة ولاية المنستير

محضر جلسة لجنة الاستقصاء و المصالحة في مادة الانتزاع للمصلحة العامة بولاية المنستير يتعلق بتقرير ختم أعمال اللجنة بخصوص ملف مشروع اقتناء قطعتي ارض لازمتين لانجاز خزان مياه بمنطقة زبيد من معتمدية البقالطة ولاية المنستير

في اليوم الثالث و العشرين من شهر مارس لسنة 2012 وعلى الساعة التاسعة صباحا اجتمعت لجنة الاستقصاء و المصالحة في مادة الانتزاع للمصلحة العامة بولاية المنستير المنصوص عليها في تركيبتها وسير أعمالها و مشمولاتها بالأمر عدد 1551 لسنة 2003 المؤرخ في : 02 جويلية 2003 بدعوة من رئيسها السيد منصف المرعوي و بحضور أعضاء اللجنة السادة و السيدات :

– نائلة الغندري : ممثل عن الإدارة الجهوية لأملاك الدولة والشؤون العقارية بالمنستير: مقرر اللجنة

– فاتن الماجري حرم العلويني : ممثل عن السيد والي المنستير.

– وليد البحوري : عن الإدارة الجهوية للملكية العقارية بالمنستير.

– يونس المثلوثي ومختار بن رجب : عن الإدارة الترابية للأشغال بالوسط بالشركة الوطنية لاستغلال و توزيع المياه.

– وقد تغيب كل من : عائشة رقاز الخبيرة الجهوية لأملاك الدولة ، و السيد محي الدين القربي رئيس دائرة قيس الأراضي و المسح العقاري بالمنستير.

واصلت لجنة الاستقصاء و المصالحة في مادة الانتزاع للمصلحة العامة بولاية المنستير

Survey and Reconciliation in Matters
Related to Expropriation for Public Interest
Governorate of Monastir
****

Minutes of the Meeting held by the Survey and Reconciliation Commission in charge of expropriation for public interest in the Governorate of Monastir concerning the acquisition of two land parcels required for the construction of a water tank in Zbid area, delegation of Bekalta, Governorate of Monastir.

@@@@@@

On March 23, 2012 at 10 AM, the Survey and Reconciliation Commission in charge of Expropriation for Public Interest in the Governorate of Monastir, which composition and operation are regulated by Decree n. 1551/2003 dated July 2, 2003 met at the request of its chairman Mr. Moncef Maraoui and was attended by:

- Neila Ghandri: representing the Ministry of State Domains and Real Estate Affairs in Monastir as the Commission's Reporter;
- Faten Mejri Alouini, representing the Governor of Monastir
- Walid Bhouri representing the regional real estate agency in Monastir;
- Younes Methlouthi and Mokhtar Berrjeb, representing the Center's territorial work projects department at the Tunisian water exploitation and distribution company (SONEDE);
- The following failed to join the meeting: Aicha Reguez, regional land property expert, and Mohieddine Korbi, chair of the land parceling and real estate division in Monastir.

The Expropriation Survey and Reconciliation Commission further looked into the opportunity to expropriate two land parcels required for the construction of a water tank…

Source: JICA Survey Team

Figure 9.2–2 Example of Minutes of Meeting of the Survey and Reconciliation Commission (English translation)

(2) JICA Guideline in terms of resettlement of people

According to the JICA Guideline, beneficiaries of compensations and of support to recover subsidence means related to a resettlement program are classified into three categories:

- Legal owners of buildings;
- Holders of rights and assets in buildings with no landlords;
- People with rights on buildings but depend on subject building for subsidence (workers, refugees, etc.)

On the other hand, the key principle of JICA policies on involuntary resettlement are summarized below:

Key Principle of JICA Policies on Involuntary Resettlement

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

IV. Compensation must be based on the full replacement cost* as much as possible.

V. Compensation and other kinds of assistance must be provided prior to displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period (between displacement and livelihood restoration.

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

*: Description of "replacement cost" is as follows:

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
Structure	Houses and Other Structures	The market cost of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labour and contractors' fees, plus the cost of any registration and transfer taxes.

Source: Environmental and Social Considerations: Points for Preparation of Report for Project in Category B, June 2011, JICA

(3) Comparison between JICA directives and the Tunisian Law

Comparison shows that the Tunisian procedures and the JICA Guideline are similar in terms of land acquisition but when it comes to resettlement of people, the Tunisian procedure is insufficient. A framework must be set up for the resettlement of people to comply with the JICA Guideline.

There will be no resettlement of people in the Project. Compensation, however, must be provided for the agricultural lands that will be used for the passage of transmission pipelines, for surge tanks, and other facilities.

Table 9.2-1 Comparison between JICA Guideline and the Tunisian Law

JICA Guideline	Tunisian legal framework	Gaps	Policy for this Project
1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives	Article 1 (paragraph 1) of Law 2003-26 states that "Involuntary resettlement can be made only exceptionally after exhausting all reconciliation measures stated in Article 11 (note: related to the Survey and Reconciliation of this Law"	Similar approaches	In the Project, there will be no involuntary resettlement of people and loss of means of livelihood
2. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken	Article 2 (paragraph 2) of Law n. 2003-26 states that "The expropriator can take hold of expropriated facilities only after paying or offering as a mortgage a fair compensation paid in advance."	Similar approaches	Not applicable in the Project
3. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels	Article 2 (paragraph 3) of Law 2003-26 states the following : "All rights held on all or part of the expropriated facility, including ENZEL leases, assets in settlement or subject to claims and any other real assets shall be transferred on the expropriation indemnity"	Similar approaches	Not applicable in the Project
4. Compensation must be based on the full replacement cost as much as possible.	Article 4 of Law 2003-26 states the following :"The expropriation indemnity is set	Similar approaches	Not applicable in the Project

JICA Guideline	Tunisian legal framework	Gaps	Policy for this Project
	based on the value of the building assessed according to its consistency and the effective and assigned use"		
5. Compensation and other kinds of assistance must be provided prior to displacement.	Article 2 (paragraph 2) of Law 2003-26 "The expropriator can take hold of expropriated buildings only after payment or mortgage of a fair indemnity paid in advance"	Similar approaches	Not applicable in the Project
6. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.	In case of large-scale involuntary resettlement, procedure of Law 2003-26 must be applied for each specific case	The absence of a general resettlement plan endangers community preservation	In the Project, there will be no resettlement of people.
7. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	-	There is no resettlement plan hence no consultation with people	Not applicable in the Project
8. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	Files are drafted in Arabic. (As Arabic is the language spoken by the people.)	Similar approaches	Files are drafted in Arabic
9. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.	-	There is no follow up of the resettlement plan hence no consultation with people.	Not applicable in the Project
10. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	The Survey and Reconciliation Commission is set up by Article 10 of Law 2003-26.	Concerns land acquisitions only. Nothing is planned for other impacts	Concerning land acquisition, the law is suitable. For other impacts, specific mechanisms must be set up.
11. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the 0 identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.	The acquisition procedure starts with a real estate survey. The starting date of the survey represents the cut-off date for non-right holders. As for right holders, the cut-off date is the publication of the expropriation decree as per Article 11 of Law 2003-26.	The cut-off date for compensation procedures of other impacts is not defined.	Regarding the acquisition of lands, the cut-off dates are the expropriation decree or the real estate survey. For other impacts, the cut-off date is when public consultations start about subject impact.
12. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized	Article 2 (paragraph 3) of Law 2003-26 states the following : "All rights held on all or part of the expropriated facility,	Non-right holders are not recognized.	Regarding right holders, Law n. 2003-26 is suitable. A compensation

JICA Guideline	Tunisian legal framework	Gaps	Policy for this Project
under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying	including ENZEL leases, assets in settlement or subject to claims and any other real assets shall be transferred on the expropriation indemnity"		procedure must also be set up for non-right holders.
13. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.	Law 2003-26 provides only for financial compensations	No in-kind compensation is planned (agricultural lands)	When implementing the resettlement plan, compensations based on lands will eventually be preferred.
14. Provide support for the transition period (between displacement and livelihood restoration..	Law 2003-26 provides only for financial compensations	No compensation during transition periods	Compensations will be granted for transition periods
15. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.	-	No special care is made to vulnerable populations	The resettlement plan must include special provisions for vulnerable people.
16. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared..	-	There is no resettlement plan	In the Project, there will be no involuntary resettlement of people.

Source: JICA Study Team

(4) Policies for Land Acquisition and Resettlement of People for this Project

Based on the comparison stated above, the Tunisian legal framework does not entirely comply with guideline of JICA and World Bank regarding the planning the resettlement of people, therefore the resettlement policy suggested for this Project is given below:

Resettlement Policy for the Seawater Desalination Plant Construction Project in Sfax

1. The Government of the Republic of Tunisia will use the following resettlement policy (project strategy) for the construction project of the Sfax seawater desalination plant (Tunisia), particularly because national laws and regulations in force were not designed to reply to involuntary resettlement as provided for by international practices including JICA Guideline. The project policy aims at compensating shortfalls in local laws and regulations in order to ensure that PAP (People Affected by the Project) are able to recover at least their pre-project situations. This section describes principles of the project policy and PAP's rights according to the type and degree of their loss. Whenever there is a gap between the Tunisian legal framework in terms of PAP resettlement and JICA Guideline regarding involuntary resettlement, mutually acceptable approaches are suggested in compliance with the government practices and JICA Guideline.

2. The acquisition of land and involuntary resettlement will be avoided as much as possible or reduced to the best extent, by identifying other possible outlines that would have less negative impacts on the project area's communities.

3. In case the displacement of households is inevitable, all PAPs (including communities) losing their means of subsidence or their resources shall be entirely compensated and supported in order to be able to improve or at least restore their previous social and economic conditions.

4. Compensations and support to reintegration will be provided to all PAPs, people, households or companies, who because of the Project would:

- See their living standards deteriorate;
- Lose assets, securities or interests, or the right to use lands including premises, farming lands, pasturages, commercial facilities, leased premises, or the right in crops, annual or perennial trees, or any other fixed or variable assets, acquired or owned, whether temporarily or permanently;
- Lose possibilities to make additional profits, companies, jobs, worksite or site of residence, or which housing may be temporarily or permanently affected;
- Lose social and cultural activities and relations or any other loss that may be identified during the planning and reinstallation process.

5. All impacted people shall be eligible for compensations and support to reintegration, regardless of their occupation status, social and economic conditions, and other factors that may determine the achievement of objectives stated above. The absence of legal rights on lost properties or the affected occupation status and the social and economic conditions shall not constitute a reason to prevent PAPs from enjoying compensation, reintegration and resettlement measures. Any PAP who is residing, working, making business and / or cultivating lands in project areas affected on the date of the last census and inventory of lost properties shall be liable for due compensation against lost properties (lands and / or real estate properties), replacement costs, and when needed the restoration of revenues and companies, in addition to sufficient rehabilitation measures to help them improve or at least maintain their pre-project living standards, the capacity to earn revenues and their production standards.

6. PAPs who lose only one part of their physical assets shall not be left with a part that would be insufficient to maintain their current living standard. The minimal size of remaining lands and structures shall be agreed upon during the resettlement planning process.

7. People temporarily affected must be considered as PAPs and resettlement plans shall include the temporary acquisition issue.

8. If a hosting community is affected by the development of a reinstallation site within the community, it shall be involved in all resettlement planning and decision making processes. All efforts must be made to minimize the negative impacts of the passage of vehicles on the local community.

9. Resettlement plans shall be designed according to the Tunisian policy and procedures pertaining to land acquisition and compensations and to JICA Guideline related to involuntary resettlement.

10. The resettlement plan shall be translated in the local languages and forwarded to PAPs and to other concerned parties and groups;

11. The payment of real estate and / or non-land properties shall be based on the principle of the replacement cost.

12. The compensation of PAPs depending on agricultural activities will be in the form of land exchange whenever possible. “land” strategies may include the supply of replacement land parcels, offer much larger employment safety, and improve the means of subsidence for people not holding legal real estate property certificates. In the absence of replacement land parcels, other strategies may be built around re-training possibilities, capacity building, waged employment or self-employment, including access to credits. The only option that should be avoided is cash compensations, as this can never indemnify losses that cannot be easily quantified, such as access to services and to customary rights, and may induce situations that are worse than before the Project;

13. Replacement lands, if this is the preferred option for PAPs shall be made whenever possible in the close vicinity of impacted lands and with comparable production capacities. As a second option, sites must be identified so as to reduce as much as possible social troubles for people affected; land parcels must also have access to services and facilities that are similar to those in affected areas;

14. Support to resettlement must be provided not only for the immediate loss but also for a transition period required to restore means of subsidence and PAP’s living standards. Such support can be short term employment, support for

subsidence, keeping the payment of salaries or similar measures;

15. The resettlement plan must take in consideration needs of the most vulnerable people to displacement negative impacts (including the poor, people with no property certificates, ethnic minorities, women, children, old people, and the handicapped) and must ensure they are properly accounted for in resettlement planning and mitigation measures. Assistance must be offered to help these groups improve their socioeconomic status;

16. PAPs will be involved in resettlement plans' development and implementation processes;

17. PAPs and their communities will be consulted about the Project, informed about their rights and options open to them, in addition to measures to reduce negative effects, and they will be as much as possible involved in decisions that will be taken regarding their resettlement;

18. An appropriate budget support will be fully engaged and provided to cover costs for land acquisition (including compensation measures and restoration of revenues) within agreed implementation period. Funds for resettlement activities will be covered by the Tunisian Government;

19. Displacement shall not take place before providing compensation and other forms of assistance required for resettlement. A sufficient civil infrastructure must be provided in the resettlement site before this operation is made. The acquisition of assets, payment of allowances, resettlement and the launch of rehabilitation activities for PAPs means of subsidies must be complete before the start of construction works, only in the case of an expropriation order issued by the court. (subsidence means' restoration measures must also be set up but not necessarily complete before the beginning of construction works, as they may be ongoing activities).

20. The administrative organization and provisions for the preparation and effective implementation of the resettlement plan will be identified and set up before starting the process. This includes supply of appropriate supervision human resources, consultation and follow up of land acquisition, and re-adaptation activities;

21. Appropriate reports (including audit and appeal reports), supervision and evaluation mechanisms, shall be identified and implemented in the framework of the resettlement management system. An external follow up team will also work on the project to assess the resettlement plan and final results. This team may include qualified NGOs, research institutions or universities. Follow up reports will be directly sent to JICA.

CUT-OFF-DATE OF ELIGIBILITY

The cut-off-date of eligibility refers to the date prior to which the occupation or use of the project area makes residents/users of the same eligible to be categorized as PAPs and be eligible to Project entitlements. In this Project, cut-off dates for holders of real estate certificates is the notification date as per the real Estate Acquisition Law (expropriation decree for public use/Law n. 85 dated August 11, 1976 modified by Law n.26 dated April 14, 2003 related to land acquisition for public interest works); as for holders not having property certificates, the cut-off date is the beginning of the field study (social and real estate survey and preliminary works), carried out by SONEDE in 2015). This date has been disclosed to each affected village by the relevant local governments and the villages have disclosed to their populations. The establishment of the eligibility cut-off date is intended to prevent the influx of ineligible non-residents who might take advantage of Project entitlements

PRINCIPLE OF REPLACEMENT COST

All compensation for land and non-land assets owned by households/shop owners who meet the cut-off-date will be based on the principle of replacement cost. Replacement cost is the amount calculated before displacement which is needed to replace an affected asset without depreciation and without deduction for taxes and/or costs of transaction as follows:

a. Productive lands (agriculture, orchards, gardens) based on the current market real prices, reflecting recent land sales in the region, and in the absence of these recent sales, they shall be based on recent sales in comparable areas with other similar attributes such as charges and taxes, and in the absence of these sales, based on their productive value;

b. Residential land parcel based on based on the current market real prices, reflecting recent land sales in the region, and in the absence of these recent sales, they shall be based on recent sales in comparable areas with other similar attributes such as charges and taxes,

c. The Government's current regulations and the Law on real estate acquisitions to calculate compensations on constructions, cultures and trees whenever possible;

d. Houses and other related facilities based on the current market real prices of subject materials;

e. Annual crops equivalent to the market's current value of crops at the time of compensation;

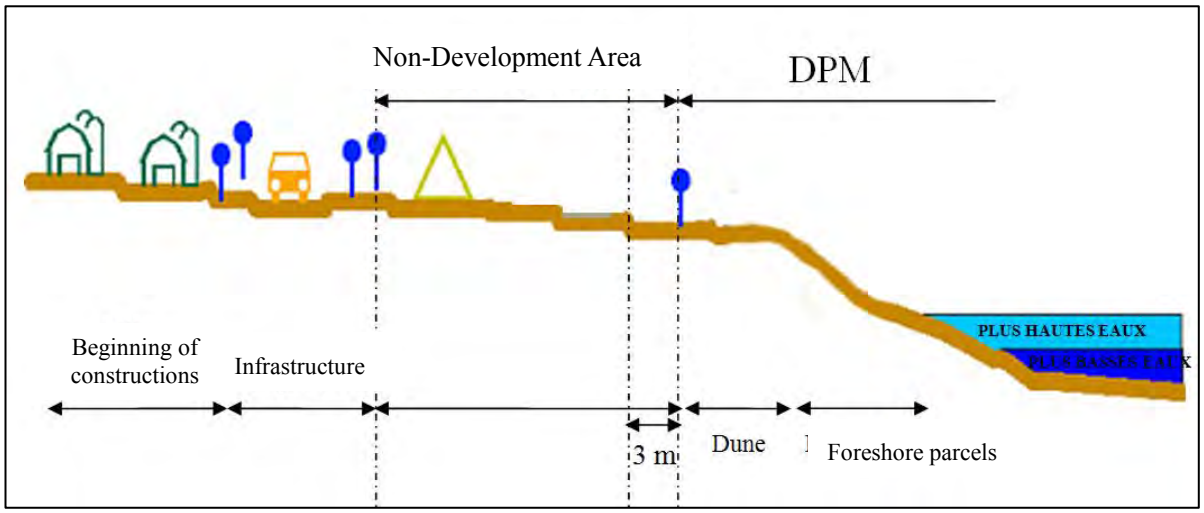
f. For sustainable cultures, cash compensation for the replacement cost which shall be in line with local regulations when available, is equivalent to the market's current value with regard to the type and age at the time of compensation.

g. Regarding wood and fruit trees such as olive trees, cost of compensation for the replacement value which shall be in line with the Government's local regulations when available, is equivalent to the market's current value for each type, age and the appropriate productive value at the time of compensation based on the diameter at every tree's chest height.

Source: Environmental and Social Considerations: Points for Preparation of Report for Project in Category B, June 2011, JICA

(5) Public maritime domain

The public maritime domain is regulated by Law No. 95-72 dated July 24, 1995 providing for the creation of APAL and Law No. 95-73 dated July 24 related to the public maritime domain (DPM). The following figure shows the scope of the public maritime domain:



Source : APAL 2003

Figure 9.2–3 Public Maritime Domain

When the public maritime domain is specifically demarcated and when there is an urban development plan, the radius of the non-development area is 25 m. In the absence of an urban development plan, the radius of this area increases to 100 metres. When the public maritime domain is simply not demarcated, a building is not allowed within a radius of 200 metres from the highest sea water level.

Since the site of the desalination plant is entirely located within DPM which is already subject to an urban development plan. The construction of the desalination plant is planned at least 25 metres from the limits of DPM. As the desalination plant is not a structure that can be dismantled, a special authorization is required before starting construction works so far scheduled for the beginning in

October 2019. The concession procedure shall be completed by January 2019 to secure preparation work period of SONEDE. As shown in Figure 9.2-4, there will be enough time to complete the required procedure even if it starts from 2017.

Item	Authority in charge	2017									2018							
		-.	Apr	May.	Jun	Jul	Aug	Sep	Oct	-	Feb	Mar	Apr	May	Jun	Jul	—	Dec
DPM concession request	SONEDE																	
Analysis of request and report to PM	APAL																	
Approval of PM about the choice of SONEDE as Franchisee	Prime Minister																	
Preparation of the concession contract (Approved EIA must be included)	SONEDE + APAL																	
Examination of contract by 3 Ministries	Ministry of Env. & Sustainable Development Ministry of Justice Ministry of State Properties																	
Approval of contract by the Prime Minister	Prime Minister																	
Concession Decree	APAL																	

Source : APAL DPM management Department; JICA Survey Team

Figure 9.2–4 Execution Schedule of DPM Concession Procedure

The agency in charge of evaluating the request file is the DPM management department, APAL. The DPM management department is in charge of; 1) Checking the use of DPM (management of beach); 2) Managing DPM usage concession files; and 3) Monitoring the environment and its cleaning operations.

The DPM usage fee will be defined during negotiations between SONEDE and the Ministry of State Domains and Land Affairs. Fees may amount to nothing, but in general, the following formulas are used (annually):

- Non-covered areas: 0.3TND/m^2+30TND
- Covered areas: 3 times the price of non-covered areas
- Pipelines: 0.072TND/m+10TND

Regarding this Project, the covered area is estimated at about 10 ha, the non-covered area at 10 ha, and the pipeline's total linear at about 9000 m. This would reflect an annual fee of; 4 x (100 000 x 0.3 + 30) + 9000 x 0.072 + 10 ~ 120,800 TND/year to be paid to the Public Treasurer.

9.3 Scale and Scope of Land Acquisitions and Resettlement

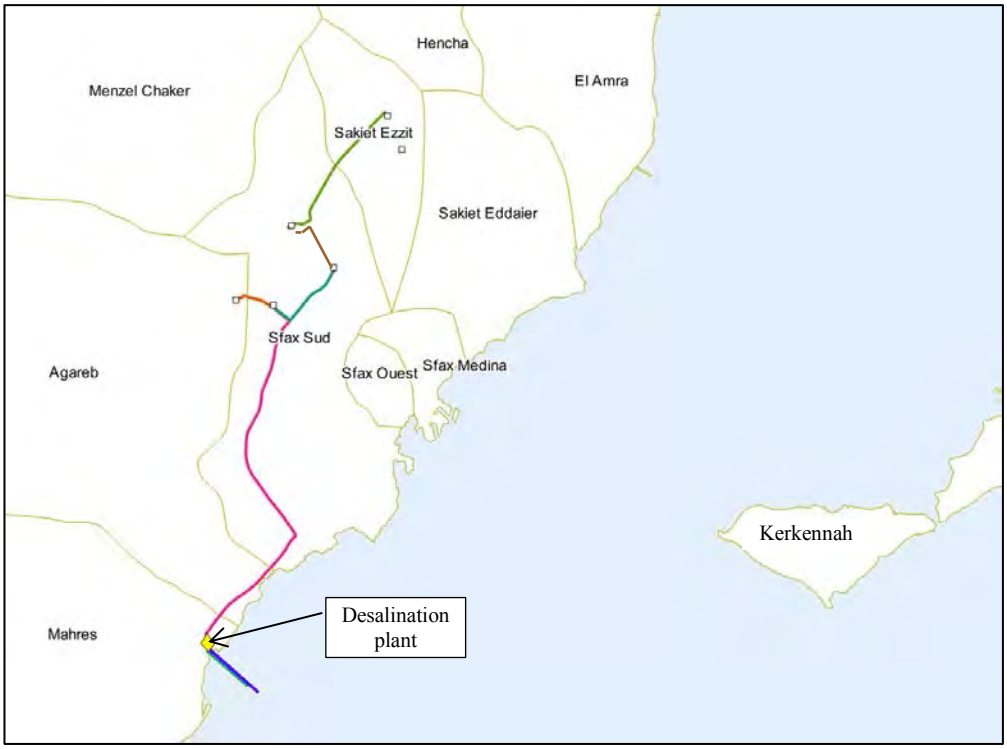
(1) Summary of acquisitions and concerned population

This Project's policy is to avoid resettling people by making all appropriate design modifications, consequently, no resettlement is expected. As shown in Figure 9.3-1, however, land acquisitions will be made only for some sections of the transmission pipelines and surge tanks..

Non-Disclosure Information

Figure 9.3-1 Scope of Land Acquisitions

As shown on the following map, villages and delegations (counties) crossed by the transmission pipeline are; Mahres, Agareb, Sfax South, and Sakiet Ezzit.



Source: JICA Survey Team

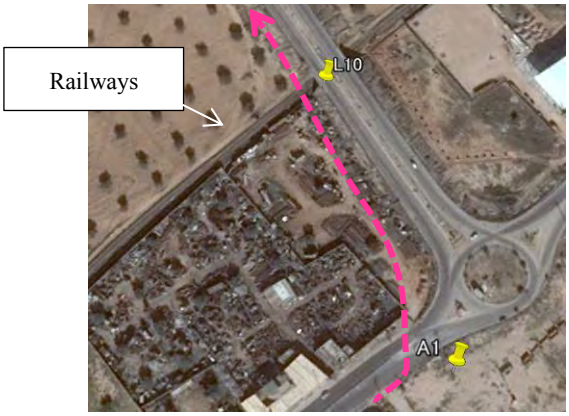
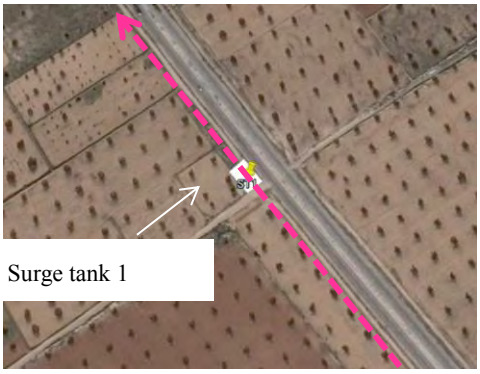
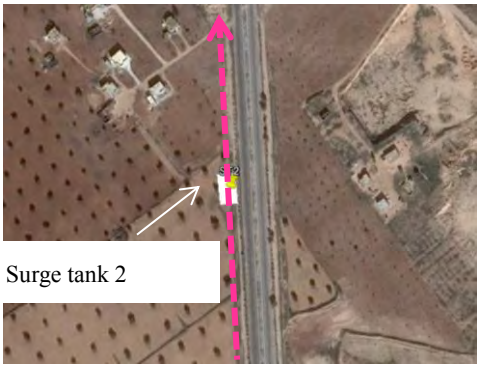
Figure 9.3-2 Villages crossed by the Project

A field study conducted along the transmission pipeline showed that lands that will be crossed are mainly olive groves, while few sections cross buildings or housing areas.

Table 9.3-1 Current Conditions along the Outline of the Transmission Pipeline

No	Section	Localization	Current conditions
1			
		Note The industrial fence on the right of the roadway may be affected by the works. Community: Mahres Outline in dotted pink: φ1,400mm	

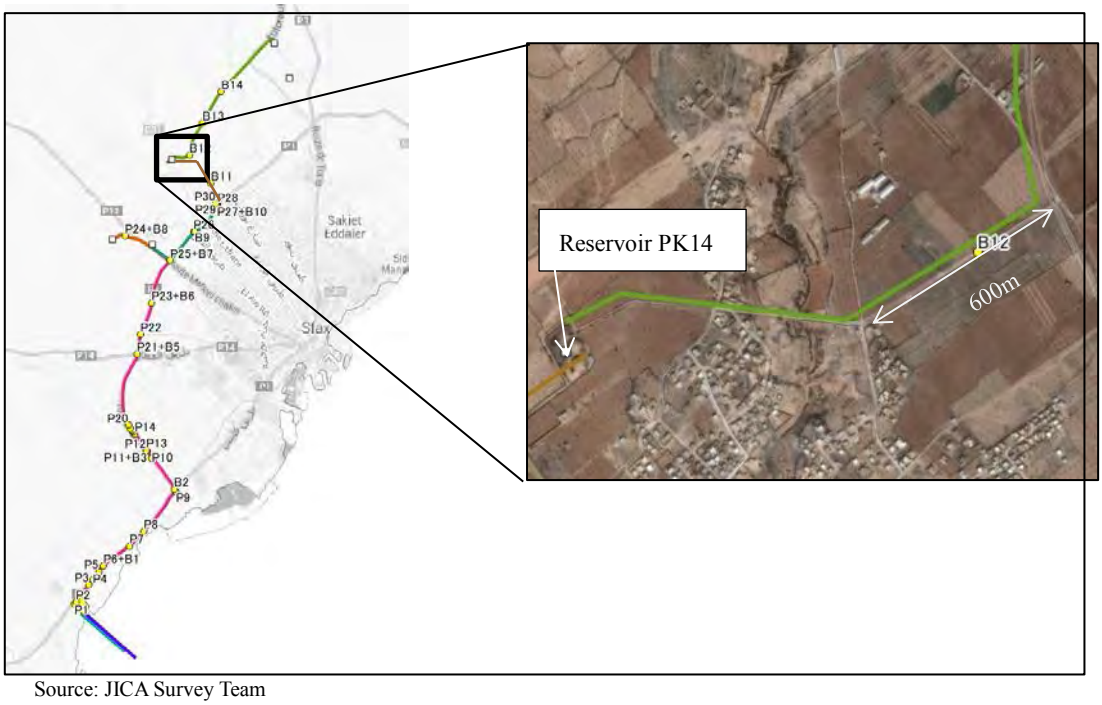
No	Section	Localization	Current conditions
2			
	Note The agricultural fence on the right of the roadway may be affected by the works. Community: Agareb Outline in dotted pink: φ1,400mm		
3			
	Note The industrial fence on the right of the roadway may be affected by the works. Community: Sfax South Outline in dotted pink: φ1,400mm		
4			
	Note The industrial fence on the right of the roadway may be affected by the works. Community: Sfax South Outline in dotted pink: φ1,400mm		
5			
	Note The agricultural fence on the right of the roadway may be affected by the works. Community: Sfax South Outline in dotted pink: φ1,400mm		

No	Section	Localization	Current conditions
6			**Note** The pipeline crosses the roadway and the railways. The industrial fence on the left of the roadway may be affected by the works. Community: Sfax South Outline in dotted pink : φ1,400mm
7			**Note** The acquisition of a land parcel covering about 17m x 31 m for the surge tank will be required. This will also require the logging down of two olive trees. Community : Sfax South Outline in dotted pink: φ1,400mm
8			**Note** The acquisition of a land parcel covering about 17m x 31 m for the surge tank will be required. This will also require the logging down of 2 olive trees. Community: Sfax South Outline in dotted pink: φ1,400mm

No	Section	Localization	Current conditions
9			
		Note Laying of pipes in the road's right of way area. Community: Sfax South Outline in dotted pink: φ1,400mm, in green :φ1,000mm	
10			
		Note Laying of pipes in the road's right of way area. Community: Sfax South Outline in dotted orange : φ400mm	

Source : GOOGLE satellite images, Photos : JICA Survey Team

In addition, when test boring was made along the pipeline as shown in the following Figure 9.3-3, the local people claimed ownership of lands at the level of boring point B12 (an unpaved road of about 600 metres).



Source: JICA Survey Team

Figure 9.3-3 Sites of Test Boring and Situation of Boring Point B12

Besides transmission pipelines, the main component which will require land acquisition is the work for the power transmission line. Although SONEDE will pay STEG the required amount as the cost for power supply, STEG will plan, design, construct and maintain the facilities. Ownership of the power transmission line will be held by STEG. However, the power transmission towers and their sites will be owned by SONEDE.

Since the area around the Seawater Desalination Plant is almost flat farmland, the power transmission line will be installed above ground in the air in principle because of the non-necessity of resettlement of residents.

SONEDE initially stated that the length of the transmission line will be 15.5km from the desalination plant, but presently, this has not yet been defined in detail, because STEG has not started the examination on the transmission route. Assuming that the required transmission towers will be 40 in number with an average interval of 400m, and size of the tower base will be 10 m x 10m, requiring an area of land acquisition of approximately 4,000m^2. It is also assumed that compensation will be needed for the land under the power transmission lines because high height structures cannot be constructed under the power line. STEG, however, has no experience of payment for such compensation so far. Land use under the power line, however, will be olive field and unused land. Therefore, the required compensation cost will not be a large amount. As a result of discussion between SONEDE and STEG, the cost for land acquisition and compensation shall be paid for by SONEDE, not by STEG who will have ownership of the power transmission towers and lines. SONEDE, therefore, shall take part in the study for selection of the power line route by STEG, so that such cost for land acquisition and compensation is at a minimum.

The results of the survey mentioned above show that the population affected by acquisitions is as follows:

Table 9.3-2 Population affected by Acquisitions

Item	Population	Observations
Resettlement		
Total	0	Based on the Project's policy
Land acquisitions		
Landlords	9 people (+transmission tower affected persons: 40 at maximum)	Table 9.3-1 ; Items 1 to 8 and are nearby B12

Source: JICA Survey Team

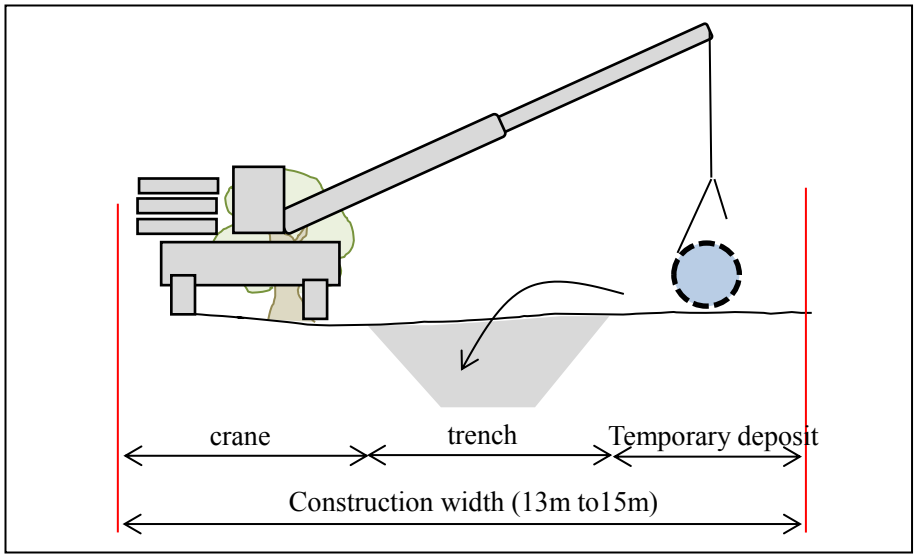
Except for the lands relating to the power transmission line, the real estate survey can be started by SONEDE once the detailed outline of transmission pipes is designed in 2018. STEG will also conduct the real estate survey for the power transmission line upon completion of its detailed design in 2018.

This survey will show the precise area of land acquisitions, the number of landlords, right-holders, and others holding other rights to land parcels, which will be useful to update the Table 9.3-2. The cut-off

date to submit claims on lands is the publication date of the expropriation decree for landlords and rights-holders and the date when the real estate survey starts for non-rights holders.

(2) Real estate and patrimony

The acquisition of land for the laying of the pipe will be done based on a total width of 8 metres. However, since the project plans the use of pipes with a diameter of 1400 mm, it will be necessary to log down some olive trees along the width required for pipe laying. The distance between olive trees in Sfax averages 24 metres.



Source : JICA Survey Team

Figure 9.3-4 Construction Width

Consequently, the acquisition and compensation widths for this Project will be determined as follows:

- Acquisition width = Maximum 8m
- Compensation width ＝ width of construction work

Table 9.3-3 Construction and Compensation Widths for Transmission Pipelines

Diameters	Width of trench	Temporary deposit	Crane (including margin)	Construction width = compensation width	Acquisition width
-	A	B	C	A+B+C	Maximum 8 (or A)
1400mm	4m	3m	6m (crane 16t) +2m (margin) =8m	15m	8m
1000mm					
800mm	3m	2m		13m	
700mm					
400mm					

Source: JICA Survey Team

As it would be possible to partly use the existing roadway for construction works and since olive trees are usually distant from roadways, the following table should be adapted for each specific case.

However, in this study, land parcels to acquire and the impacted agricultural patrimony (olive trees) are estimated in the following table:

Table 9.3-4 Property and Patrimony Damage related to Water Transmission Pipelines

Real estate property						
Item	**Community**	**Type**	**Area**			**Total (m^2)**
			Length (m)	**Width(m)**	**Area (m^2)**	
Table 9.3-1,No.1	Mahres	Industry	275	8	2,200	2,200
Table 9.3-1,No.2	Agareb	Farming	1,320	8	10,560	10,560
Table 9.3-1,No.3	Sfax South	Industry	155	8	1,240	17,394
Table 9.3-1,No.4		Industry	100	8	800	
Table 9.3-1,No.5		Farming	970	8	7,760	
Table 9.3-1,No.6		Industry	205	8	1,640	
Table 9.3-1,No.7		Farming	31	17	527	
Table 9.3-1,No.8		Farming	31	17	527	
Table 9.3-1 No.11		Farming	10	10	100	
Figure 9.3-3 (B12)		Farming	600	8	4,800	
Structures						
Item	**Community**	**Type**	**Length (m)**			**Total (m)**
Table 9.3-1,No.1	Mahres	Wall	275			275
Table 9.3-1,No.2	Agareb	Wall	150			150
Table 9.3-1,No.3	Sfax South	Wall	155			810
Table 9.3-1,No.4		Wall	100			
Table 9.3-1,No.5		Wall	350			
Table 9.3-1,No.6		Wall	205			
Farming Patrimony						
Item	**Community**	**Type**	**Length(m)**	**Width(m)**	**Area(m^2)**	**Number**	**Total**
Table 9.3-1,No.2	Agareb	Olive trees (25/ha)	1,320	15	19,800	50	50
Table 9.3-1,No.5	Sfax South		970	15	14,550	37	61
Table 9.3-1,No.7			31	17	527	2	
Table 9.3-1,No.8			31	17	527	2	
Figure 9.3-3 (B12)			600	13	7,800	20	

Source: JICA Survey team

The required land for 40 power transmission towers is about 4,000 m^2. For construction work to be carried out, however, an area of 20 m x 20 m is required on a temporary basis. Therefore, compensation shall cover the area of 10 m × 10 m + 20 m × 20 m = 500 m^2 for each transmission tower. For total of 40 towers, 40 towers × 500 m^2/tower = 20,000 m^2, and therefore, 2 ha × 25 tree/ha = 50 olive trees logged will be the subject of compensation. Regarding compensation for the land under the power line, its subject area will be 10 m x 15 km = 15 ha, and 375 olive trees. Compensation for it will be quite small

because farming activities can be continued. As stated previously, the cost for land acquisition and compensation will be shouldered by SONEDE.

As stated above, the land acquisition area is 3.41ha at maximum including those for power transmission line, and compensation is necessary for the fence of 1,235metres, and 536 olive trees as shown in Table 9.3-5.

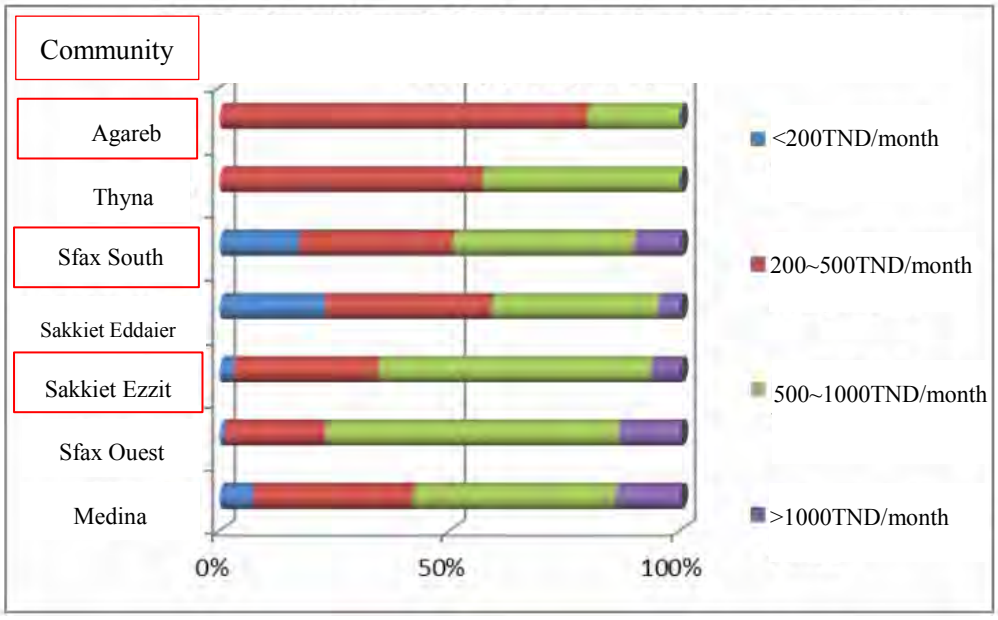
Table 9.3-5 Summary of Land Acquisition and Compensation for Water and Power Transmission Facilities

Subject	Water Transmission Pipeline			Power Line	Total
	Mahres	Agareb	Sfax South		
Land (m^2)	2,200	10,560	17,294	4,000	**34,054**
Structures (fence, m)	275	150	810	-	**1,235**
Olive Trees (tree)	-	50	61	50+375	**536**

Source: JICA Survey team

(3) Households survey

A socioeconomic study was also conducted in the framework of this survey. Results show that the average household includes 4.3 people and that households are made up of one person or more than six people represent 21% of the population (of which 12% represent households with more than six individuals). Finally the average revenue amounts to 650 TD/month among communities concerned by the Project, the smallest revenues are in Agareb. Expenditure for water is 45 TND/3months in average and equivalent to 2% of average income.



Source: JICA Survey Team

Figure 9.3–5 Households' Average Revenue around Sfax

9.4 Implementing the Compensations System

(1) Compensations

Unanticipated expenses related to the Project are land acquisitions (loss of real estate) and sea shore constructions (temporary loss incurred by fishing activities). There will be no resettlement of people.

As already mentioned in Section 9.2 (1), cut-off dates for claims related to real estate acquisitions are determined on the publication date of the expropriation decree (scheduled in 2016) for rights holders in compliance with Law 2003-26 ; while the date set for the beginning of the real estate survey will be the cut-off date for non-rights-holders (scheduled in 2016).

On the other hand, the cut-off date for claims or to request the compensation of interrupted fishing activities, the starting date is set when information meetings on site about planning and sea shore construction methods take place.

All cut-off dates must be notified for all sites concerned at least one month prior to the dates. Compensation for the land where people is earning his living by utilization of it will be made by land with similar value as far as possible. In other cases, financial compensations will be granted.

(2) Rights allocation matrix

Based on the previous, the matrix used to allocate rights for compensations is as follows:

Table 9.4-1 Matrix for the Allocation of Compensation Rights

N	Incurred losses	People concerned	Compensation method	Implementation	Party in charge
1	Land losses,	People holding rights over subject land parcels	a) Equivalent land parcels for people living from lands, whenever possible. b) Compensation determined based on the evaluation of losses	i) According to Law 2003-26.	i) SONEDE Department of juridical and real estate affairs, Ministry of State Properties. ii) SONEDE iii) Land acquisition and compensation will be done by SONEDE
2	Constructed or agricultural assets	People holding rights over subject land parcels; non-rights holders living from subject land parcels		i) According to Law 2003-26. ii) Regardless of ownership, people receiving impacts are subject to compensation. iii) To be compensated in accordance with national law and JICA guideline.	
3	Loss of fishing activities due to non-access to fishing areas because of pipes laying works	Fishing boats registered at the port of Mahrès	Evaluation of the period concerned by the loss of fishing activities, financial compensation based on that period.	a) Organization of information meetings planning and construction methods b) Identify concerned boats and women collectors c) Calculate compensation amounts and payment	a) SONEDE and UTAP b) DGPA or local representation c) SONEDE
4	Loss of fishing activities due to sea water high turbidity because of excavation works in the sea	Walking fishermen (including women collectors) registered at the competent authority (UTAP)	Evaluation of the period for collection activities, financial compensation based on this period		

Source : JICA Survey Team

9.5 Claim Management Mechanisms

Appropriate mechanisms to manage claims must be implemented in order to maximize social acceptance of the Project and avoid problems during construction or operation.

The mechanism for land acquisition is provided for by Law No. 2003-26 as it concerns the Survey and Reconciliation Commission. Expropriation files must be published to the public (posting at the municipality, radio spots, etc.) one month at least before their final confirmation. Plaintiffs may appeal this decision before the Survey and Reconciliation Commission which composition is given below (as per Decree 2003-1551):

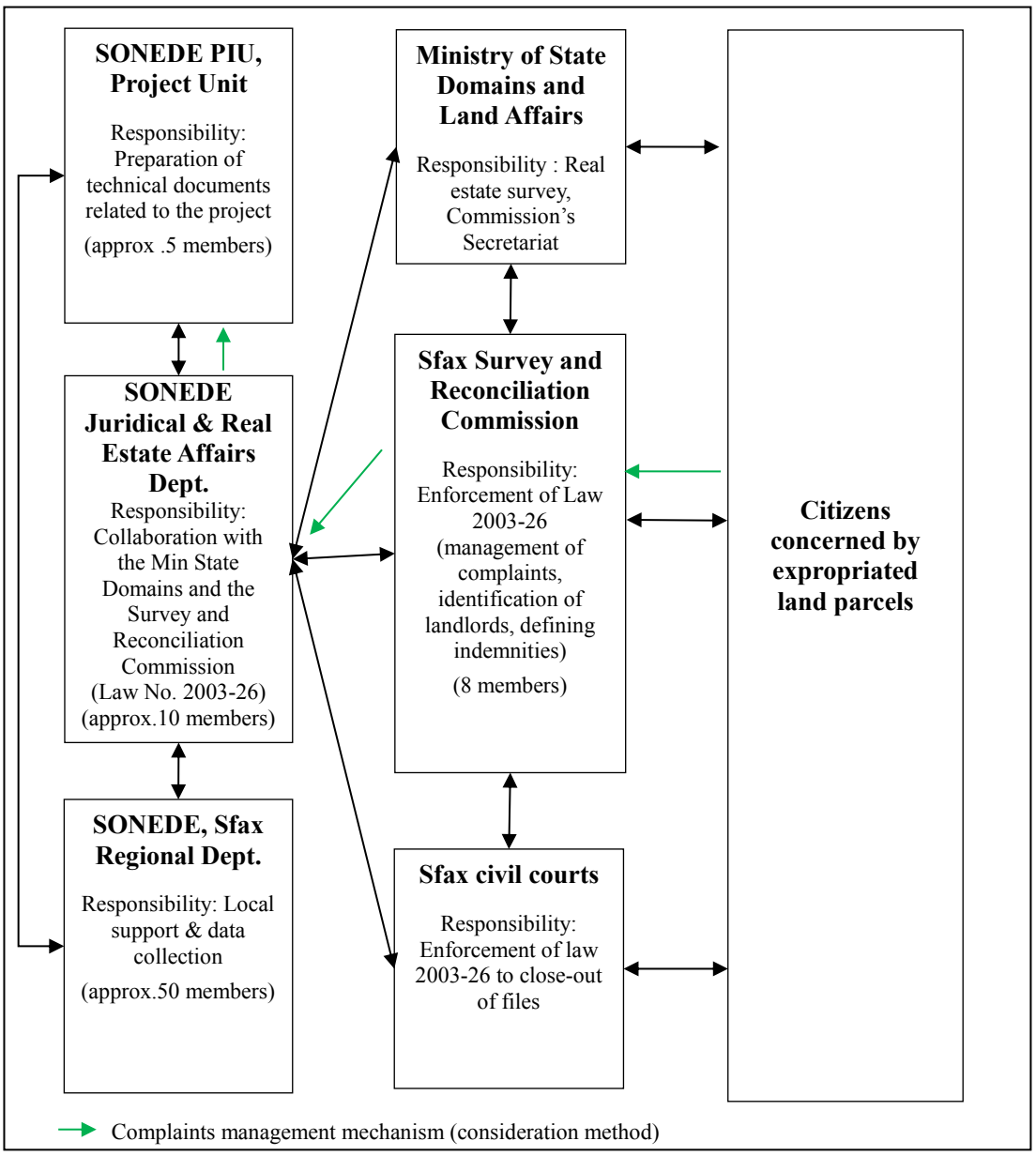
- A magistrate : Chair,
- Representative of the Governor: member,
- Regional Director of the State Domain and Real Estate Affairs of his/her representative: member
- Regional Director of the Topography and Cartography Office (OTC) or his/her representative: member;
- A representative of the Ministry or the company gaining from expropriation (in this case the Director of juridical and real estate affairs at SONEDE or STEG): member;
- Expert in State properties: member;
- Representative of the real estate conservation and properties: member;
- A representative of the municipality or municipalities where the expropriated property is expropriated: member.

As for unanticipated losses in fishing activities, the complaints management mechanism may be made through UTAP (Tunisian Agriculture and Fishing Union). UTAP is a nation-wide union bringing together small producers and cooperatives. UTAP can be the appropriate interlocutor to defend fishermen's rights and interests.

9.6 Organization for the Implementation of Social Considerations

This Project will be implemented by a project implementation unit (hereafter referred to as PIU). Land acquisitions will be implemented by PIU and the juridical and real estate affairs department in SONEDE. Contributors shall be the Ministry of State Domains and Land Affairs (including its local representations), the Survey and Reconciliation Commission of the Sfax Governorate as well as civil courts.

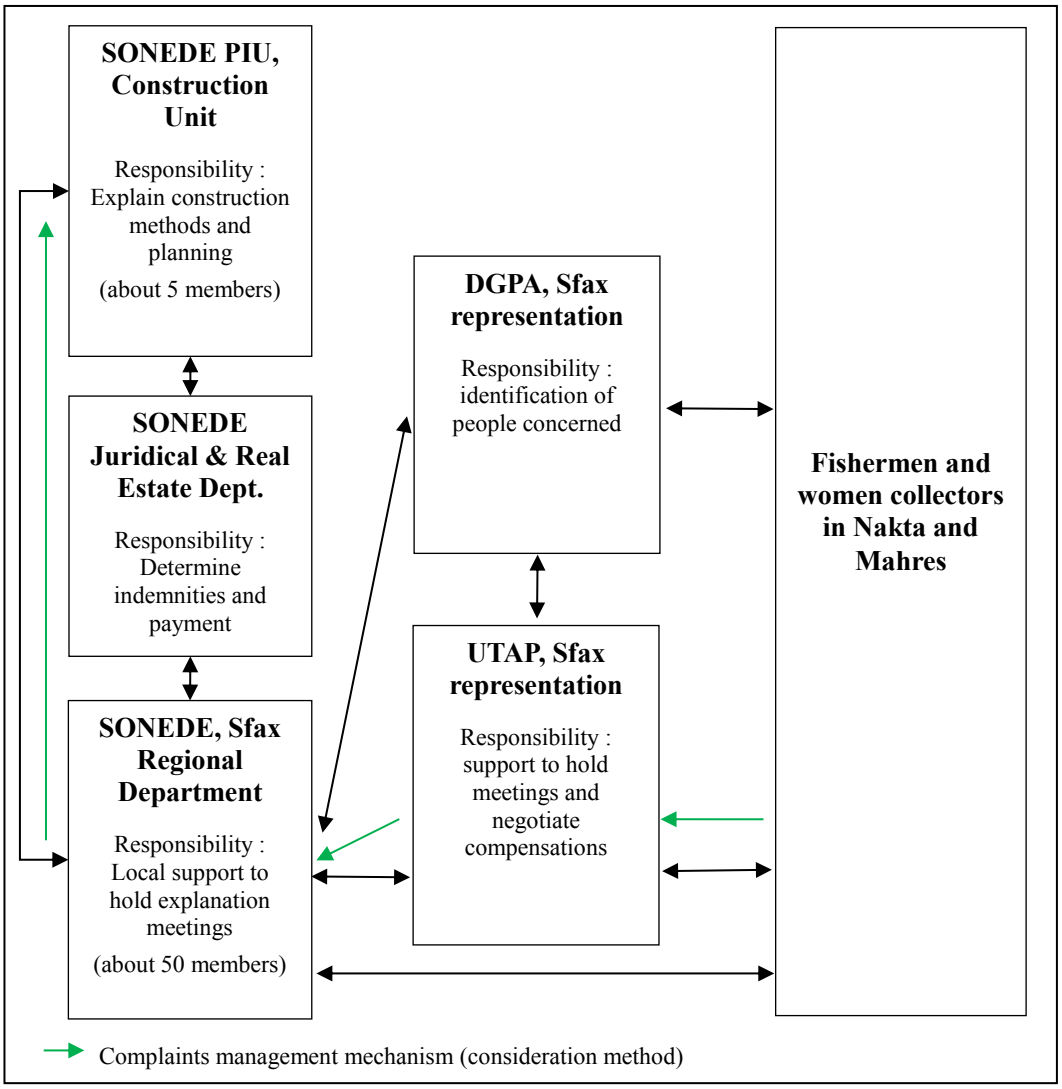
Social considerations will therefore be implemented based on the following plan:



Source : JICA Survey team

Figure 9.6–1 Organization and Implementation of Land Acquisition Operations

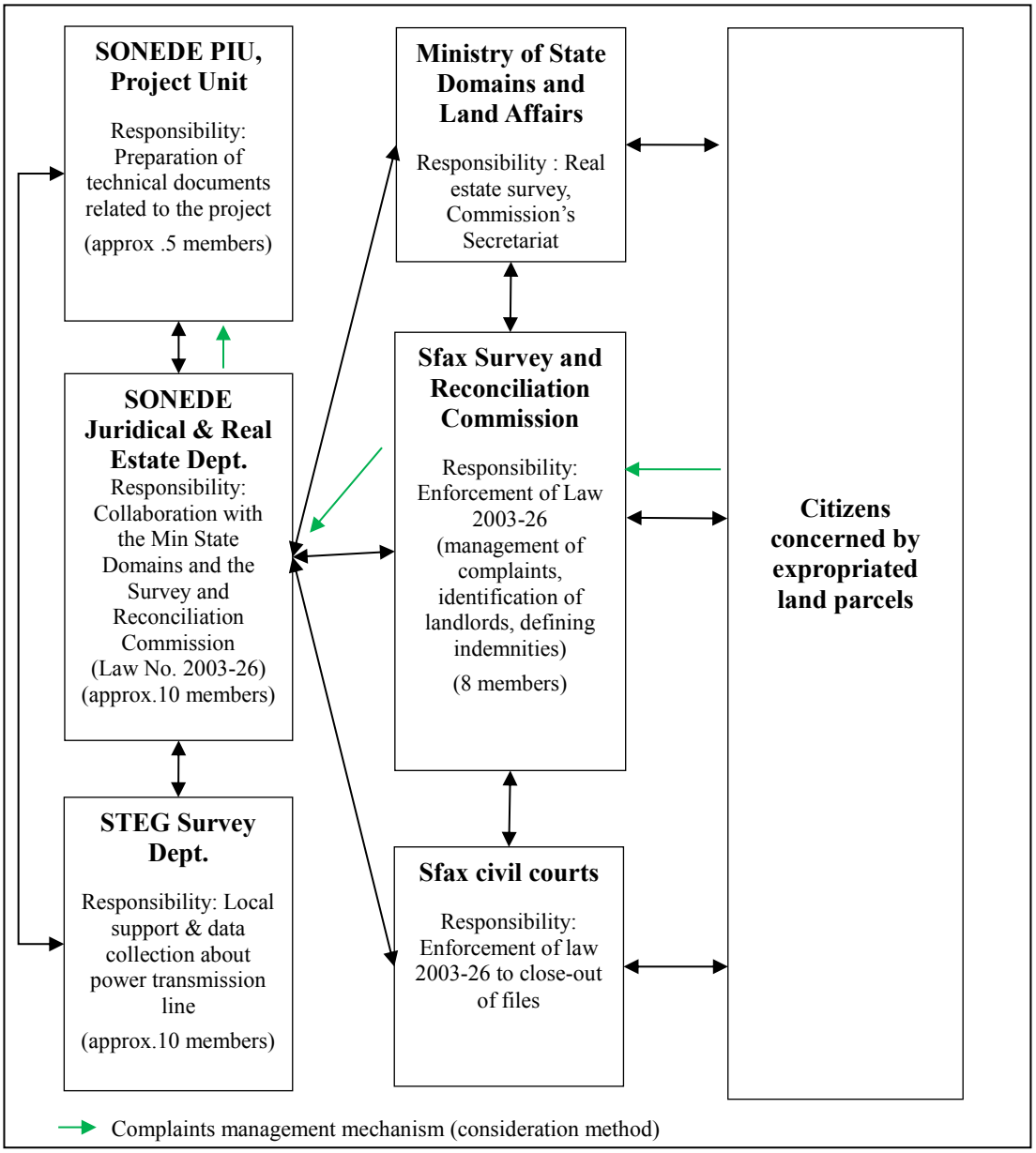
The Juridical and Real Estate Affairs Department and the Sfax Regional Department will work together on complaints regarding fishing activities PIU's Construction unit. The main interlocutor will be UTAP and its branch in Sfax.



Source : JICA Survey team

Figure 9.6–2 Organization and Implementation of Compensations to Fishing Activities

The power transmission line will be constructed and maintained by STEG, however, land acquisition and compensation will be performed by SONEDE. Therefore, social considerations will be implemented based on the following plan.



Source : JICA Survey team

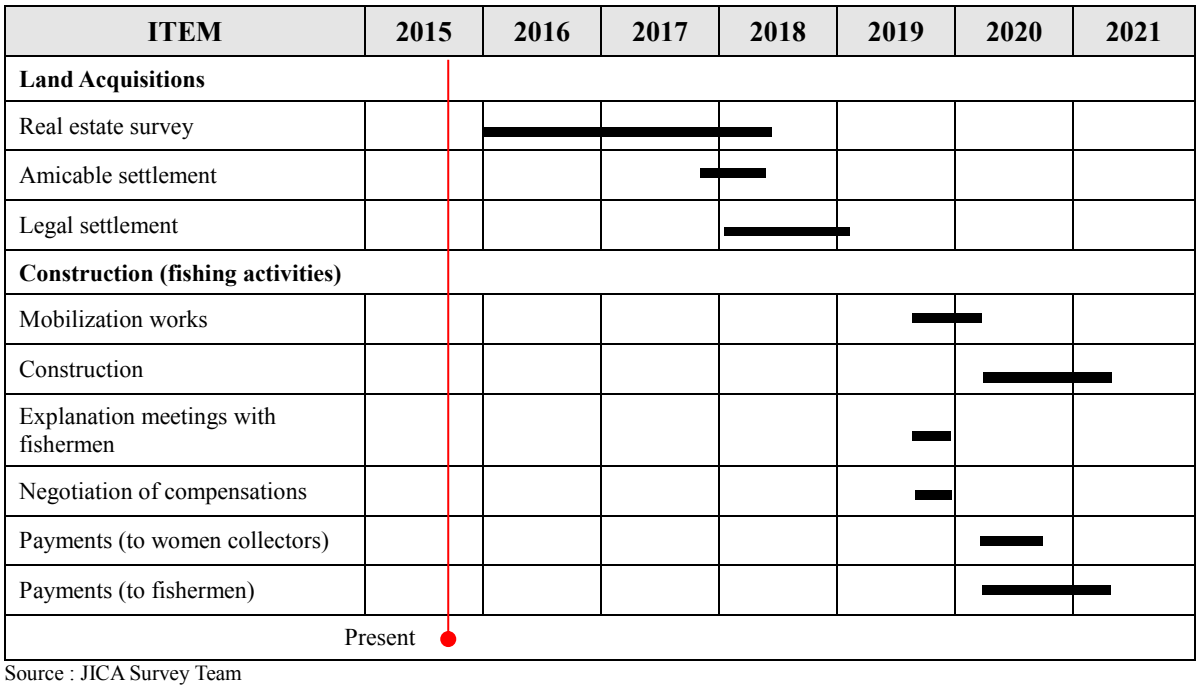
Figure 9.6–3 Organization and Implementation of Compensations for Land Acquisition for Power Transmission Line

9.7 Implementation Schedule

When the detailed pre-project concerning transmission pipes is finalized (planned in July 2017), the real estate survey may then start and amicable settlements may be finalized by the end of 2017, legal procedures will need to be finalized by the end of 2018.

Information meetings about the schedule and construction methods will start in the autumn of 2019

when the Contractor is selected. The procedure must be finalized towards end of 2019 and compensations will be disbursed during construction works, for six months for issues related to turbidity and one year for issues related to access to fishing areas, with the disbursement made on a monthly basis. Based on the preceding, the schedule may be displayed as follows:



Source : JICA Survey Team

Figure 9.7–1 Social Considerations Implementation Schedule

9.8 Costs and Funding

In order to define an appropriate budget for social considerations, costs and findings are planned as follows:

(1) Costs related to acquisitions

Costs related to acquisitions are evaluated based on Table 9.3-4. Unitary costs for olive trees and other fruit trees are estimated based on another expropriation file submitted by the Juridical and Real Estate Affairs Department of SONEDE. Close out is estimated at NDI TND/m.

Table 9.8-1 Unit Price of Olive Trees and Other Fruit Trees

Size	Olive trees	Fruit trees (almonds)
Big	Non-Disclosure Information	
Medium		
Small		

Source : SONEDE Juridical and Real Estate Affairs Department, Unit : TND

Square meter costs of lands along the transmission pipeline were provided by SONEDE's General Department in Sfax.

Source : SONEDE, Sfax Regional Department, May 2014

Figure 9.8–1 Unit Price of Lands for Acquisition in Sfax

Based on the information shown in Table 9.3-4, the costs for land acquisition are estimated in Table 9.8-2:

Table 9.8-2 Land Acquisition and Compensation Costs for Transmission Facilities

Land						
Item	**Community**	**Type**	**Area (m^2)**	**U. Price[1)] (TND)**	**Total (TND)**	**Total (TND)**
Table 9.3.1,No.1	Mahres	Industry	2,200	Non-Disclosure Information		
Table 9.3.1,No.2	Agareb	Farming	10,560			
Table 9.3.1,No.3	Sfax South	Industry	1,240			
Table 9.3.1,No.4		Industry	800			
Table 9.3.1,No.5		Farming	7,760			
Table 9.3.1,No.6		Industry	1,640			
Table 9.3.1,No.7		Farming	527			
Table 9.3.1,No.8		Farming	527			
Figure 9.3.3 (B12)		Farming	4,800			
Power Transmission Tower	Based on STEG's Plan[2)]	Farming	4,000			
Structures						
Item	**Community**	**Type**	**Length(m)**	**Price**	**Total**	**Total**
Table 9.3.1,No.1	Mahres	Wall	275	Non-Disclosure Information		
Table 9.3.1,No.2	Agareb	Wall	150			
Table 9.3.1,No.3	Sfax South	Wall	155			
Table 9.3.1,No.4		Wall	100			
Table 9.3.1,No.5		Wall	350			
Table 9.3.1,No.6		Wall	205			
Agricultural assets						
Item	**Community**	**Type**	**Number**	**Price**	**Total**	**Total**
Table 9.3.1,No.2	Agareb	Olive trees (25/ha)	50	Non-Disclosure Information		
Table 9.3.1,No.5	Sfax South		37			
Table 9.3.1,No.7			2			
Table 9.3.1,No.8			2			
Figure 9.3.3 (B12)			20			
Power Transmission Tower	Based on STEG's Plan		425			

Note 1): price in 2014
Note 2): Mahres, Agareb, Sfax South
Source: JICA Survey team

The total costs amount to NDI TND in Mahres, NDI TND in Agareb, NDI TND in Sfax South, with the overall amount totalling NDI TND. The above includes the costs for land asset, structure and crops assets, based on market prices in the region. This cost can be considered as full replacement costs.

SONEDE will also shoulder the following costs for land acquisition and compensation for power

transmission line; TND NDI (land acquisition) + TND NDI (olive) = TND NDI

(2) Compensations to fishing activities

As described in Table 8.10-2, the compensation cost for fishing activities amounts to NDI TND.

(3) Budget and funding for social considerations

The total budget necessary for compensations on expropriation and for fishing activities amounts to NDI + NDI + NDI = NDI TND. Since this Project is being implemented by SONEDE, funding will be provided by SONEDE and may be charged to the budget of the Juridical and Real Estate Affairs Department.

The current budget devoted to expropriation at the Juridical and Real Estate Affairs Department amounts to about 1,000.000 TND. According to the implementation schedule (Figure 9.7-1), the budget for land acquisition and compensation of NDI TND shall be secured in the four years from 2018 to 2021 besides of usual budget. Therefore, the annual budget for land acquisition and compensation of SONEDE shall be TND NDI (= NDI /4+ NDI) per year. Assuming that 25% for unanticipated expenses is taken, the total budget will amount to million TND.

9.9 Monitoring Implementation Follow-up Form

The Project's overall schedule depends on the enforcement of social considerations including land acquisition and compensation relating to power transmission line, therefore, follow up must be conducted by PIU by means of the follow up form presented in Table 9.9-1. This form shall be modified in accordance with the result of EIA study being conducted by SONEDE.

Table 9.9-1 Follow-Up Form of Social Considerations

Meetings with stakeholders and information during EIA			
No.	Date	Community	Content and Comments
1			
2			

Land acquisition								
Activities	Item	Mahres		Agareb		Sfax South	
		Water pipe	Power line	Water pipe	Power line	Water pipe	Power line
Real estate survey	Starting date						
	Publication date and site						
	Progress 1 month after the starting date (% of transmission line length surveyed)						
	Progress 3 months after the starting date						
	Main results : ➢ Area to acquire ➢ Length of fence ➢ Number of olive trees ➢ Number of landlords ➢ Number of right-holders ➢ Non-right holders						

Amicable settlement	Number of cases						
	Compensations amount						
	Planned disbursement date						
	Effective disbursement date						
	Progress 1 month after the starting date (% of cases completed)						
	Progress 3 months after the starting date						
Legal settlements	Number of cases						
	Reasons for rejecting amicable settlement						
	Commission meetings dates						
	Date of expropriation decree						
	Compensations amount						
	Planned disbursement date						
	Effective disbursement date						
	Progress 3 month after the starting date (% of cases completed)						
	Progress 6 months after the starting date						

Compensations to fishing activities

Activities	Content
Meetings about schedule information and construction methods	Dates : Communities : List of participants :
Identification of people concerned and compensations amount	Number of people concerned: Selection method of people: Compensations calculation method:
Payment of compensations	Compensation amount: Compensation period: Disbursement method:

Source: JICA Survey Team

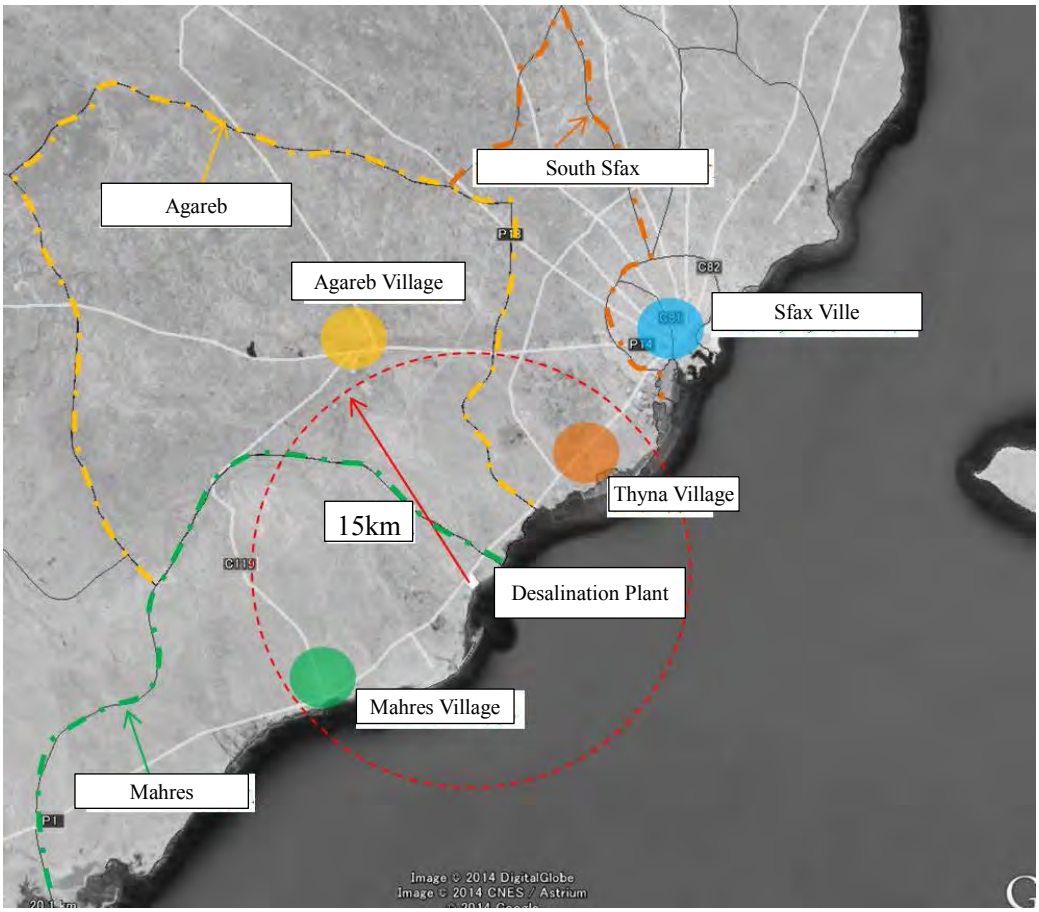
9.10 Explanation to Residents about Power Transmission Line

In addition to the support for the stakeholders meeting, the JICA Survey Team also supported SONEDE to explain and collect the opinions of residents about power transmission line for the desalination plant. Collection of residents' opinions was carried out by distribution of explanation papers and questionnaire survey. Outlines of activities are as follows:

(1) Subject area

Subject area where receive influence by construction work of power transmission line is presented in the Figure 9.10-1. The route of 15km[1] long transmission line has not been identified yet by STEG.

[1] STEG changed the planned distance of the power transmission line to 15km from initially planned 15.5km.



Source: JICA Survey Team

Figure 9.10–1 15kmLong Power Transmission Line Construction Site

Subject area is supposed to be Mahres, Agareb, and Thyna. Since STEG has not identified the route of the power line in detail yet, the questionnaires were sent to representative people in each region. Contents of the distributed papers are as shown in Figure 9.10-2, i.e. general map, questionnaire, outlines of the Project, policies of land acquisition and compensation relating to construction of the power transmission line.

الشركة الوطنية لاستغلال وتوزيع المياه

SOCIETE NATIONALE D'EXPLOITATION ET DE DISTRIBUTION DES EAUX

تونس في 12 ... 2014

29036

إلى السيد والي صفاقس

الموضوع: - مشروع انجاز محطة تحلية مياه البحر بسعة 200 ألف متر مكعب في اليوم بصفاقس الكبرى
- حول ربط المحطة بالكهرباء

المصاحيب: - ملحق عدد1 حول المسار الأولي لخط الجهد العالي،
- ملحق عدد2 حول وثيقة استشارة (للاحظات و التساؤلات حول المشروع)
- ملحق عدد3 حول العناصر الأساسية للمشروع،

تحية طيبة وبعد،

في إطار تدعيم تزويد صفاقس الكبرى بالماء الصالح للشرب، كما تعلمون برمجت الشركة الوطنية لاستغلال وتوزيع المياه انجاز محطة لتحلية مياه البحر بسعة 100 ألف متر مكعب في اليوم كمرحلة اولى، وتبعا لذلك ستقوم الشركة التونسية للكهرباء و الغاز بجلب الطاقة الكهربائية اللازمة لكافة المنشآت التابعة للمشروع عن طريق مد خط كهربائي جهد عالي،

كما نفيد سيدتكم علما بأن الشركة التونسية للكهرباء و الغاز تقوم حاليا بإعداد الدراسات الضرورية لتحديد مسار خط الجهد العالي لربط محطة التحلية بالكهرباء، وعند الانتهاء من هذه الدراسة و تحديد المسار النهائي، سيتم انجاز دراسة المؤثرات البيئية التي ستشمل منشآت محطة التحلية وخط الكهرباء ذات الجهد العالي من قبل مكتب دراسات مختص. وخلال الدراسة البيئية سيتم تنظيم يوم إعلامي للعموم قصد شرح كل تفاصيل المشروع و خاصة الجزء المتعلق بربط المحطة بالكهرباء.

وبهدف الإعلام المسبق للسكان المعنيين بهذا المشروع، تجدون صحبة هذا ملخصا للعناصر الأساسية للمشروع (ملحق عدد3). كما نطلب من سيادتكم مدنا بملاحظاتكم و تساؤلاتكم بخصوص عناصر المشروع وذلك طبقا لوثيقة الاستشارة المصاحبة (ملحق عدد2).

وحتى نتمكن من إدراج ملاحظاتكم في الدراسة البيئية للمشروع، الرجاء موافاتنا بإجاباتكم في أقرب الآجال.

تقبلوا سيدي الوالي فائق عبارات التقدير و الاحترام.

المدير المركزي للدراسات

عدنان بوبكر

Explanation about Papers - cover

Annexe 1 Tracé provisoire de la ligne

Source: STEG

General map (annex 1)

Annexe 2 Commentaires et questions à propos du projet de la centrale de dessalement de Sfax

Destinataire: Agence de Sfax, SONEDE
A l'attention de M. Youssef Shel (email: y.shel@sonede.com.tn, fax: 74297335)
Ou M.Charfeddine Sliti (email: c.sliti@sonede.com.tn, fax: 71494185)

Mes commentaires à propos du projet de la centrale et de la construction de la ligne à haute tension sont les suivants:

☐J'ai le commentaire suivant:
....
....
....

☐Je n'ai pas de commentaire

☐J'ai la question suivante:
....
....
....

☐Je n'ai pas de question

Date: le........décembre 2014
Nom : M /Mme.................................
Fonction/Titre :.................................
Délégation :.................................
Occupation/Emploi: ....
Tel.............................Fax:.................................
Email:...@...

Questionnaire (annex 2)

Annexe3

Projet de la Station de dessalement d'eau de mer de Sfax

Principaux éléments :

1 **Installations de dessalement**
- 1.1 Composantes
  - Centrale de dessalement d'eau de mer
  - Conduites d'adduction (depuis la centrale jusqu'aux réservoirs)
- 1.2 Centrale de dessalement
  - Capacité à terme : 200 000m3/jour (phase I , 100 000m3/jour)
  - Localisation : Gouvernorat de Sfax, Délégation d'Agareb, en bord de mer face à British Gas
- 1.3 Résultats attendus
  - Augmentation de la quantité d'eau potable
  - Amélioration de la qualité de l'eau potable
- 1.4 Mise en service prévue
  - Courant 2020

2 **Installations électriques**
- 2.1 Puissance nécessaire : 40MW (phase I , 20MW)
- 2.2 Méthode d'approvisionnement (en cours d'étude)
  - La puissance nécessaire sera approvisionnée jusqu'à la centrale par une ligne à haute tension à partir des lignes existantes de la STEG (ligne existante de 150kV partant de Sfax vers l'ouest)

3 **Impacts liés à la ligne haute tension et méthode de compensation**
- 3.1 Impacts envisagés
  - Le tracé de la ligne à haute tension n'est pas encore arrêté, cependant la ligne devrait s'orienter de la centrale vers le nord sur environ 16kmpour rejoindre les lignes existantes. La ligne traversant principalement des champs d'oliviers, aucun impact significatif sur des bâtiments n'est prévu (le tracé provisoire de la ligne est montré en annexe).
- 3.2 Méthode de compensation
  - Environ 40 pylônes électriques seront nécessaires à la construction de la ligne. Les acquisitions de terrains nécessaires à l'emplacement des pylônes seront réalisées par la STEG.
  - Les compensations pour l'acquisition des terrains seront réalisées suivant la loi tunisienne qui est conforme aux directives du bailleur de fonds en la matière.
  - La STEG est responsable de la mise en œuvre des procédures.

Outlines of the Project , policies about land acquisition and compensation (annex 3)

Source: SONEDE

Figure 9.10–2 Questionnaire distributed for Explanation about Power Transmission Line

(2) Results of the Survey

The Sfax Governorate office is the sole responsible authority for administrative issues in the Sfax Governorate under Ministry of Interior of Tunisia. SONEDE cannot contact each region directly, but through the governorate office. SONEDE sent the said questionnaire to the governorate office on 12 December 2014, and requested the office to deliver the questionnaire to representatives of each region. As a result, the governor of the Sfax Governorate answered on 14 February 2015 with the letter shown

in Figure 9.10-3. The answer was that there had been no objection from Sfax Ville, West Sfax, and Thyna, and the governor also had no objection about the Project. It may be considered that no objection to construction work of the power transmission line at present.

04-02-2015 17:49 GOUVERNORAT DE SFAX 74 403 625 P.01/01
04 Feb. 2015 11:37 P 3

Annexe 2 : Commentaires et questions à propos du projet de la station de dessalement de Sfax

Destinataire: Direction régionale de Sfax ou Direction de dessalement et d'environnement (SONEDE) (email : [illegible]@sonede.com.tn, fax: 74297335)
Ou M. Charfeddine Sifti (email : c.sifti@sonede.com.tn fax : 71494185)

Mes commentaires à propos du projet de la centrale et de la construction de la ligne à haute tension sont les suivants:

☐J'ai le commentaire suivant:
.....
.....
.....

☒Je n'ai pas de commentaire

☐J'ai la question suivante:
.....
.....
.....

☒Je n'ai pas de question

Date:le.....décembre 2014
Nom : M /Mme.....
Fonction/Titre :.....
Délégation :.....
Occupation/Emploi:.....
Tel:.....Fax:.....
Email:.....@.....

مهدي شلبي

TOTAL PAGE(S) 01

Source: SONEDE

Figure 9.10–3 Answer to the Questionnaire from the Governor

Social survey will be conducted by SONEDE at the time of detailed design of the power transmission line by STEG. Subject area and residents will be identified through the survey, and then, the land required to be acquired and amount of compensation will be identified. Furthermore, SONEDE will hold explanation meetings with residents in the subject areas to explain about policies for land acquisition and compensation and to confirm that there is no opposition to the Project.

CHAPTER 10

IMPLEMENTATION PLAN

CHAPTER 10 IMPLEMENTATION PLAN

Non-Disclosure Information

CHAPTER 11

CONFIRMATION OF VIABILITY AND RISK ANALYSIS

CHAPTER 11 CONFIRMATION OF VIABILITY AND RISK ANALYSIS

The necessity for installing a seawater desalination plant installation was examined in Chapter 4. In constructing the plant, there are some issues on finance, the environment, and power supply. This chapter discusses these issues as well as mitigation of risks associated with the issues presented.

11.1 Concern about Financial Aspect

The initial costs in the construction of seawater desalination plant will be shouldered by the government of Tunisia. SONEDE is not required to consider the payment of the initial cost from its account, but the operation and maintenance cost shall be borne by SONEDE from its own revenue. The O&M cost of the desalination plant is higher compared with other common water treatment process. Without implementing measures to increase revenue, SONEDE will not able to shoulder the increased expenditure for operation and maintenance of the desalination plant.

Measures to increase revenue are; 1) increasing water tariff; 2) reducing non-revenue water ratio; and 3) increasing subsidy. Among these measures, it is only the first that is feasible at this time. For example the present NRW ratio is relatively low comparing with the one in developing countries so further reduction will entail continuous investment. Subsidy at this time is also not advisable as;

i) the government will shoulder the construction cost, and

ii) SONEDE has a responsibility to continue being a self-supporting and autonomous authority.

Therefore, the most applicable practical measure is to increase water tariff.

As described in the FIRR analysis, the water production cost from the seawater desalination plant is estimated at NDI TND/m^3. This is based on the water production cost of four existing desalination plants at Kerkennah Gabes, Djerba and Zarzis, as well as the investigated cost found out in this survey. The annual water production volume by this project is 36,500,000m^3/year or only about 6.7% of SONEDE's present production volume at 540,000,000m^3/year. SONEDE has applied the uniform water tariff rate to all users in the entire country. If all the customers of SONEDE cover the increased cost brought by this project, the required water tariff is NDI TND/m^3. The required increase will be approximately NDI TND/m^3 or NDI % of the present tariff. The percentage of the water tariff against the disposable income is 0.67 % after the increase.

In 2014, SONEDE increased the tariff by 7%. There were, however, no serious complaints from customers. SONEDE has a plan to increase the tariff using the same rate annually in the next two years. With these increases, the operation and maintenance cost of the desalination plant constructed in this project can be covered by the net increase at 7% in next two years.

Generally it is said that the acceptable water tariff level is 4% of disposable income, which is 179TND/person/year based on the disposable income of 4,478TND/person/year in 2013. As shown in Table 11.1-1, 87% or more among the connections belongs to the category of 41-70 m^3/3 months. These customers pay less than 20 TND/3months or around 80TND/year, that is 45% of the acceptable tariff

level mentioned above. Therefore, the increase falls under the acceptable level.

Table 11.1-1 Water and Sewerage Bills in Category

unit: TND

Category		No of connection (%)	Water consumption (%)	Average water consumption (m^3/3 months)	Tariff (TND)	Water tariff (%)	Sewerage tariff (%)	VAT (%)
Domestic	(0-20) m^3 /3 months	37.3%	8.0%	9	7.5	68.2%	19.5%	12.3%
	(21-40) m^3 /3 months	29.9%	21.0%	30	16.9	66.8%	21.1%	12.0%
	(41-70) m^3 /3 months	20.0%	23.6%	50	38.4	50.9%	39.9%	9.2%
	(71-100) m^3 /3 months	5.2%	10.1%	82	91.9	55.4%	34.6%	10.0%
	(101-150) m^3 /3 months	1.9%	5.3%	119	153.4	56.8%	33.0%	10.2%
	(151-500) m^3 /3 months	0.8%	4.1%	222	374.8	58.8%	30.7%	10.6%
	(501-+) m^3 /3 months	0.1%	2.3%	1264	2,244.2	57.9%	31.7%	10.4%
Central government		1.3%	6.2%	207	407.4	50.5%	40.4%	9.1%
Commerce + Local Government + others		2.9%	5.3%	78	119.0	40.9%	51.7%	7.4%
Industry		0.58%	7.6%	4995	9,841.3	52.2%	38.5%	9.4%
Tourism		0.06%	3.8%	2749	6,174.5	45.8%	45.9%	8.3%
Domestic, not connected		0.04%	2.7%	3154	555.0	84.7%	-	15.3%

Sources: RAPPORT DES STATISTIQUES ANNEE 2012

Note: Tariff is charged every three months.

11.2 Concern about Social and Environmental Aspect

There are two categories of environmental issues caused by the implementation of the project, i.e. concerns under the sea and on ground.

Since intake and discharge pipelines will be installed under the seabed, the pipe installation will directly impact the aquatic environment. Seagrasses are observed to grow by the seafront of the proposed site for the desalination plant, which means that other marine creatures inhabit the area. In the field investigation, no other remarkable sea creatures were observed except for the presence of seagrasses.

In the interview survey, the environmental authority responded there would be no particular concern, but the issue will still be clarified when the EIA will be implemented. Since the intake and the discharge pipelines will be installed under the seabed, the seagrasses' habitat will temporary be disturbed during the construction period. It is necessary to reduce the impacts during the construction work, and if required, transplanting of the seagrasses from the construction site will be done. After construction, the area will be restored to its original state.

The seawater desalination plant is to be installed at non-utilized open space facing the coast, so a big impact to the environment will not be expected. However, there will be vehicles for construction plying the roads. The transmission pipelines are to be installed along main roads for long distance, thus pipeline

construction work will affect traffic conditions. Efforts will be taken to minimize the effect on traffic.

With the identification of impacts of the project and measures by the EIA, appropriate mitigation measures will be undertaken to lessen its adverse impacts.

11.3 Concern about Power Supply Aspect

Power demand of the proposed sea water desalination plant is assumed at 40MW in the final stage of the project. SONEDE inquired of STEG's availability to provide 40MW power supply, which requires the payment for a new power distribution system including a substation. STEG, however, orally answered to the JICA Survey team that 40 MW (150kV) power supply will be possible. It is expected that STEG will be able to supply the required power based on the following:

- Generating capacity: an increase at 1.51 times from 2007 to 2013
- Power sales: an increase at 1.28 times from 2007 to 2013
- Securing of power receiving capacity: reliable enough to secure the power receiving capacity due to the high voltage power receiving.
- Record of power failure: few records of power failure according to the investigation at the existing sea water desalination plants

As shown in Figure 2.2-6, the average increase in the power generation from 2007 to 2013 is 370MW. This increase exceeds 40MW or the power demand of the proposed seawater desalination plant. When an average rate of power demand (an annual average for hourly maximum power demand) is assumed at 90%, the annual power consumption of the proposed plant will approximately be 158 GWh. Compared to the present power sales of 563GWh in 2013 to water supply and sewage sector, it indicates that the project requires an unprecedented increase of power supply. It, however, can be seen in Figure 2.2-7 that the average power sales increase from 2007 to 2013 was 530 GWh, three times more than compared the power consumption of the proposed plant. The power demand of 40 MW is for the plant in final stage. Water production in Phase 1 is half of the production in final stage, so the power demand will be approximately half as well.

According to the reasons mentioned above, it is considered that STEG has the power supply capacity to meet the requirement of the proposed seawater desalination plant.

11.4 Concern about Delay of the Project

The implementation schedule of the project is prepared as follows:

- Pledge of the JICA ODA loan for the project: December 2015
- Loan Agreement: March 2016
- Start of Construction work after selection of consultants and contractors: October 2019
- Start of Operation: October 2022

If this schedule is delayed, water shortage in the Greater Sfax anticipated to occur from 2017 will be

reality until the completion of the project. Furthermore, if completion is delayed by one year, it will affect the project by a decrease of the EIRR by 1.34%.

Besides the Saida Seawater Desalination Plant Construction Project, the first phase of the Saida Reservoir and Kalaa Kebira Reservoir & Water Treatment Plant projects is expected to be completed by 2020, while completion of the second phase will be by 2024. If these projects are delayed, water shortage in the Greater Sfax will be more serious because water to be supplied by the said project is more than that of the Sfax Seawater Desalination Plant.

11.5 Risks and Mitigation Measures

11.5.1 Financial Risks and Mitigation Measures

At present, Government of Tunisia is responsible for paying the initial investment cost of the project, while SONEDE will cover the operation and maintenance cost from its own revenue. Power, chemicals, and personnel, the major O&M costs, should be properly calculated and covered by the projected increase in the water tariff. Together with the tariff increase, there is also a need to review the operation and maintenance costs and operating expenses including outsourcing, enhancement of water-saving awareness, and the study on mitigation measures.

The risks are analysed on the financial and water tariff impacts by its resultant increase in the operation and maintenance cost when the project is implemented. Together with the risks, the mitigation measures are shown below, which make it necessary to:

i) Conduct a review of the costs involved in construction work, in having an effective organization structure and in the procurement for operation and maintenance, and

ii) Promote and gain public understanding for the tariff increase. According to the result of social survey, the customers showed dissatisfaction with the water supply service. The improvement of the value-added service, particularly water quality is the future challenge to obtain better customer satisfaction.

Table 11.5-1 Financial Risks and Mitigation Measures

Financial Risks	Cause of Risks	Mitigation Measures
Initial cost of sea water desalination facility	• Increase in construction cost	• Increase the burden of the government • Review of construction work
Operation and maintenance cost of sea water desalination facility	• Increase the amount of water supply due to the high unit cost production process	• Consideration of tariff increase • Review of the supplies and personnel expenses • Reduction of operating expenses, including the use of outsourcing • Decrease in the utilization rate of the high unit cost production process with water-saving[1]
Opposition of residents to the tariff increase	• Rapid rate increase	• Explanation to residents and public relations on a review on water tariff • Information to residents about the benefit on sea water desalination plant • Information to residents about water-saving

11.5.2 Socio-Environmental Risks and Mitigation Measures

The socio-environmental risks are those that have impact on the lives of residents during construction, and citizens' movements or legal actions if the construction of the desalination plant is opposed. Therefore, it is necessary to give proper and advance information on the project to the stakeholders and the local residents during the construction period. Regarding land acquisition, SONEDE has not had any serious problems in the past project. However, it is necessary to confirm the land ownership when the site for this project is selected.

The other risks related to environment are the approval process of EIA required by Tunisia, whether approval is delayed or is not given. Employing local consultants to study the EIA will be indispensable. In addition, the impact of the construction of the intake and the discharge pipeline to undersea environment should be fully studied during the detailed design to minimize effects during construction. It is also necessary to investigate the effect of the project on fishery activities especially on changes in the surrounding natural environment. If expected, the risk of these effects has to be eliminated at the earliest time.

The socio-environmental risks and mitigation measures are summarized in Table 11.5-2.

[1] The operation rate of the Chatan Sea Water Desalination Plant in Okinawa, Japan with a capacity of 40,000 m^3/day was 25% on average for 10 years from when it started operation in 1997 to 2006. In 2011 it was 12.3%. The reasons of its low operation rate are; high power consumption at 6.17 kWh/m^3, and other water resource development after its completion.
Umi-no-nakamichi Nata Sea Water Desalination Plant in Fukuoka, Japan with a capacity of 50,000 m^3/day was 78% in 2011 due to drought of surface water and water shortage caused by other works. However, not only that year but also other years, the plant had high operation rate of 60% to 83%/ since the start of its operation in 2005. Though the high power consumption at 5.87 kWh/m^3,is much higher than that of the nearby Ushikubi Water Treatment Plant at 0.18 kWh/m^3, this plant keeps high operation rate because of lack of water supply capacity originated from surface water.

Table 11.5-2 Socio-Environmental Risks and Mitigation Measures

Socio-Environmental Risks	Cause of Risks	Mitigation Measures
Social impact • Impact on life of residents during construction • Legal action if the residents do not agree with the construction of the desalination plant	• Lack of social awareness for water supply development plan • Lack of public relations • Failure of negotiation • Impact on economic activities (For instance: impact of intake/discharge pipes to fishery activities, noise at pump station, traffic congestion caused by construction)	• Verification of the necessity of the project • Explanation to residents and public relations • Installation of transmission pipes or pump stations along roads, or public land avoiding residential areas, and technical and economic applicability • Securing sufficient budget for land acquisition
Impact on the natural environment • Non-approval of the EIA • Impact on the economic activities	• Impact of intake and discharge pipes on marine environment (change in salinity, change in current, excavation for pipe installation, etc.) • An increase in sewage by an increase in water supply, and pollution expansion at public waters	• Selection of the site with less or insignificant impact to marine environment • Optimization of design by simulating intake/discharge pipe operation • Verification of impact on economic activities with change in the natural environment • Promotion of sewerage development plan

11.5.3 Power Supply Risks and Mitigation Measures

As mentioned previously in Section 11.3, a sufficient power capacity must be secured. The risk next to the power capacity is power failures due to accidents. It is desirable not to have power failures in order to provide continuous water supply and to conserve the equipment at the desalination plant. Actually, there is hardly a record of power failures at the existing seawater desalination plants with two power receiving systems. Once there was an eight-hour power failure at Ben Guerdane plant due to single incoming power line. Although power failures depend on the season and time, these will not cause a complete shut-down of water supply because there are alternative water transmissions from different water sources. In addition, the reservoir has enough capacity in case of power failure. The capacity of the water tank at the desalination plant is designed for a hydraulic retention time of six hours in order to secure the transmission of water for a certain period. There are also emergency power generators installed at the transmission pump stations at the desalination plant, and reservoirs of PK11, PK10, and PK14. However, the emergency power generators are not installed for the desalination process equipment for the following reasons:

- As mentioned above, water is supplied continuously at a certain period if the transmission facilities are operated during the power failure.
- Large amount of investment for generators is required for operation of the desalination process because the desalination plant consumes a large amount of power.

Table 11.5-3 Power Supply Risks and Mitigation Measures

Power Supply Risks	Cause of Risks	Mitigation Measures
Power failure	• Lack of emergency generators • Accidents	• To intensify generating facilities (below: measures at the plant) • Two-line power receiving system • To receive power from high voltage line • To secure large capacity of production water tanks • To install standby generators for the transmission pumps.

11.5.4 Project Delay Risks and Mitigation Measures

There will be various causes for delay risk. Most probable case is the delays in processing various procedures shown in Table 10.7-1 and Figure 10.7-1. Furthermore, delays in getting approval from related authorities for the implementation of works, such as permission of road authorities for works in road premises can cause delay of the works. The project shall be implemented under the control of the PIU which will be established in SONEDE together with cooperation with related authorities. The PIU is expected to have strong leadership and approaches with related authorities for implementing the project without delay.

The risks and mitigation measures are summarized in Table 11.5-4.

Table 11.5-4 Project Delay Risks and Mitigation Measures

Risks of Delay of Implementation	Cause of Risks	Mitigation Measures
Delay in implementation of the Project	• Delay in establishment of PIU • Delay in making Loan Agreement • Delay in preparing Tender Documents • Delay in the approval of various procedures by HAICOP • Delay in Tender evaluations • Rupture of Tender • Delay in the concurrence in various procedures by JICA • Delay in land acquisition • Delay in the approval of implementation of works by related authorities • Delay in marine works due to bad weather.	• Strong leadership and approach to related authorities by PIU. • Secure sufficient number of PIU staff • Hire consultants • Preparation of appropriate and easily understandable tender documents. • Preparation of flexible construction plan.