CHAPTER 6 IMPLEMENTATION SCHEDULE

6.1 Water Resources Development Projects

Implementation schedule of the projects for domestic and industrial water supply and irrigation water supply is shown in Table-6.1. The following distinctions were set to give high priority to the projects proposed in the Master Plan: 1) Large water shortage and rate of beneficiaries, 2) Long period for plan and construction, 3) Large construction volume, and 4) Multi-purpose project.

(1) Integrated Water Supply Projects for Urban and Large Rural Area

On-going projects and existing planned projects proposed to PROAGUA, such as 1) Expansion Project of Sao Francisco Pipeline System, 2) Aracaju Well Development Project, 3) Project Expansion of Agreste and Piauitinga projects, should firstly be completed. As Xingo Dam Pipeline Project and Vaza Barris Dam Project are expected to take long period and as these projects supply water to the area of large water shortage and rate, these should start as soon as possible. These projects should divide into two phases to develop water according to the increase of water demand. Since the area covered by Project Expansion of Itabaianinha Pipeline Project also have large water shortage and rate but water demand is gradually increasing, this project was divided into three phases. The first phase of this project should start earlier. As the water shortage and rate of the other projects are relatively small, these projects have not so high priority. These projects should divide into two phases to develop water according to the increase of water demand

Water supply programs of the blocks of Piauitinga (Lagarto), Agreste (Itabaiana) and Aracaju are shown in Figure-6.1.

(2) Independent Water Supply Projects for Urban and Large Rural Area

The 35 projects of independent water supply should complete within 20 years until the year of 2020. According to water shortage and water shortage rate of benefited area, priority was put to each project. Depending on the increasing rate of water demand, some projects were divided into two phases. Deep well development projects should be implemented in line with increased demand.

Water supply programs in the municipalities of Maruim (deep well), Rosario do Catete (weir and deep well) and Itaporanga d'Ajuda (weir only) are shown in Figure-6.2.

(3) Water Supply Projects for Small Rural Area

Deep well development projects for small rural area should be implemented step by step in line with increased demand.

(4) Irrigation Water Supply Projects

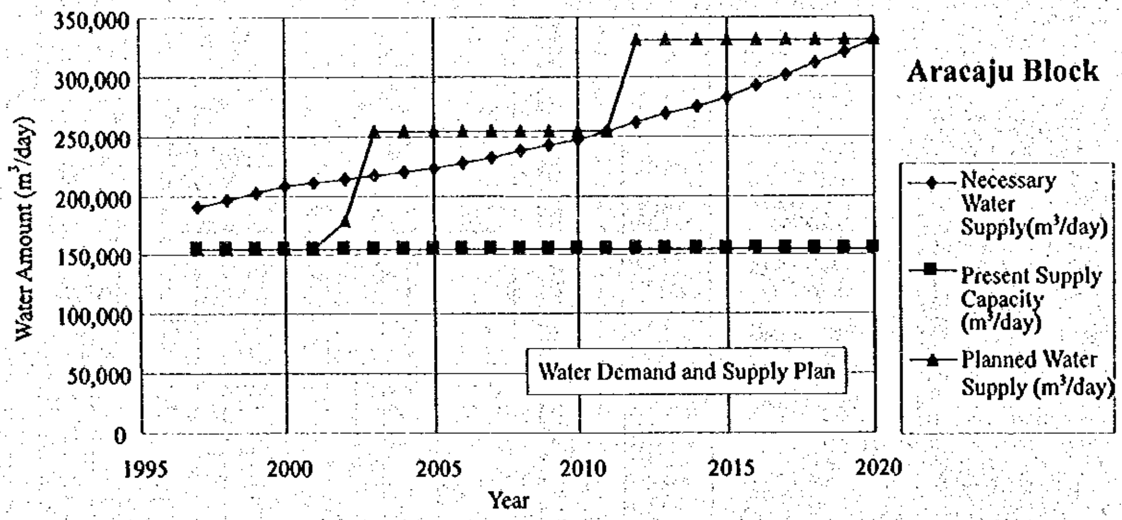
As Jacare-Curituba and Jacarecica II irrigation projects are on-going, these projects should firstly be completed. Sao Francisco irrigation project has large irrigation area and project period of 10 years is necessary to be implemented. Vaza Barris irrigation project should commence after completion of Vaza Barris dam.

Table-6.1 Implementation Schedule

Project	Water Developed (m^3/day)	Project Cost (1,000R$)	1st: 2000-2004					2nd: 2005-2009					3rd: 2010-2014					4th: 2015-2019					
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Industrial and Municipal Water Supply	515,605	945,806																					
Urban and Large Rural Area (Integrated System)	347,901	701,938																					
Project Expansion of Sao Francisco Pipeline System	151,600	258,011	##	##	##									##									
Aracaju Well Development Project	23,292	27,003	**	##																			
Project Expansion of Agreste Pipeline System	22,200	14,562		**	##																		
Project Expansion of Piauitinga Pipeline System	30,200	9,293		**	##																		
Xingo Dam Pipeline Project	43,999	145,662			==	==	==	==				==	==	==									
Caninde Block	-	53,729		**	**	##									##								
Nossa Senhora da Gloria Block	-	54,872		**	**		##						##										
Frei Paulo Block	-	37,061		**	**			##						##									
Vaza Barris Dam Project	76,610	154,618		==	==	==	==	==	==		==	==			==	==	==	==					
Dam Construction	-	-		**	**	**	##	##	##														
Water Supply facilities (Itabaiana)	-	-						**	##						**	##							
Water Supply facilities (Lagarto)	-	-									**	##					**	##					
Project Expansion of Itabaianinha Pipeline System	13,321	34,305			**	##			**	##					##								
Project Expansion of Propria Pipeline System	6,189	4,814							**	##					##								
Project Expansion of Alto Sertao Pipeline System	5,495	20,518								**	##					##							
Project Expansion of Sertaneja Pipeline System	6,493	33,152								**	##					##							
Urban and Large Rural Area (Independent System)	158,351	170,002																					
Gararu: SFR Direct Intake	510	635									**	##											
Muribeca: Deep Well Development	465	846								##		##		##		##		##		##		##	
Nossa Senhora das Dores: Pinol R. Development	3,302	2,870							**	##													
Malhador: Vermelha R. Development	1,377	2,113									**	##											
: Deep Well Development	-	598															##	##	##	##	##	##	
Tobias Barreto: Jabiberi Dam Raising Project	7,727	16,787					**	**	##														
Brejo Grande: Deep Well Development	722	564						##										##					
Ilha das Flores: Deep Well Development	788	591					##										##						
Neopolis: SFR Direct Intake	16,916	8,310			**	##			##								##						
Santana do Sao Francisco: SFR Direct Intake (Exp.)	3,841	1,861					**	##					##										
Capela: Siriri R. Development	6,694	3,650					**	##															
: Adeira R. Development	-	3,301														**	##						
Divina Pastora: Deep Well Development	479	523					##					##					##					##	
Santa Rosa de Lima: Deep Well Development	306	457					##					##					##					##	
Siriri: Deep Well Development	507	628												##		##		##		##		##	
Japaratuba: Deep Well Development	2,794	1,762					##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	
Japoata: Deep Well Development	471	540										##			##			##			##		
Pacatuba: Santo Antonio R. Development	4,298	1,922				**	##							##									
Pirambu: Deep Well Development	2,165	1,327		##			##			##			##			##			##			##	
Sao Francisco: Deep Well Development	373	503								##			##			##			##			##	
Carmopolis: Deep Well Development	891	612														##		##		##		##	
General Maynard: Deep Well Development	388	465						##							##							##	
Maruim: Deep Well Development	2,990	1,511		##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	
Riachuelo: Jacarecica R. Development	7,765	1,793			**	##			**	##													
: Deep Well Development	-	2,039													##	##	##	##	##	##	##	##	
Rosario do Catete: Siriri R. Development	17,531	2,042		**	##				##														
: Deep Well Development	-	3,454											##	##	##	##	##	##	##	##	##	##	
Santo Amaro das Brotas: Deep Well Development	807	552						##							##							##	
Barra dos Coqueiros: Deep Well Development	6,277	2,925						##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	
Sao Cristovao: Deep Well Development	4,599	2,732								##	##	##	##	##	##	##	##	##	##	##	##	##	
Araua: Camboata R. Development	1,680	1,195								**	##												
: Deep Well Development	-	1,159											##	##	##	##	##	##	##	##	##	##	
Boquim: Garangal R. Development	2,929	3,748									**	##											
Cristinapolis: Itamirim R. Development	2,656	4,106							**	##							##						
Pedrinhas: Araua R. Development	1,647	2,193							**	##													
: Deep Well Development	-	644										##	##	##	##	##	##	##	##	##			
Salgado: Grilo R. Development	2,906	2,002							**	##													
: Deep Well Development	-	1,159												##	##	##	##	##	##	##	##	##	
Estancia: Piauitinga R. Development	23,758	6,825				**	##																
: Piaui R. Development	-	4,061								**	##						##						
: Deep Well Development	-	2,938																			##	##	
Indiaroba: Paripe R. Development	1,105	1,184									**	##											
Itaporanga d'Ajuda: Fundo R. Development	24,640	5,851		**	##							**	##										
: Tejupeba R. Development	-	63,538																	**	##			
Santa Luzia do Itanhy: Ariquitiba R. Development	1,947	1,481						**	##					##									
Small Rural Area (Municipal Water Supply Only)	9,353	73,866																					
Single Well System (Public Tap)	9,353	73,866		##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	
Irrigation Water Supply	1,906,301	427,497																					
Quixabeira	262,873	35,051													**	##	##	##					
Jacare-Curituba	272,394	37,852	##	##																			
Sao Francisco	933,333	223,071			**	##	##	##	##	##	##	##	##	##	##								
Ladeirinhas	58,147	28,742												**	**	##	##	##					
Jacarecica II	97,900	44,545	##	##	##																		
Vaza Barris	260,000	54,839						**	##	##	##	##											
Entre Rios	16,095	2,397																**	##	##			
Estancinha	5,559	1,001																		**	##	##	

Note: **: Plan and Design ##: Construction

WATER SUPPLY PROGRAM						
Items	1997	2000	2005	2010	2015	2020
Present Supply Capacity (m^3/day)	155,315	155,315	155,315	155,315	155,315	155,315
(1) Expansion of Sao F. P. Phase-I	0	0	75,800	75,800	75,800	75,800
(2) Expansion of Sao F. P. Phase-II	0	0	0	0	75,800	75,800
(3) Aracaju Well Development	0	0	23,292	23,292	23,292	23,292
Planned Water Supply (m^3/day)	155,315	155,315	254,407	254,407	330,207	330,207



WATER SUPPLY PROGRAM						
Items	1997	2000	2005	2010	2015	2020
Present Supply Capacity (m^3/day)	12,810	12,810	12,810	12,810	12,810	12,810
(1) Expansion of Agreste P.	0	0	22200	22200	22200	22200
(2) Vaza Barris Project Phase-I	0	0	0	19638	19638	19638
(3) Vaza Barris Project Phase-II	0	0	0	0	19638	19638
Planned Water Supply (m^3/day)	12,810	12,810	35,010	54,648	74,286	74,286

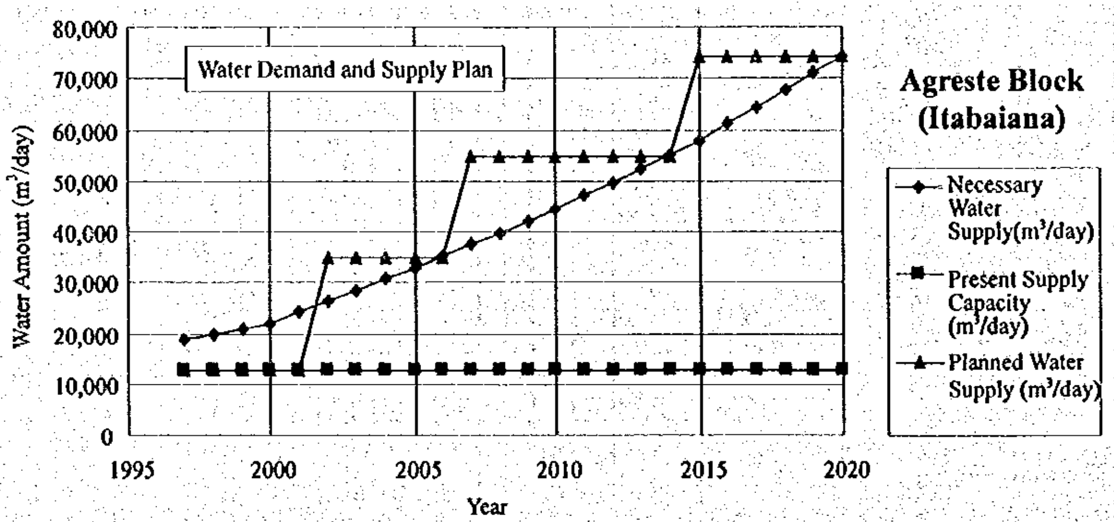


Figure-6.1 (1/2) Water Supply Program of Integrated Pipeline System

WATER SUPPLY PROGRAM						
Items	1997	2000	2005	2010	2015	2020
Present Supply Capacity (m³/day)	12,130	12,130	12,130	12,130	12,130	12,130
(1) Expansion of Piauitinga P.	0	0	30,200	30,200	30,200	30,200
(2) Vaza Barris Dam Project Phase-I	0	0	0	18,667	18,667	18,667
(3) Vaza Barris Dam Project Phase-II	0	0	0	0	0	18,667
Planned Water Supply (m³/day)	12,130	12,130	42,330	60,997	60,997	79,664

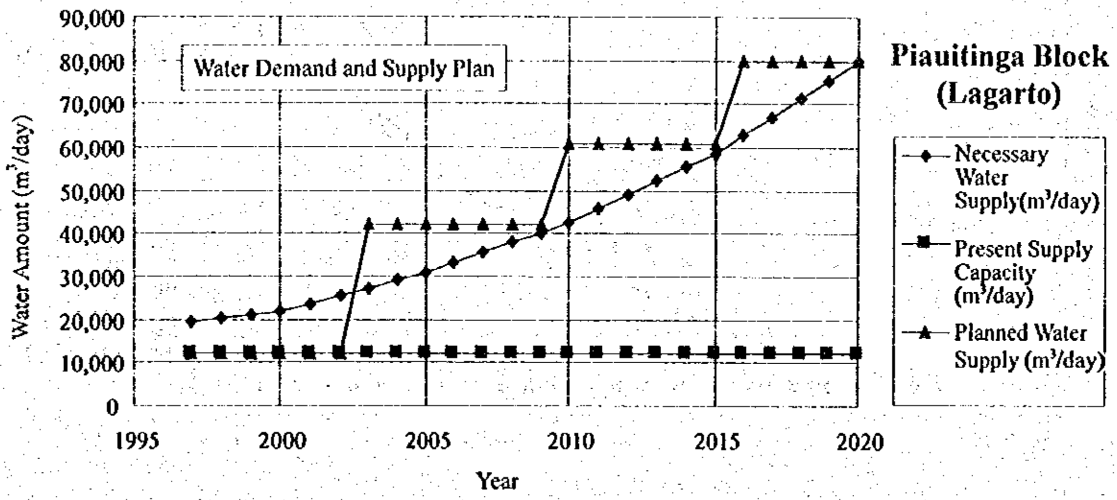


Figure-6.1 (2/2) Water Supply Program of Integrated Pipeline System

WATER SUPPLY PROGRAM						
Items	1997	2000	2005	2010	2015	2020
Present Supply Capacity (m³/day)	2,015	2,015	2,015	2,015	2,015	2,015
(1) Deep Well development	0	0	629	1,416	2,203	2,990
Planned Water Supply (m³/day)	2,015	2,015	2,644	3,431	4,218	5,005

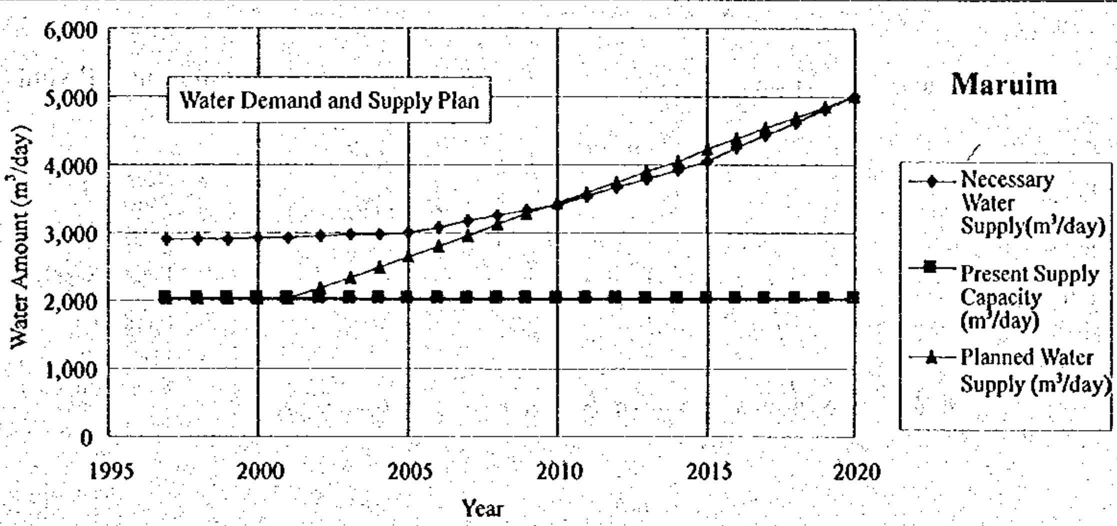
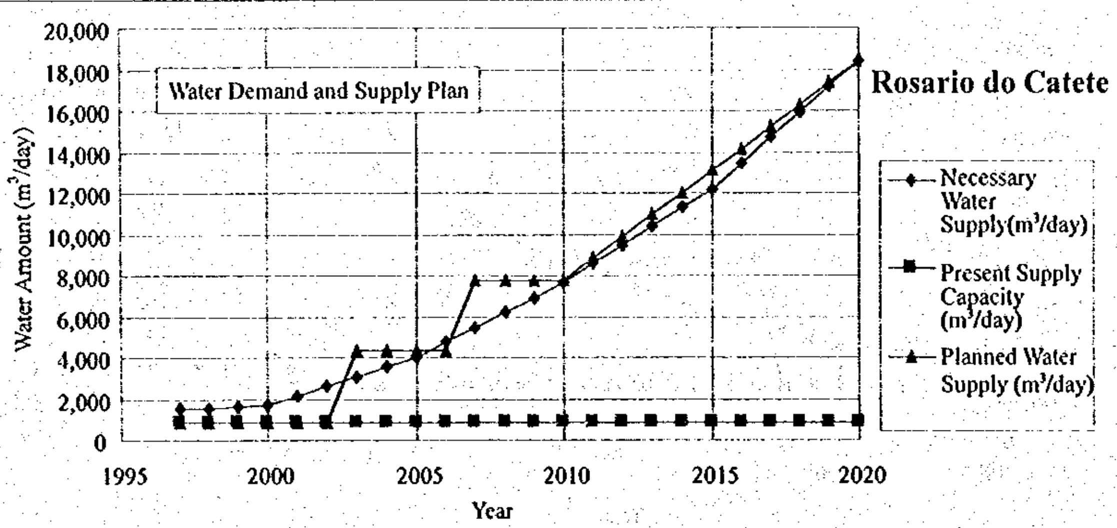


Figure-6.2 (1/2) Water Supply Program of Independent Pipeline System

WATER SUPPLY PROGRAM						
Items	1997	2000	2005	2010	2015	2020
Present Supply Capacity (m^3/day)	880	880	880	880	880	880
(1) Siriri R. Development Phase-I	0	0	6,900	6,900	6,900	6,900
(2) Siriri R. Development Phase-II	0	0	0	0	17,250	34,500
(3) Deep Well Development	0	0	0	0	10,631	
Planned Water Supply (m^3/day)	880	880	7,780	7,780	35,661	42,280



WATER SUPPLY PROGRAM						
Items	1997	2000	2005	2010	2015	2020
Present Supply Capacity (m^3/day)	1,773	1,773	1,773	1,773	1,773	1,773
(1) Fundo R. Development Phase-I	0	0	9287	9287	9287	9287
(2) Fundo R. Development Phase-II	0	0	0	9286	9286	9286
(3) Tejupeba R. Development	0	0	0	0	0	6067
Planned Water Supply (m^3/day)	1,773	1,773	11,060	20,346	20,346	26,413

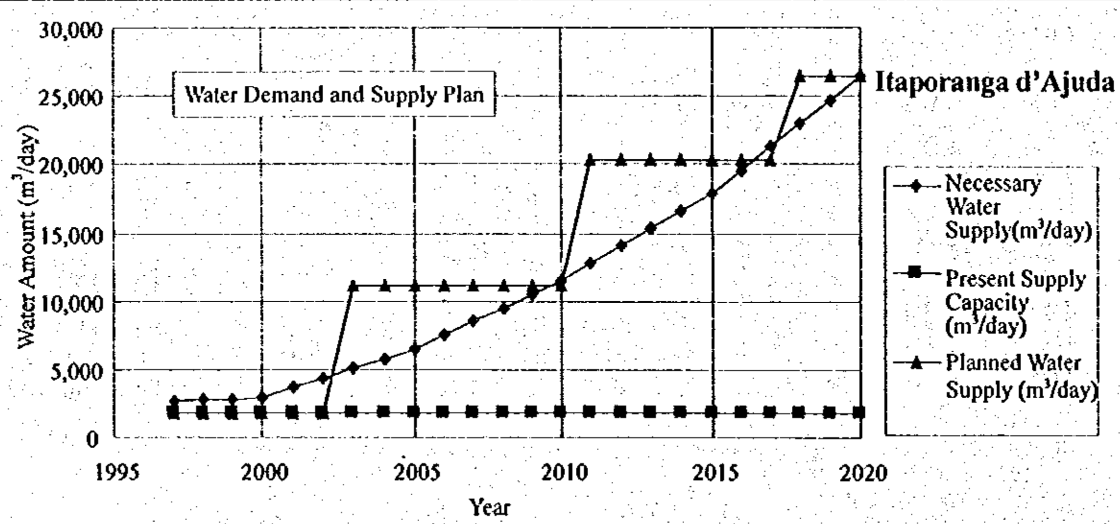


Figure-6.2 (2/2) Water Supply Program of Independent Pipeline System

6.2 Water Resources Management Plans

Implementation schedule of water resources management plans are shown in Table-6.2, and is formulated with the following concepts, in principle.

1) For the implementation of sequence of programs, a program whose implementation is prerequisite to another program is placed earlier.
2) For the preparation of a program of social interests or multiple sectors, two years are considered as necessary, while one year is allocated for preparation of a program within a sector or a division of the government.
3) Overburden on a division of the government is to be avoided.

(1) Institutional Plan

Grant of water rights is the most fundamental instrument for equitable water resources management. Although preparation has already started, two years will be necessary for establishing the system. For the preparation, organization set-up, of first phase, comprised of strengthening SRH and establishing State Water Council and River Basin Committees to promote public participation, has to be started immediately. Charging to water right holders can be stared after establishment the granting system. Preparation for establishing cost allocation rule of multi-purpose facility should be started immediately to promote the development of multi-purpose facilities.

With the maturity of the granting and charging system, relevant organizations should evolve. Organizational development and charging system reflecting economic value of water resources would be completed by 2020.

(2) Water Resources Management Programs

Enhanced hydrological assessment is a base for water resources development and management. However, the enhancement requires substantial initial costs and training of the staff. The enhancement may take three years.

Classification of waters requires comprehensive studies. After the studies, discussion among sectors and communities of different localities, such as residents between upstream and downstream is necessary. A long period of preparation should be taken. Water quality monitoring and regulation of land development/use can follow. Besides, effluent control can start earlier although full-fledged control can be attained after the classification and water quality monitoring.

(3) Management Improvement of Water Supply

Streamlining the management of DESO can start soon although efforts to attain sufficient level of the efficiency should continue. Establishing tariff control system may take comparatively long period.

Establishing management system may take as long as two year or more, since it requires the change in sense of cost recovery of rural people. Well organized management will promote full cost recovery cost recovery. Financial arrangement for funding reserves for repairs and replacement and for cross-subsidy in rural water supply can be evolved corresponding to the expansion of operation.

Table-6.2 Implementation Schedule of Water Resources Management Plans

Programs	Initial Cost (R$ 1,000)	Annual Cost (R$ 1,000)	1st: 2000-2004					2nd: 2005-2009					3rd: 2010-2014					4th: 2015-2019					
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Institutional Plan	---	---																					
1 Grant of Water Rights			**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
2 Charging to Use of Water Resources				**	**	##	##	(from nominal ones to the ones reflecting economic value)															##
3 Organization Set-up			**	##	##	(phase 1)			##	##	##	##	(phase 2)			##	##	##	##	(phase 3)			##
4 Cost Allocation for Multi-purpose Facilities			**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
Water Resources Management Programs	1,176	234																					
1 Classifications of Waters	160	---		@	@	@	**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
2 Enhancement of Hydrological Assessment	700	24	**	**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
3 Water Quality Monitoring	316	210						**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##
4 Establishing a System for Effluent Control	---	---	**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
5 Regulation of Land Development and Use	---	---						**	**	##	##	##	##	##	##	##	##	##	##	##	##	##	##
Management Improvement of Water Supply	---	---																					
1 Improvement in Efficiency of Water Supply in Urban and Large Rural Areas			**	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
2 Management System of Rural Water Services			**	**	##	##	(expansion corresponding to facility development)														##	##	##

**: Legislative arrangement, institutional set-up, initial training or other preparations
##: regular operations and management with gradual enhancement and periodical institutional review
@@: study by consultants

CHAPTER 7 EVALUATION

7.1 Technical Evaluation

The proposed Master Plan of Water Resources Development in the State of Sergipe was planned according to the following technical information, standards, judgment and proper planning procedures, and is assessed to be technically feasible as a result.

1) The information related to socio-economic conditions, topographical and hydro-geological conditions, hydrological conditions, environmental conditions, water use conditions and so on are collected from the data and information that the Federal Government and the State Government own and was applied to the Master Plan after precise examination and careful selection. And the standards established by the Federal Government were applied for the planning and design required in the Master Plan. However, the international standards such as in Japan and USA were also used when necessary.

2) The long-term projection of the state population for the estimation of future water demand was conducted applying the same method of the State Government based on the latest population census of 1996. However, population decentralization was recommended in the Master Plan to alleviate the centralization of economy and population in the state capital and to mitigate the economic disparity among regions.

3) To attain the sustainable water resources development, the plan was established based on the study of possibility of safe water supply estimating water resources potential by regions and considering probability evaluation. Concretely, probability draught discharge for the surface water and safe yield for the groundwater were applied in the Master Plan.

4) The projects were planned sufficiently for 10-year return period draught year as to the safety of supply. Current water supply systems don't always maintain the safety of supply. However, when kept mechanically in good repair as proposed in the Mater Plan, the safety could be lifted as a result.

5) The catchment area should be found near the demand area from the economic viewpoint. Therefore the resources that contain small quality problem such as high salinity-concentration surface water and groundwater were also recommended for development. The simple desalination equipment for rural water supply in the semi-arid region and surface water quality improvement of Vaza Barris dam by storing inundated water are the good examples.

6) The information and opinions concerning the basic policy of the Master Plan and alternatives of the plan were exchanged aggressively between the Study Team and organization related to water of the State Government through 10 workshops.

The proposed Master Plan of Water Resources Development in the Sergipe State was set for target year of 2020 based on the population and economic growth projection conducted by the Study Team. Therefore the plan should be reviewed and changed if necessary according to the change of socio-economic conditions and accumulated collections of hydrologic data.

7.2 Social Evaluation

The proposed 54 projects of the master plan will induce several effects to the project area as well as to the state. The projects will increase a supply of clean and sufficient domestic, industrial and agriculture water to users. At the same time, the projects will induce other social benefits and social environmental impacts to the affected area.

7.2.1 Social Benefits

(1) Increase of Employment Opportunity and Activation of Regional Economy

Construction works for projects such as dam and pipelines for domestic/industrial and irrigation water supply would offer a new labor opportunity to the people unemployed and underemployed of the region in construction sector itself and the related sectors. The consumption by the workers will stimulate the business activities of the region. Thus, this increased consumption by new workers will induce a multiplied economic effect to the region, which activates the regional economy as a whole.

(2) Improvement of Safe Water Coverage and Public Health

After the completion of the projects in 2020, all incremental urban population and 85% of rural population (only 35% in 1997) could enjoy their living conditions with clean and sufficient potable water. The expansion of potable water supply could decrease water-borne diseases and mortality rate in the region. And it is clear that the inhabitants not supplied with potable water at moment in the dwellings can significantly reduce the time spent for carrying water. These times saved could be used for another effective activities.

(3) Alleviation of Demographic Centralization and Economic Disparity

The industrial water supply rate through public water supply is currently assumed at only 5% of the demand and it will be lifted to 30% by the target year of 2020 in the Master Plan. Irrigated agriculture projects could produce many benefits such as: 1) higher agricultural productivity, 2) extension of cultivating season and possible multi-cropping, and 3) safe cropping particularly during droughts and so on.

Thus, the projects will alleviate the impact of water scarcity in the project area of the state that will attract the manufacturing companies to set up its plant in the region and also give agricultural farmers an incentive to cultivate harder. That will intensively stimulate regional economic activities and bring peoples more sufficient living conditions there. As a result, it could lead the mitigation of economic disparity compared with the nation level and the alleviation of economic and demographic centralization to metropolitan area like Aracaju.

7.2.2 Social Environment Impacts

The proposed projects could induce several social problems among societies and residents in the project area during construction and operation period. The negative social impacts derived from the problems must be mitigated through implementation of the projects. Careful planning will be effective to mitigate the social negative impacts, but should be disclosed and explained publicly, and discussed with the society and the residents. All of theses entire implementations could effectively minimize the social environment impacts.

7.3 Economic Evaluation

7.3.1 Assumptions

The economic cost and benefit are estimated based on the following conditions:

1) Prices:	As of August 1998 for cost and benefit
2) Exchange Rate of Real:	R$ 1.18 = US$ 1.00
3) Opportunity Cost of Capital:	10 %
4) Conversion Factor:	85 %
5) Time Horizon for Evaluation:	50 years
6) Economic Life	
- Dam:	80 years
- Weir and Well:	50 years
- Other Structures:	40 years (to be replaced after life termination)
- Equipment:	15 years (ditto)
7) Benefits	
- Residential Water (Rural):	3% of monthly household income of R$270: R$ 1.6 /capita/month
- Residential Water (Urban):	3% of monthly household income of R$650: R$ 4.6 /capita/month
- Commercial Water:	Actual water charge base: R$ 0.5 / capita
- Public Water:	Actual water charge base: R$ 0.8 / capita
- Industrial Water:	Actual water charge base: R$ 2.6 / m^3
- Agriculture Water:	Incremental Net Cash Flow under with/without project

7.3.2 Results of Economic Evaluation

The 54 projects proposed in the Master Plan are economically analyzed. These projects includes 1) 48 projects of Domestic and Industrial Water Supply System (10 projects of Integrated System, 35 projects of Independent System, Single Well System for Small Rural Area) and 2) 8 projects of Irrigation Water Supply System. Table-7.1 summarizes the results of the economic analysis on each project.

(1) Whole Master Plan Project

The EIRR (Economic Internal Rate of Return) of total (54) projects resulted in 13.1 %, exceeding opportunity cost of 10 %. 37 projects or 70 % of 54 projects exceeded opportunity cost of 10 %. As a whole, the projects are judged to be in economic efficiency and deserve to be promoted.

(2) Domestic and Industrial Water Supply Projects

Integrated System resulted in 10.8 % of EIRR, slightly above the opportunity cost. Independent System resulted in good economic efficiency of 27.7 % of EIRR mainly due to the lower investment cost. However, it is quite costly to provide water to small rural areas that showed negative EIRR. Consequently, the EIRR of total domestic and industrial water supply projects shows 11.8 % that means economic feasible level.

Table-7.1 Result of Economic Evaluation on Master Plan Projects

	Project	Project Cost (R$ thousand)	EIRR*1 (%)	NPV *2 (R$ million)	B/C
Domestic and Industrial Water Supply Projects		945,806	11.8	91.1	1.13
Urban and Large Rural Area (Integrated System)		701,938	10.8	32.9	1.06
1	Project Expansion of Sao Francisco Pipeline System	258,011	11.7	34.3	1.15
2	Aracaju Well Development Project	27,003	13.6	10.0	1.28
3	Project Expansion of Agreste Pipeline System	14,562	8.2	-4.8	0.86
4	Project Expansion of Piauitinga Pipeline System	9,293	25.6	19.0	1.59
5	Xingo Dam Pipeline Project	145,662	7.1	-17.7	0.76
6	Vaza Barris Dam Project (include dam allocation cost)	154,618	12.1	13.1	1.19
7	Project Expansion of Itabaianinha Pipeline System	34,305	4.7	-6.7	0.67
8	Project Expansion of Propria Pipeline System	4,814	17.8	1.3	1.26
9	Project Expansion of Alto Sertao Pipeline System	20,518	#	-4.8	0.56
10	Project Expansion of Sertaneja Pipeline System	33,152	#	-10.6	0.36
Urban and Large Rural Area (Independent System)		170,002	27.7	87.7	1.82
1	Gararu: SFR Direct Intake	635	#	-0.7	0.39
2	Muribeca: Deep Well Development	846	15.0	0.1	1.28
3	Nossa Senhora das Dores: Pinol R. Development	2,870	17.1	0.7	1.27
4	Malhador: Vermelha R. Development, Deep Well Development	2,711	#	-0.9	0.50
5	Tobias Barreto: Jabiberi Dam Raising Project	16,787	8.5	-0.6	0.94
6	Brejo Grande: Deep Well Development	546	66.5	0.7	2.68
7	Ilha das Flores: Deep Well Development	594	20.8	0.2	1.54
8	Neopolis: SFR Direct Intake	8,310	37.1	13.9	2.94
9	Santana do Sao Francisco: SFR Direct Intake (Exp.)	1,861	29.8	1.8	1.82
10	*Capela: Siriri R. Development, Adeira R. Development*	6,951	20.8	3.1	1.59
11	Divina Pastora: Deep Well Development	523	19.6	0.1	1.68
12	Santa Rosa de Lima: Deep Well Development	457	16.0	0.1	1.36
13	*Siriri: Deep Well Development*	628	32.6	0.1	1.51
14	Japaratuba: Deep Well Development	1,762	27.5	1.5	2.21
15	Japoata: Deep Well Development	540	14.1	0.0	1.18
16	Pacatuba: Santo Antonio R. Development	1,922	75.0	11.1	6.14
17	Pirambu: Deep Well Development	1,327	21.1	0.7	1.72
18	Sao Francisco: Deep Well Development	503	14.4	0.0	1.24
19	*Carmopolis: Deep Well Development*	612	82.0	0.6	3.68
20	General Maynard: Deep Well Development	465	14.4	0.0	1.24
21	Maruim: Deep Well Development	1,511	37.8	3.5	3.97
22	Riachueiro: Jacarecica R. Development, Deep Well Development	3,832	39.7	8.9	3.81
23	Rosario do Catete: Siriri R. Development, Deep Well Development	5,496	53.2	23.2	5.26
24	Santo Amaro das Brotas: Deep Well Development	522	43.4	0.5	2.43
25	Barra dos Coqueiros: Deep Well Development	2,925	9.1	-0.1	0.96
26	*Sao Cristovao: Deep Well Development*	2,732	70.3	3.1	2.99
27	Araua: Camboata R. Development, Deep Well Development	2,354	6.4	-0.2	0.86
28	Boquim: Gaiangal R. Development	3,748	10.1	0.0	1.00
29	Cristinapolis: Itamirim R. Development	4,106	#	-1.2	0.52
30	Pedrinhas: Araua R. Development, Deep Well Development	2,837	21.9	1.2	1.50
31	Salgado: Grilo R. Development, Deep Well Development	3,161	5.9	-0.4	0.86
32	*Estancia: Piauitinga R. Development, Piaui R. Development and Deep Well Development*	13,824	33.3	20.1	2.78
33	Indiaroba: Paripe R. Development	1,184	#	-0.8	0.47
34	Itaporanga d'Ajuda: Fundo R. Development, Tejupeba Development	69,390	6.1	-2.5	0.92
35	Santa Luzia do Itanhy: Ariquitiba R. Development	1,481	#	-0.4	0.79
Small Rural Area (Municipal Water Supply Only)					
1	Single Well System (Public-Tap)	73,866	#	-29.5	0.18
Irrigation Water Supply Projects		427,497	17.2	116.1	1.48
1	Quixabeira	35,051	26.9	9.4	1.93
2	Jacare-Curituba	37,852	22.5	27.7	1.68
3	Sao Francisco	213,070	22.3	83.1	1.68
4	Ladeirinhas	28,742	10.2	0.1	1.02
5	Jacarecica II	44,545	3.1	-16.3	0.55
6	Vaza Barris (include dam allocation cost)	54,839	15.0	11.8	1.46
7	Entre Rios	2,397	14.4	0.1	1.22
8	Estancinha	1,001	14.4	0.0	1.22
Total of Projects (54)		1,373,304	13.1	207.2	1.23

Note: *1 "#" indicates EIRR with less than zero percent.
*2 Discounted at 10%

(3) Irrigation Water Supply Projects

The EIRR of all the irrigation projects shows 17.2 %. Six projects out of total 8 projects exceeded 14 %. Projects with lower investment cost per hectare and higher profit such as Quixabeira, Jacare-Curituba and Sao Francisco resulted in more than 20 % of EIRR. As to the Vaza Barris, Ladeirinhas and Jacarecica-II, investment cost per hectare is extremely high due to the dam construction. However, the Vaza Barris resulted in 15.0 % of EIRR that means sufficient for economic efficiency.

(4) Multi-purpose Projects

The EIRR of two multi-purpose projects is shown in Table-7.2 and exceed opportunity cost of 10 %.

Table-7.2 Result of Economic Analysis of Multi-purpose Projects

Project	EIRR (%)	NPV (R$ million)	B/C
Xingo Dam Multi-purpose Pipeline Project (Domestic/Industrial and Irrigation Water Supply Project)	15.2	65.4	1.33
Vaza Barris Dam Multi-purpose Project (Domestic/Industrial and Irrigation Water Supply Project)	12.9	24.9	1.26

(5) Results of Economic Evaluation by River Basin

The results of economic evaluation of the projects in the six river basins are shown in Table-7.3. Five river basins with the exception of Real river basin indicate more than 10 % of EIRR. Japaratuba river basin showed the highest result among all river basins, due to the low project cost of Independent Systems.

Table-7.3 Result of Economic Analysis of Sector by River Basin

River Basin	Water Supply Sector	EIRR*1 (%)	NPV (R$ million)	B/C
Sao Francisco	Total	18.0	123.0	1.45
	Domestic and Industrial Water	10.2	2.6	1.02
	Irrigation Water	22.3	120.4	1.67
Japaratuba	Total	26.0	24.0	2.10
	Domestic and Industrial Water	26.0	24.0	2.10
	Irrigation Water*	-	-	-
Sergipe	Total	10.8	27.5	1.07
	Domestic and Industrial Water	11.4	43.8	1.12
	Irrigation Water	3.1	-16.3	0.55
Vaza Barris	Total	11.6	7.8	1.09
	Domestic and Industrial Water	8.5	-4.0	0.93
	Irrigation Water	15.0	11.8	1.46
Piaui	Total	14.8	34.6	1.46
	Domestic and Industrial Water	14.8	34.5	1.30
	Irrigation Water	14.4	0.1	1.22
Real	Total	2.0	-9.7	0.66
	Domestic and Industrial Water	2.0	-9.7	0.66
	Irrigation Water*	-	-	-
Total	Total	13.1	207.2	1.23
	Domestic and Industrial Water	11.8	91.2	1.13
	Irrigation Water	17.2	116.0	1.48

Note: *: No irrigation projects in Japaratuba and Real River basins

7.4 Financial Evaluation

7.4.1 State Budget

The water supply system is managed by the public entities, mostly by DESO and COHIDRO. The state government basically provides the entities with funds for capital investment of water resources development. The investment of water resources development provided to DESO and COHIDRO is summarized in the Table-7.4. The averaged share of water resources development investment to the total expenditures and to the tax revenues was respectively 2.4% and 3.1%.

Table-7.4 State Budget and Investment for Water Resources Development

Unit: R$ million

Revenues and Expenditures	1994	1995	1996	1997	1998
Revenues	429.3	733.9	934.1	1,575.9	893.6
Tax Revenues *	305.8	617.8	710.2	814.2	782.7
Expenditures	453.3	770.4	938.0	1,253.0	893.6
Capital Investment	141.3	70.0	218.8	409.2	206.3
(% of Expenditures)	(31.1)	(9.1)	(23.3)	(32.7)	(23.1)
Water Supply Investment	15.8	18.9	17.7	41.7	7.6
(% of Expenditures)	(3.5)	(2.5)	(1.9)	(3.3)	(0.9)
(% of Tax Revenues)	(5.1)	(3.0)	(2.5)	(5.1)	(1.0)

Source: Balanco Geral, Governo de Sergipe, 1994,1995,1996 and 1997
Orcamento-Programa, Governo de Sergipe, 1998 (Original Budget)
Note: *: Tax revenues include transfers from Federal Government

7.4.2 Investment by Public Entity

The investment for water resources development by DESO for three years from 1995 to 1997 is presented in Table-7.5. The company spent more funds rather than the budget provided by the state. The company has raised them mostly from the state banks generally with the conditions of long-term maturity and low interest rate. It means that from public financial institutions DESO raised 40 % of the funds required to the investment for the water resources development during the period.

Table-7.5 Investment for Water Resources Development by DESO

Unit: R$ million

Item	1995	1996	1997	Total
Investment by DESO	14.1	19.0	39.0	72.1
(Funds from State Budget)	(7.0)	(10.4)	(27.1)	(44.5)

Source: Financial Statement of DESO and COHIDRO in 1995, 1996 and 1997
Balanco Geral, Governo de Sergipe, 1995,1996 and 1997

7.4.3 Domestic and Industrial Water Supply Projects

(1) Projected Investment Amount

In the Master Plan, total initial investment for all 54 projects amounts to R$ 1,370 million (equivalent to US$ 1,160 million at the exchange rate of August 1998). The initial investment costs for 46 projects of Domestic and Industrial Water Supply System amount to R$ 950 million. The construction period is planned for 20 years. R$ 660 million or 70 % of initial investment costs concentrate in the first decade according to the implementation schedule.

The investment amount of water resources development in the state budget was 3.1 % of the tax revenues as shown in Table-7.6. Tax revenues would increase generally with economic growth (assumed at 5 % per annum of economic growth rate in the Master Plan). Thus the future investment amount for water resources development during 20 years from 2000 to 2019 was estimated at R$ 900 million. For the first decade, the amount would be R$ 390 million.

(2) Source of Fund for Initial Investment

The state budget is considered as the principal source of funds for the initial investment of the projects, which would be R$ 390 million in the first decade and R$ 510 million in the second decade. In case that the economic growth as set in the plan would be attained, the required investment will possibly be arranged by the state. Public entities are assumed also to share the financial burden: 10 % of the initial investment. As a result, an amount of R$ 210 million should be raised in the first decade. However, initial investment could be covered entirely by the state budget in the second decade.

Table-7.6 Estimated Source of Fund for Domestic/Industrial Water Supply Projects

Unit: R$ million

Items	1st decade	2nd decade	Total	Remarks
Expenditures	660	500	1,160	
Initial investment	660	290	950	Proposed in master plan
Repayment	-	210	210	Repayment of soft loan
Source of Fund	660	540	1,200	
State Budget	390	510	900	3.1 % (max) of tax revenue
Public Entities	60	30	90	Self-finance (10% of initial investment)
Soft Loan	210	-	210	Amount to be raised
Balance	0	40	40	Surplus

The current debt amount of the state government as of September 1998 was R$ 740 million, which are almost with long-term (12 to 30 years of maturity) and low interest rate from the federal government. Judging from the current debt service coverage ratio which was 7.7 % in 1998 fiscal budget, the state government financial situation is expected to keep still healthy condition if the additional funds of R$ 210 million would be soft loan with long-term maturity and low interest rate.

(3) Financial Burden of the Government

Recovery of financing cost for initial investment (R$ 70 million) of domestic water supply projects in the small rural area cannot be expected. So all the related investment cost should be covered by the state budget. As to the other domestic and industrial water supply projects, it would be almost impossible to raise the tariff to cover the financial cost for initial investment (R$ 870 million) because customers suffers from comparatively high tariff mainly caused by inefficient management of the public entity. However, some portion of the related cost could be covered by the entity in the second decade after expansion of the service and enhancing the management efficiency. So the financial burden of the state government could be eased in the second decade.

7.4.4 Irrigation Water Supply Projects

In the Master Plan, total initial investment costs for 8 projects amount to R$ 430 million. The construction period is planned for 20 years. R$ 280 million or 70 % of initial investment costs concentrate in the first decade according to the implementation schedule. The funds for initial investment for irrigation water supply projects should be covered by the State Government, when considering the size of investment costs and financial conditions of agricultural producers.

7.5 Initial Environmental Examination

7.5.1 Potential Environmental Impact

(1) Change of River Flow and Wastewater Discharge

River development projects with direct intakes or dam reservoirs and well development projects will cause change of the flow regime. In general, the developed water does not completely return into the rivers. Therefore, surface water developments will decrease the river flow even if the developed water returns into the same river basin. New water resources developments lead to increase in wastewater discharge. Change of river flow and wastewater discharge by each basin after project implementation identified in this Master Plan Study is shown in Table-7.7. The numerical analyses are carried out based on the following two assumptions:

Case-I: Water used for irrigation does not return to a river at all.
Water used for other purposes completely returns into a river.

Case-II: Half of developed water including groundwater returns into a river.

These analyses ignore amount of evaporation from newly constructed reservoirs and change of groundwater recharge caused by well development projects.

Table-7.7 Change of River Flow and Wastewater Discharge in 1997 - 2020

Item	S. Francisco R. Basin	Japaratuba R. Basin	Sergipe R. Basin	Vaza Barris R. Basin	Piaui R. Basin	Real R. Basin	Total or Average
Average Flow (m^3/day) : 1997 at River Mouth	153,792,000	915,840	1,195,776	1,351,296	1,980,288	1,767,744	161,002,944
Total Developed Surface Water (m^3/day)	1,660,568	79,196	111,583	344,457	107,267	8,832	2,311,903
Developed Surface Water Rate to Surface Flow at River Mouth	1.1%	8.6%	9.3%	25.5%	5.4%	0.5%	1.4%
Case-I: Average Flow (m^3/day): 2020 at River Mouth	152,202,219	872,226	1,345,729	1,055,634	1,982,127	1,780,141	159,238,076
Surface Flow Change Rate	99.0%	95.2%	112.5%	78.1%	100.1%	100.7%	98.9%
Case-II: Average Flow (m^3/day): 2020 at River Mouth	152,877,439	885,585	1,262,332	1,157,043	1,938,052	1,769,527	159,889,978
Surface Flow Change Rate	99.4%	96.7%	105.6%	85.6%	97.9%	100.1%	99.3%
Domestic Wastewater Rate to Surface Flow: 1997	0.02%	1.40%	11.15%	1.64%	1.92%	0.84%	0.16%
Domestic Wastewater Rate to Surface Flow: 2020 Case-I	0.04%	2.74%	16.61%	3.71%	3.25%	1.32%	0.27%
Industrial Water Rate to Surface Flow: 1997	0.01%	2.63%	7.67%	0.24%	0.97%	0.06%	0.09%
Industrial Water Rate to Surface Flow: 2020 Case-I	0.03%	6.51%	30.60%	5.76%	4.76%	0.12%	0.42%

After implementations of the two big projects, Xingo Dam Pipeline Project and Vaza Barris Dam Project, the flows of Sao Francisco River and Vaza Barris River will be decreased. In Sao Francisco River that have abundant flow throughout the year, the decrease will be 0.1% in the Case-I and have no serious impact on the flow regime. In Vaza Barris River, the decrease will be 22% throughout the year. Because the flow changes between the rainy season and the dry season considerably, Vaza Barris Dam project will have some impact on the flow regime.

In Sergipe River, wastewater discharge will increase considerably in 2020. Because, compared with other basins, the wastewater rate will be high level, measures against the water contamination should be given priority in this basin.

(2) Water Pipeline Projects

(a) Potential Environmental Impacts

Water pipeline projects generally have no serious negative impacts potential. But depending on the location of pipeline, negative impacts will occur. Major environmental impacts will occur at construction stage.

Land acquisition and relocation of residents in urban areas may be needed. But in the case of pipeline located along existing roads, these problems hardly occur. In the case of pipeline located in archaeological and historical sites, construction works affect directly these properties. Construction works may cause changes in the physical environment. Especially land clearing and excavation may damage the wildlife, the soil, the water and the air. However, significant negative impacts on the wildlife will not occur because most of the study area is flat or rolling topographically, moreover the vegetation is poor and monotonous biologically. Heavy equipment operation may generate harmful dust and noise that would affect trees, crops, animals as well as residents near the construction site. During construction works, temporary traffic jams may occur in urban areas.

(b) Mitigation and Monitoring

The design of pipeline alignment should consider minimizing the changes to physical environment as well as the construction cost. In forest areas, land clearing and tree cutting should be well planned and implemented within the restricted area. To minimize soil erosion during construction, land clearing and excavation works should be mainly implemented during the dry season, in other way, sediment load is necessary to properly be treated with.

The contractors should maintain heavy equipment in good condition and use appropriate methods and equipment to prevent noise, dust, water pollution, soil contamination, vibration and traffic jam.

(3) Vaza Barris Dam Project

(a) Potential Environmental Impacts

Vaza Barris dam project has potentially serious negative impacts on many environmental items. Major environmental impacts will occur at operation stage as well as construction stage.

Large land acquisition and relocation of residents may be needed for the dam site and the reservoir. Vegetation, cultural properties, houses, cemeteries, farm roads and farmland located in the reservoir area will be submerged. However, because there are no villages in the reservoir area, people requiring relocation would be expected to be a small number. Because most of the inundated area is extensive pastureland, the agricultural resources loss will not be large. There are no major infrastructure facilities or cultural properties in the area also.

Construction works such as land clearing, excavation, blast and hauling operations will change the physical environment drastically and will damage the landscape, the wildlife, the soil, the water and the air. Although the small areas of riverside forests provide wildlife habitats, most of the dam site and reservoir area is relatively void of wildlife.

Therefore serious negative impacts on terrestrial wildlife will not occur. Heavy equipment operation may generate harmful dust and noise. However, the impacts are limited because of no residences in the dam site.

After the dam is closed, the hydrological situation will change drastically. The sediment load of the downstream will be greatly reduced. Moreover migration of fish will be obstructed. Changes of water quality and hydrological situation may damage the ecosystem, the water use and the fisheries in downstream area. There is mangrove forest zone in the estuary, where shrimp fishery is flourishing. The registered fisher persons were 1,401 people as of 1998, the total including unregistered reaches approximately 6,000 people in a season. State environmental protection area is located in the estuary. It is said that decreases in down flow, sediment load and nutrient due to dam construction influence ecosystem of mangrove zone.

The reservoir will lead to an increase in the potential of water borne disease and provide breeding areas for mosquitoes. Therefore water or mosquito borne disease such as Schistosomiasis or dengue fever would increase.

An increase of workers to the area will put additional pressure on the social services and the medical facilities. On the other hand, dam construction works will bring additional income to the local residents in terms of the employment of workers, the local economy will be revitalized subsequently.

(b) Mitigation and Monitoring

To obtain the agreement of affected population, the information disclosure should be conducted at an early stage. The resettlement program should consider quality of life, economic and social support and cultural background. The compensation for land acquisition must be sufficient.

Land clearing and tree-cutting should be well planned and implemented within the restricted area. To minimize soil erosion, cut slope, land clearing and soil stripping works should be mainly implemented during the dry season, in other way, sediment load is necessary to properly be treated with. To prevent noise, dust, water pollution, soil contamination and vibration, the contractors should maintain heavy equipment in good condition and use appropriate construction methods and equipment.

Buffer areas around the reservoir should be created, where reforestation programs should be implemented to replace lost vegetation and to cover the riverside. The choice of plants species must be considered adaptable to the environment. It is available to use local plants on the reservoir area.

Environmental monitoring should be conducted to recognize the transition of environmental aspects such as air, water, soil, noise, vibration, fauna and vegetation in both periods during construction and operation. Especially, the long-term transitions of ecosystem and topography in the estuary should be monitored according to the prior plan before the construction begins.

Disease vectors tend to breed in stagnant drains and field edges. The design of spillway, channel and drainage should be considered measures against vectors. An educational program on these diseases should be conducted for local people and construction worker.

An environmental specialist should be enlisted in the site supervisor consultants to help prevent soil erosion, noise, dust, water pollution and inadequate tree cutting, and to monitor the mitigation measures and the environmental aspects.

(4) Well Development Projects

(a) Potential Environmental Impacts

Generally well development projects have no potentially serious negative impacts. But depending on the location of projects, negative environmental impacts will occur at construction stage.

Digging works may generate harmful turbid water, vibration and noise that would affect crops, animals as well as residents near the construction site. The main impacts during the operation stage are related to over pumping-up. Over pumping may cause ground subsidence in thick clayey layer area and saltwater intrusion in coastal zone or northern part of Sergipe State where increase the salinity level in deep ground water. Private wells may be affected by over pumping near the site. However, if the quantity of development water would adequately identified in this study, significant impacts will not occur consequently.

(b) Mitigation and Monitoring

The contractors should maintain heavy equipment in good condition and use appropriate construction methods and equipment to prevent noise, water pollution and vibration. Groundwater level and water quality should be monitored for over pumping, ground subsidence and salinization problems.

(5) Irrigation Projects

(a) Potential Environmental Impacts

Construction works may cause changes in the physical environment. Especially land clearing and excavation may damage the wildlife, the soil, the water and the air. Heavy equipment operation may generate harmful dust and noise that would affect trees, crops, and residents near the construction site. In case of intake from Sao Francisco River, reconsideration of the water right should be needed in advance.

The irrigation channels will lead to an increase in the potential of water borne disease and provide breeding areas for mosquitoes. Therefore water or mosquito borne disease such as Schistosomiasis or dengue fever would increase.

An excessive water use for the irrigation may cause salt damage of the agricultural lands and water logging. However, because heavy rains are expected during the rainy season in Sergipe State, the rainfall will flush the salt in the soil. Agricultural chemicals may lead to water pollution.

(b) Mitigation and Monitoring

The contractors should maintain heavy equipment in good condition and use appropriate construction methods and equipment to prevent noise, water pollution and vibration. Because Schistosomiasis has broken out in Sao Francisco River basin more than other basins, the channel and drainage should be considered measures against the vectors. An educational program on these diseases should be conducted for local people and construction worker. Construction of drainage channels should be considered in areas where the drainage is in a difficult situation. Water quality monitoring should be conducted to check the water pollution by agricultural chemicals.

7.5.2 Initial Impact Assessment

The results of environmental impact examination on each project proposed in this Master Plan Study are show in Table-7.8.

The initial impact assessment presenting in this section is limited in scope. Therefore some of the results are not enough to make an accurate estimate of the impacts. Environmental considerations should be made as soon as a project would be realized. During a feasibility study stage, a preliminary Environmental Impact Assessment should be prepared including a survey of project acceptability by concerned people and agencies. Careful studies on the ecology, the water quality, flow regimes, design standards, alignments and construction methods should be conducted at this stage. All efforts should be made to avoid adverse environmental impacts.

Projects proposed as "Integrated Water Supply System" are relatively large-scale development plans. However, these impacts on natural environment, except for Vaza Barris dam project, will be limited because projects sites are far away from the protected areas and sizable undisturbed forests, moreover these projects are pipeline projects or well development project that have no serious environmental impacts potentially.

In case of small-scale developments such as projects proposed as "Independent Water Supply System" and as "Small Rural Water Supply", the impacts on social and natural environment will be generally limited. However, if the projects are located in environmental critical area such as forest, mangrove zone, archeological or cultural site, and urban area, proper environmental mitigation plans should be considered.

Small areas of riverside forests provide wildlife habitats. In case of projects with clearing the forests, environmental considerations on the wildlife should be needed.

In case of surface water development projects located in Sao Francisco River basin, because Schistosomiasis has broken out in Sao Francisco River basin more than other basins, the designs of the channel and drainage should be taken into account against the vectors. An educational program on these diseases should be conducted for local people and construction worker.

Table-7.8 Result of Initial Impact Assessment on Each Project

Project	Assessment (Construction / Operation)	Main Environmental Problems	Mitigating Measures / Remarks
Integrated Water Supply System			
Project Expansion of Sao Francisco Pipeline System	B / D	Dust, noise, vibration and traffic jam during construction works. Water right.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Aracaju Well Development Project	D / C	Noise, vibration and turbid water during construction works. Saltwater intrusion.	Machinery control. Propre construction plan. Water quality monitoring. Major impacts are limited at construction
Project Expansion of Itabaiana Pipeline System	B/ D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Project Expansion of Agreste Pipeline System	B / D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Project Expansion of Piauitinga Pipeline System	B / D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Xingo Dam Pipeline Project	B / D	Dust, noise and vibration during construction works. Loss of vegetation. Water right.	Machinery control. Propre construction plan. Major impacts are limited at construction stage. Reconsideration of water right.
Vaza Barris Dam Project	A / C	Relocation. Dust, noise and vibration during construction works. Loss of vegetation. Change physical environment. Change of hydrological situation. Effect on fishery and ecosystem in downstream area. Increase in water borne disease.	Propre relocation plan and compensation. Consideration of dam design and operation. Machinery control. Prepre construction plan. Creation of buffer zone. Monitoring program. Education program.
Project Expansion of Itabaianinha Pipeline System	B / D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Project Expansion of Propria Pipeline System	B / D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Project Expansion of Alto Sertao Pipeline Project	B / D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Project Expansion of Sertaneja Pipeline Project	B / D	Dust, noise and vibration during construction works.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Independent Water Supply System			
Sao Francisco River Direct Intake Projects	B / D	Dust, noise, vibration and traffic jam during construction works. Water right.	Machinery control. Propre construction plan. Major impacts are limited at construction stage.
Deep Well Development Projects	B / C	Noise, vibration and turbid water during construction works. Saltwater intrusion.	Machinery control. Propre construction plan. Water quality monitoring. Major impacts are limited at construction stage.
River Development Projects	B / C	Dust, noise, vibration and turbid water during construction works. Increase in water borne disease.	Machinery control. Propre design and construction plan. Water quality monitoring. Education program.
Jabiberi Dam Raising Project	B / C	Land acquisition. Dust, noise, vibration and turbid water during construction works. Loss of vegetation. Increase in water borne disease.	Propre compensation. Consideration of dam design. Propre construction plan. Turbid water control. Education program.
Small Rural Water Supply			
Single Well Systems (Public Taps)	B / C	Noise, vibration and turbid water during construction works. Saltwater intrusion.	Machinery control. Propre construction plan. Water quality monitoring. Major impacts are limited at construction stage.
Irrigation Water Supply			
Quixabeira Irrigation	B / C	Turbid water during construction works. Salt damage. Increase in water borne disease. Water right.	Machinery control. Propre design and construction plan. Soil quality monitoring. Education program.
Jacare-Curituba Irrigation	B / C	Turbid water during construction works. Salt damage. Increase in water borne disease. Water right.	Machinery control. Propre design and construction plan. Soil quality monitoring. Education program.
Sao Francisco Irrigation	B / C	Turbid water during construction works. Salt damage. Increase in water borne disease. Water right.	Machinery control. Propre design and construction plan. Soil quality monitoring. Education program.
Ladeirinhas Irrigation	D / D	-	-
Jacarecica II Irrigation	B / C	Dust, noise and turbid water during construction works. Salt damage.	Machinery control. Propre design and construction plan. Soil quality monitoring.
Vaza Barris Irrigation	B / C	Dust, noise and turbid water during construction works. Salt damage.	Machinery control. Propre design and construction plan. Soil quality monitoring.
Entre Rios Irrigation	D / D	-	-
Estancinha Irrigation	D / D	-	-

A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

CHAPTER 8 PRIORITY PROJECTS

8.1 Water Resources Development Projects

Water resources development plans toward the year of 2020, including the domestic/industrial water supply and irrigation water supply projects, were proposed and described in Chapter 4. Priority projects are selected from the water resources development projects, applying the following criterion:

1) Projects whose implementation is scheduled in the first 5 years of the 20 year period covered by this plan
2) Projects serving large amount of domestic/industrial water to the area with severe water shortage
3) Projects which require longer implementation period for the plan, design and construction

Of the water resources development projects proposed, the following projects are selected as the priority projects based on the above criterion.

< Integrated Water Supply Projects >

1) Project Expansion of São Francisco Pipeline System (on-going)
2) Aracaju Well Development Project (on-going)
3) Project Expansion of Agreste Pipeline System (PROAGUA)
4) Project Expansion of Piauitinga Pipeline System (PROAGUA)
5) Xingo Dam Pipeline Project
6) Vaza Barris Dam Project
7) Project Expansion of Itabaianinha Pipeline System

< Independent Water Supply Projects >

1) Neopolis Water Supply Project (Direct Intake from São Francisco River)
2) Riachuelo Water Supply Project (Weir and Deep Wells)
3) Rosario Do Catete Water Supply Project (Weir and Deep Wells)
4) Estancia Water Supply Project (Weirs and Deep Wells)
5) Itaporanga D'Ajuda Water Supply Project (Weirs)

< Small Rural Water Supply Project >

1) Small Rural Water Supply Project in Semi-arid and Agreste Region (PROAGUA)

< Irrigation Water Supply Projects >

1) Jacare-Curituba Irrigation Project (on-going)
2) Jacarecica II irrigation Project (on-going)
3) Sao Francisco Irrigation Project
4) Vaza Barris Irrigation Project

Small Rural Water Supply Project proposing to PROAGUA includes 1) installation and recovering of deep wells and 2) construction of watering ponds and rainfall collecting systems. Although the rainfall collecting systems do not take a seat in this master plan, this project must have a high priority as one of an urgent measure until the water supply projects will be realized in concerned area.

Except on-going and existing planned projects, Xingo Dam Multi-purpose Pipeline Project (Xingo Dam Pipeline Project and Sao Francisco Irrigation Project) and Vaza Barris Multi-purpose Dam Project (Vaza Barris Dam Project and Vaza Barris Irrigation Project) should have high priority. Feasibility study of these projects should be commence at an early stage.

Xingo Dam Multi-purpose Pipeline Project is a multi-purpose project to supply domestic/industrial water of 43,999 m^3/day to semi-arid area such as N. S. da Gloria, Frei Paulo etc., and to supply irrigation water of 933,333 m^3/day to Sao Francisco Irrigation Project. The estimated cost of this project is R$ 369 million and it was evaluated to be feasible with 15.2 % of EIRR.

Vaza Barris Multi-purpose Dam Project also is a multi-purpose project to supply domestic/industrial water of 76,610 m^3/day to Agreste area such as Itabaiana, Lagarto, etc., and to supply irrigation water of 260,000 m^3/day to Vaza Barris Irrigation Project. The estimated cost of this project is R$ 209 million and it was evaluated to be feasible with 12.9 % of EIRR.

8.2 Water Resources Management Plans

Water resources management is a continuous activities, starting with a basic part of each program. Gradual upgrading should continue in each of the program. Although there are some sequences among programs, each program has its basic or fundamental parts and additional parts for upgrading. Implementation of this parts has a priority, in principle. Therefore, the highest priority should be placed on the implementation of the fundamental parts of a program which is placed earlier stages in the implementation schedule.

(1) Institutional Plans

The State Water Resources Policy introduces new sets of paradigm and concepts. To realize the policy, priority should be place on the implementation of fundamental programs. Fundamental programs are granting system of water rights and public participation through River Basin Committees. The highest priority should be placed on organization setup of phase-1, which includes strengthening SRH for the preparation and management of equitable water right granting and establishment of River Basin Committees for attaining public participation in water resources management.

Charging on use of water resources and cost allocation of multi-purpose facilities are the instruments to achieve rational use of limited water resources. To establish the basic rules to manage these tools should have the next priority.

(2) Water Resources Management Programs

Enhancement of hydrological assessment and classification of waters are fundamental programs. On the base of these two programs, effective programs and projects for water resources development, management and conservation can be implemented. These two programs should have the highest priority.

(3) Operation and Maintenance Plan

Customers of domestic water services are paying to inefficient management. It is urgent to improve the efficiency. To establish basic rules for the management of rural water services should also have high priority. Management system of rural water services should expand and enhanced corresponding the development of facilities.

CHAPTER 9 RECOMMENDATIONS

(1) Implementation of the Water Resources Development Plan

The Master Plan proposes water resources development projects mainly for domestic/industrial and agricultural water supply, to meet the future water demand estimated on the basis of long-term socio-economic framework. As a regional development framework, "strategic scenario", of which the policy is decentralization of GRDP and population from Aracaju to exterior cities, was adopted, instead of "trend scenario" following the present trend of socio-economic development. The following projects were proposed in the Master Plan for the target year of 2020:

- Ten (10) Projects of Integrated Water Supply for Urban and Large Rural Areas
- Thirty-five (35) Projects of Independent Water Supply for Urban and Large Rural Areas
- Deep Wells Development Project for Small Rural Areas of 75 municipalities
- Eight (8) Projects for Irrigation Water Development

Since the fundamental frame on water resources development, namely "Water Resources Master Plan in the State of Sergipe" has been formulated, the next step should be the implementation of these projects according to their priority, in order to attain better living standards for the State peoples and the stable state economic development. Except on-going projects, Xingo Dam Multi-purpose Pipeline Projects and Vaza Barris Multi-purpose Dam Project should be commenced as soon as possible. Besides, although small rural projects present low economic feasibility, positive implementation is recommended for the minority suffering from severe drought.

(2) Review of Water Resources Master Plan

Proposed water resources development plan is formulated based on the projected population and GRDP increases, for 20 years towards 2020. Socio-economic development plans are normally formulated every five years with projections of population and target economic growth. Water resources development plan should also be reviewed every five years, if necessary, based on these revised projections.

Water supply to Aracaju City, which is the political, economic and cultural center of the State, is estimated to require a large volume of water to be conveyed over a long distance, 130 km from Sao Francisco River. The project for Aracaju is estimated to cost R$ 285 million or 29% of the whole cost of water development project in the State. As the Master Plan assumes "strategic scenario", the strong state direction is inevitable to realize the decentralization. In the viewpoint of the above, future GRDP and population might be varied and the review of the Master Plan is essential for sustainable water resources development and management.

When revising the Master Plan, security level of existing water supply is necessary to be evaluated, using the hydrological data that will be continuously observed, archived and processed.

(3) Financing of the Project Cost

In the Master Plan, total initial investment for all 54 projects amounts to R$ 1,370 million (equivalent to US$ 1,160 million at the exchange rate of August 1998).

The initial investment cost for 46 projects of Domestic and Industrial Water Supply System amounts to R$ 950 million, of which R$ 660 million or 70 % of initial investment cost concentrates in the first decade. The state budget is considered as the principal source of funds for the initial investment, which would be R$ 390 million in the first decade and R$ 510 million in the second decade. In case that the economic growth as set in the plan would be attained, this required investment will possibly be arranged by the state. Public entities are assumed to share the financial burden of 10 % of the initial investment. Consequently, an amount of R$ 210 million should be raised from a soft loan in the first decade. However, initial investment in the second decade could be covered entirely by the state budget.

As for the eight (8) irrigation water supply projects in the Master Plan, total initial investment cost amounts to R$ 430 million. These funds should be covered by the State Government, considering the size of investment amount and the financial condition of agriculture producers.

(4) Continuous Effort to Collecting Hydrometric Data

For the further study of the plan on water resources development, hydrometric data such as rainfall, river discharge and water quality must be observed at the present water resources development points and future promising sites. Observed data should be continuously measured, archived and processed.

PART II

FEASIBILITY STUDY

PART II FEASIBILITY STUDY

CHAPTER 1 AIMS OF THE PROJECT

1.1 Necessity of the Project

(1) Necessity of New Water Resources Development in Vaza Barris River

Itabaiana and Lagarto Water Supply areas (Agreste and Piauitinga Integrated Pipeline Systems) are located in Agreste/Semi-arid areas and are the second and third largest populated areas in Sergipe State. These areas are of poor surface/ground water resources potential and have been suffering from water shortage. In order to cope with present water shortage and increasing water demand, groundwater is not enough in quantity and quality as well as surface water conveyance costs too much if water is conveyed from other river basins affluent in water resources, Sao Francisco River for example. Vaza Barris River has large water resources potential and is located between the large water-consumed cities of Itabaiana and Lagarto. Therefore, it has been expected to develop the river water not only by benefiting municipalities but also by the state of Sergipe.

(2) Refreshing High chlorine River Water by a Proposed Dam System

Vaza Barris River, who is the second largest river in the State with the total basin area of 16,229 km^2 including a part of the Bahia State, flows down between the second and third largest populated cities of Itabaiana and Lagarto. River water of the main stream has large potential of water resources but has not been able to be utilized as potable and irrigation water due to high chlorine concentration of flow from upstream. In fact, a dam plan had been progressed on the main stream of the river in the Sergipe State in 1980's and was abandoned due to unavailable water quality of the river. After elaborate investigation of river water quality, however, it was found that river flow has high chlorine concentration only during low flow condition from upstream and has less chlorine concentration during flood time and in the downstream. Considering such condition of the water quality in Vaza Barris River, the following reservoir operation plan is being established:

1) Low flow from the upstream with high chlorine concentration is bypassed around the dam to the downstream.
2) River water with less chlorine concentration during flood and in the downstream is stored in the dam reservoir.

Then,

3) Dam reservoir water is kept clean (low chlorine concentration) and could be utilized as portable and irrigation water.

Introducing such reservoir operation plan with a new system for river water quality, river water that could not be utilized before becomes clean and comes to be utilized as potable and irrigation water.

(3) Insufficient Water Supply

In the State of Sergipe in 2020, necessary supply water amount is estimated to be totally 830,000 m^3/day including 547,000 m^3/day of supply water shortage. Of this water shortage, Aracaju Capital Area is short of 175,000 m^3/day (equivalent to 32% of total supply water shortage in the State) of water, and Itabaiana and Lagarto Water Supply areas (Agreste and Piauitinga Integrated Pipeline System) are short of 129,000 m^3/day (equivalent to 24%) of water.

The population of these areas is 259,000 inhabitants in 1996 and is estimated to be 540,000 in 2020, which represents almost two thirds of population in Aracaju Capital Area at the same year (875,000 inhabitants). The lack of adequate water supply is a serious obstacle to the development of the so mentioned regions and creates a migratory pressure towards the State capital, worsening even more problems in Aracaju.

Therefore, it's mandatory to try to stabilize the water supply for high-concentrated population, indispensable to boost its social-economical development and to improve the quality of life. The positive consequences will spread all over the State, contributing to reduce the regional differences and alleviating the population and social-economic pressures towards the area of Aracaju.

(4) Irrigation Development

Fertile land suitable for irrigation extends around the right side of the planned dam site. This area is located between the three largest cities in the State of Sergipe, such as Aracaju, Itabaiana and Lagarto. It means the area has an advantage being near to large consumer cities. This area, which is presently utilized as orchards and pastures, could be irrigated and the agricultural production is to be supplied to the city areas. This irrigation project promotes improvement of agricultural productivity and activation of regional economy.

The planned dam is implemented as a multi-purpose dam for the development of domestic/industrial water and irrigation water. It results in decrease of the both project costs.

1.2 Objectives of the Project

"The Project of Water Resources Development and Supply in Vaza Barris River –Sergipe (PROVABASE)" is proposed for securing stable life of the state people through sustainable water resources development. The objectives of the project are set as follows:

- To improve river water quality and to develop potable water resources.
- To supply clean and enough water for the people through public water supply.
- To supply irrigation water to agriculturally potential land for the achievement of high productivity.
- To develop maintenance water of the river for riparian environment.

1.3 Project Components and Location

The project components of the facilities are summarized in Table-1.1. The target facilities of the project components in this feasibility study are:

- Facilities of Vaza Barris Multipurpose Dam
- Water conveyance pipelines of domestic/industrial water supply facilities

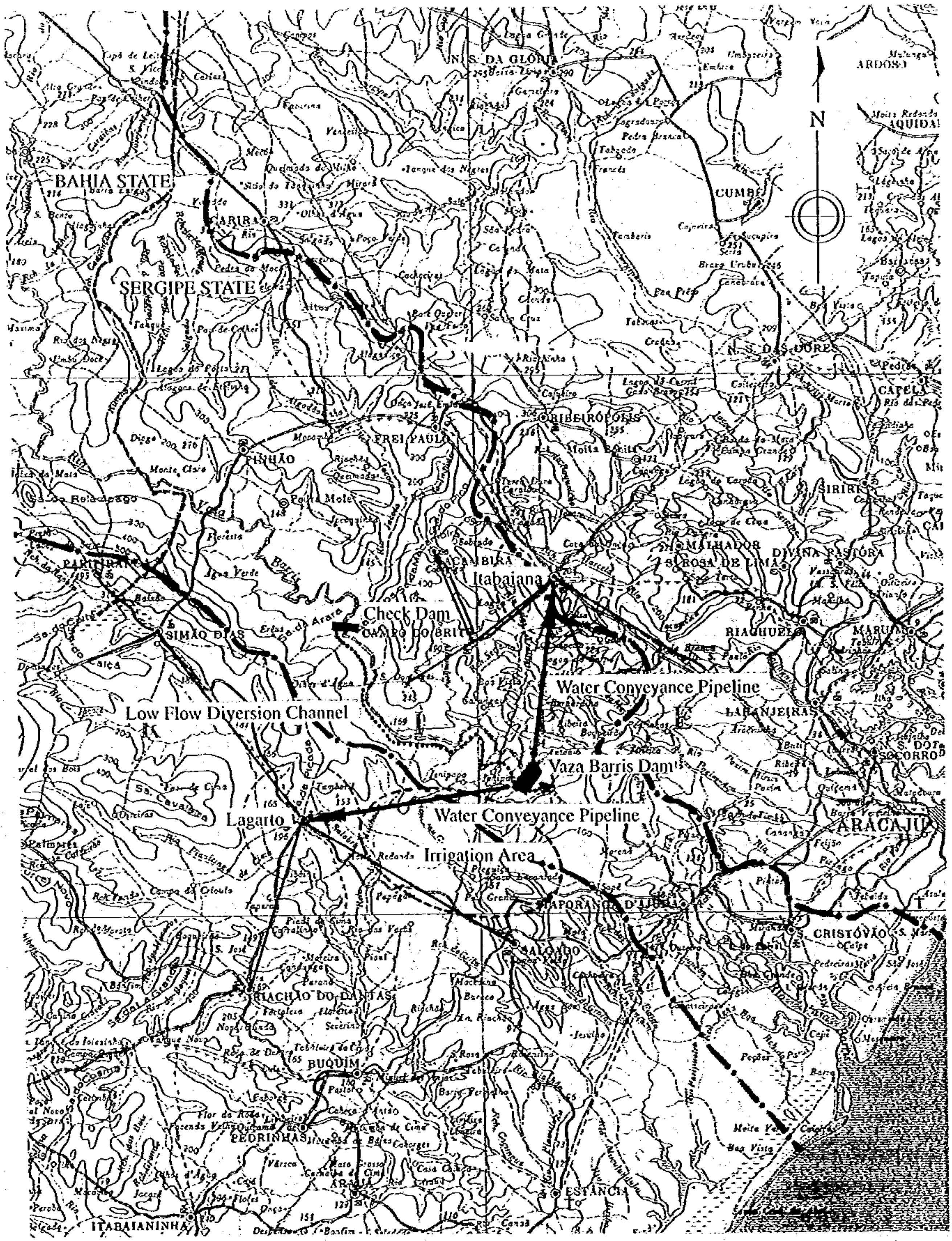
However, for the purpose of analyzing the whole project feasibility, treatment and distribution facilities are roughly planned (mostly applying the results of the Master Plan Study) as well as the results of irrigation water supply facilities, which was studied by the SEPLANTEC in September 1999, are quoted to this study.

The project location is shown in Figure-1.1.

Table-1.1 Project Component and Facilities

Project Components	Facilities	
(1) Vaza Barris Multipurpose Dam		
Dam facilities	- Main Dam	- Spillway
	- Check Dam (Bypass Intake	- Low Flow Bypass
(2) Domestic/Industrial Water Supply Facilities: <Itabaiana Water Supply Area>		
Water conveyance pipeline	- Intake and raw water pump station	- Pipeline
Treatment and distribution facilities	*- Water treatment station*	*- Distribution pipeline network*
(3) Domestic/Industrial Water Supply Facilities: <Lagarto Water Supply Area>		
Water conveyance pipeline	- Intake and raw water pump station	- Pipeline
Treatment and distribution facilities	*- Water treatment station*	*- Distribution pipeline network*
(4) Irrigation Water Supply Facilities		
Water Conveyance Pipeline	*- Intake and raw water pump station*	*- Pipeline*
Irrigation Facilities	*- Farmland development*	*- Irrigation channel*

Note: Italic parts show the facilities not including in this feasibility study.



0 Scale 1:500,000 20km

Figure-1.1 Location of the project

CHAPTER 2 CONDITION OF THE PROJECT AREA

2.1 Socio-economy

2.1.1 Population in Vaza Barris River Basin

The total population in the Vaza Barris River basin of the both states ran up to 382,000 in the 1991 census. The average population density was 23.5 persons/km^2.

In Bahia State, the basin owns an area of 13,670 km^2 or 84% of the total basin area, where ten municipalities are concerned. The 1991 census population of the basin area was estimated at 240,000 that were 3.4% of total population of Bahia State. The population density was 17.6 persons/km^2. A large part of the inhabitants live in the rural area and economic activities concentrate in primary sector.

In Sergipe State, the basin owns an area of 2,559 km^2 or 16% of total area, where fourteen municipalities are concerned. The 1991 census population of the basin area was 142,000 that were 9.5% of total population of Sergipe State. The population density was 55.5 persons/km^2.

Table-2.1 Population in Vaza Barris River Basin

Item	Bahia State	Sergipe State	Total/Average
Basin Area (km^2)	13,670	2,559	16,229
Number of municipalities	10	14	28
Population (1991 Census)	240,000	142,000	382,000
Population Density (persons/km^2)	17.6	55.5	23.5

2.1.2 Socio-economy in the Project Area

(1) Census Population

The project area contains nine (9) municipalities; Areia Branca, Campo de Brito, Itabaiana, Macambira, Sao Domingos, Poco Verde, Simao Dias, Lagarto and Riachao do Dantas. The population of the project area was 259 thousand in the 1996 census or 16% of the state population. Lagarto, Itabaiana and Simao Dias are the three largest municipalities, which shared 70% of whole population in the project area. The average population growth rate of the project area during the 1990s was 1.50% per annum. By river basin area, 40% of the population of the project area concentrated in the Piaui river basin area. Meanwhile, Sergipe river basin area showed extremely higher population growth rate.

Table-2.2 Census Population and Annual Growth

Unit: Population 1000 persons, Growth %

Item	1970	1980		1991		1996	
	Population	Population	Growth	Population	Growth	Population	Growth
Brazil	93,139.0	119,002.7	2.48	146,825.5	1.93	157,079.6	1.36
Sergipe	901.6	1,140.0	2.37	1,491.9	2.47	1,624.2	1.71
Project Area	173.1	198.7	1.39	240.6	1.75	259.2	1.50
By River Basin							
Sergipe	30.8	43.0	3.39	60.3	3.11	70.6	3.23
Vaza Barris	55.6	51.5	-0.76	54.5	0.51	57.3	1.03
Piaui	71.9	86.1	1.81	104.7	1.79	110.1	1.03
Real	14.8	18.1	2.03	21.1	1.39	21.2	0.06

Source: "Anuario Estatistico do Brasil 1996, IBGE", "Contagem da Populacao 1996, IBGE"
"Anuario Estatistico de Sergipe 1996, SEPLANTEC/SUPES"

(2) Future Population

In this study, the future population is projected on the basis of the 1996 census results, applying the method of the SUPES projection as presented in the Master Plan. Table-2.3 shows the population projected up to the year 2020 at 10-year intervals. The state population in 2020 was projected at 2.78 million. Its growth rate is 2.3% on average between 1996 and 2020.

The strategic scenario for regional development plan was presented in the Master Plan. The scenario was drawn up basically for decentralization policy to solve or to avoid foreseeable problems such as extremely concentration of population and economic activities in the central region like Aracaju and to alleviate the high level of regional socio-economic disparity among the municipalities. According to the scenario, the projected population was distributed to the project area by the respective municipalities as shown in Table-2.3. The population of the project area in 2020 was projected at 0.54 million. Consequently, the annual growth rate of the area results in 3.1% between 1996 and 2020.

Table-2.3 Projected Population

Unit: 1000 persons

Item	1997	1998	2000	2010	2020	Annual Growth Rate between 1996 and 2020 (%)
Brazil	159,060	161,070	165,715	184,157	200,306	1.0
Sergipe	1,654	1,684	1,750	2,163	2,778	2.3
Project Area	264	268	278	394	539	3.1
By River Basin						
Sergipe	73	76	81	149	231	5.1
Vaza Barris	58	59	61	74	91	2.0
Piaui	112	112	115	149	192	2.3
Real	21	21	21	22	25	0.7

Source: Anuario Estatistico do Brasil 1996, IBGE,
Anuario Estatistico de Sergipe 1996, SEPLANTEC/SUPES

(3) Labor Force

In the 1991 census, the labor force in the project area was 81,200 that were 15% of the state. The agriculture sector had the largest number of labor forces, which accounted for 36,600 that shared 45% of all labor forces in the area. Nevertheless, it recorded a drastic decrease to 35,600 in the 1980 census from 41,000 in the 1970 census. On the other hand, the number of labor forces in the industry and service sector continued to show an upward trend at an annual rate of over 6%.

Table-2.4 Number of Labor Force (over 10 years old)

Item	Gainful Workers			Percentage Distribution (%)			Growth Rate (%)	
	1970	1980	1991	1970	1980	1991	'70-'80	'80-'91
Sergipe	265.5	353.7	530.8	100.0	100.0	100.0	2.9	3.8
Agriculture	161.0	149.7	149.2	60.7	42.3	28.2	-0.7	0.0
Industry	31.1	61.4	100.5	11.7	17.3	18.9	7.0	4.6
Services	68.6	131.4	263.5	25.8	37.2	49.6	5.7	3.7
No Jobs	4.8	11.2	17.6	1.8	3.2	3.3	8.8	4.2
Project Area	52.9	58.1	81.2	100.0	100.0	100.0	0.9	3.1
Agriculture	41.0	35.6	36.6	77.6	61.3	45.0	-1.4	0.2
Industry	3.3	6.0	11.5	6.2	10.4	14.2	6.4	6.1
Services	8.6	16.5	33.1	16.3	28.4	40.8	6.7	6.6

Source: Censo Demografico 1970/1980/1991, Mao-de-Obra, No.16 Sergipe, IBGE

(4) Gross Regional Domestic Product (GRDP)

(a) GRDP

According to the strategic scenario mentioned in the above, the projected GRDP is distributed to the project area as figured in the Table-2.5. GRDP of the state is projected to an amount of R$15.02 billion by 2020. It is 3.4 times of that (R$4.43 billion) in 1995. Thus, it accounts for 0.8% in Brazil, which becomes larger than the percentage (0.55%) in 1995.

GRDP in 2020 of the project area is estimated at an amount of R$1.85 billion which is 4.3 times of that (R$0.43 billion) in 1995. It shares 12.3% in the state GRDP, which indicates an impressive gain as compared with 9.7% in 1995. GRDP growth rate is shown in Table-2.6. The growth rate of the project area between 2010 and 2020 is 6.8% that is larger than 5.0% of the state during the same period.

Table-2.5 GRDP Projection at 1998 Constant Prices

Unit: R$ billion

Item	Actual	Projection				
	1995	1997	1998	2000	2010	2020
1) Brazil	799.39	868.78	912.21	1,005.71	1,453.30	1,860.35
2) Sergipe	4.43	4.89	5.13	5.66	9.22	15.02
Agriculture	0.55	0.57	0.57	0.58	0.64	0.71
Industry	1.34	1.49	1.57	1.75	2.95	4.93
Services	2.54	2.83	2.99	3.33	5.62	9.38
3) Project Area	0.43	0.47	0.49	0.53	0.96	1.85
Agriculture	0.12	0.12	0.12	0.13	0.13	0.14
Industry	0.11	0.12	0.13	0.14	0.28	0.59
Services	0.20	0.23	0.24	0.26	0.55	1.12
4) By River Basin						
Sergipe	0.06	0.07	0.07	0.08	0.17	0.40
Vaza Barris	0.08	0.09	0.09	0.10	0.16	0.29
Piaui	0.27	0.30	0.32	0.34	0.62	1.15
Real	0.01	0.01	0.01	0.01	0.01	0.01

Source: Plano Plurianual 1996-1999, Mensagem ao Congresso Nacional, GOB, MPO
Anuario Estatistico do Brasil, 1996, IBGE

Table-2.6 GDP and GRDP Growth Rate

Unit: %

Item	Actual			Projection		
	1995	1997	1998	2000	2010	2020
1) Brazil	1.8*	4.5	5.0	5.0	3.75	2.5
2) Sergipe	1.3*	5.0	5.0	5.0	5.0	5.0
Agriculture	-5.1*	1.0	1.0	1.0	1.0	1.0
Industry	0.1*	5.6	5.6	5.6	5.4	5.3
Services	4.0*	5.6	5.6	5.6	5.4	5.3
3) Project Area	-	4.4	4.3	4.3	6.1	6.8
Agriculture	-	1.0	1.0	1.0	0.6	0.7
Industry	-	5.6	5.6	5.6	7.3	7.6
Services	-	5.6	5.6	5.6	7.3	7.6
4) By River Basin						
Sergipe	-	3.8	3.8	3.8	7.9	9.4
Vaza Barris	-	3.5	3.5	3.5	4.9	6.1
Piaui	-	4.8	4.8	4.8	6.0	6.3
Real	-	1.2	1.2	1.2	0.5	0.9

Note: * Annual growth rate between 1990 and 1995

(b) GRDP per Capita

GRDP per capita in 2020 of the project area was calculated at R$ 3,430. It is 64% of the state's level, which also indicates a clear improvement against prior decades. Thus, the regional disparity could mitigate and the people lives would get closer to the national level for this period.

Table-2.7 Per Capita GRDP at 1998 Constant Prices

Unit: R$

Item	1995	1997	1998	2000	2010	2020
Brazil	5,160	5,460	5,660	6,070	7,890	9,290
Sergipe	2,770	2,960	3,050	3,230	4,260	5,400
Project Area	--	1,770	1,820	1,910	2,420	3,430
River Basin						
Sergipe	--	940	940	950	1,110	1,750
Vaza Barris	--	1,530	1,560	1,630	2,150	3,170
Piaui	--	2,690	2,790	3,000	4,170	5,970
Real	--	450	450	460	460	450

(5) Economic Sector Profile

Main agricultural products in the project area are shown in Table-2.8. Seven major products shared at over 50%, markedly tobacco leaves 87%, maracuja fruit 68% and cassava 61% in 1993. The area was marked by a predominant share of 86% in tomato production in 1992. The area is accounted as the second largest orange production in the state.

Table-2.8 Main Agricultural Products

Unit: ton except (*1); million fruits, (*2): 1,000 fruits

Item	1992			1993		
	Sergipe	Project Area	%	Sergipe	Project Area	%
Beans	11,473	4,177	36.4	8,150	3,835	47.1
Cassava	492,396	253,078	51.4	617,411	375,800	60.9
Peanuts	1,504	705	46.9	1,526	854	56.0
Sweet Potato	19,027	11,800	62.0	22,511	13,119	58.3
Tobacco Leaves	1,960	1,657	84.5	5,782	5,050	87.3
Tomato	4,973	4,277	86.0	8,329	4,423	53.1
Orange(*1)	3,791	1,099	29.0	4,406	1,317	29.9
Maracuja(*2)	345,631	227,818	65.9	380,615	258,189	67.8
Papaya(*2)	5,119	2,533	49.5	5,042	2,717	53.8

Source: Anuario Estatistico de Sergipe, 1996, SEPLANTEC/SUPES
Note: (%); Ratio of project area to Sergipe

The number of establishments and workers were worked out as shown in Table-2.9. There were 252 establishments in the project area, which shared 17% in the total of the state. The food and non-metallic industries are the most sizable in the terms of number of establishments and workers in the area. Nevertheless, average workers per establishments are only 8. It means that small establishments predominate in the area. Lagarto, Itabaiana and Simao Dias are counted as the three largest municipalities in the above terms both in food and non-metal industries.

Table-2.9 Number of Establishments and Workers in Industrial Sector

Item	Sergipe (A)	Project Area (B)	Ratio (B/A)	Largest Municipalities in the Area		
				1st	2nd	3rd
Establishments	1,458	252	17 %	Lagarto 90	Itabaiana 86	S.Dias 28
Food	553	88	16 %	Lagarto 32	Itabaiana 24	S.Dias 10
Non-Metallic	143	32	22 %	Itabaiana 18	S.Dias 9	Lagarto 4
Workers (Person)	47,034	2,070	4 %	Itabaiana 865	Lagarto 795	S.Dias 259
Food	6,272	607	10 %	Lagarto 315	Itabaiana 152	S.Dias 51
Non-Metallic	2,525	528	21 %	Itabaiana 331	S.Dias 158	Lagarto 36
Worker/Establishment	32.3	8.2	-	-	-	-

Source: Cadastro Industrial Sergipe, 1991/92, SEIT, CODISE and SEBRAE

2.2 Topography and Geology

(1) Topography

Topography and geology of Vaza Barris River Basin is closely related. The Vaza Barris river system has its source further upstream of the State of Bahia. Vaza Barris River basin lies in tablelands of peneplain in Sergipe State and Bahia State. At the west of Sao Domingos town, two large tributaries of the Jacare River and the Salgado River join the main stream of Vaza Barris River.

Within Sergipe State, the elevation of the basin is no more than 100m in the middle-stream, and 200m in upper stream with higher remained hills of less than 400m in height. Vaza Barris River and its tributaries cut down the tablelands forming steep valleys. Vaza Barris River flows from the northwest to southwest and corresponds to the direction of large-scale geological structural line. The Vaza Barris River course has remarkable bends in many places along the river course, of which direction are dominated by the direction of faults of geological age. Moreover, the drainage pattern of Vaza Barris River in the upstream shows reticular characteristics that reflect the distribution of relatively soft rocks forming the geological formation. On the other hand, the river system shows a poor development in the downstream due to the existence of rigid rocks of the Itabaiana Dome and dominant deposits of Tertiary system.

(2) Geology

Within the Sergipe State, the geology of Vaza Barris basin consists of: 1) Pre-Cambrian rock forming the geological basement of the region, 2) Tertiary covering the basement, and 3) Alluvial sediments distributed along the rivers. The Pre-Cambrian rock belongs to Archaean system, which consists of many types of rocks such as phyllite, sandstone, limestone, schist, gneiss, quartzite. Arenaceous, pelitic to calcareous phyllitic rocks are dominant in the Vaza Barris River basin. These rocks are slightly weathered on the superficial part of the ground. Pre-Cambrian rocks outcrop on the surface of the ground in the middle-stream and up-stream of the basin but are overlaid by the Tertiary in the down-stream. The Tertiary consists of unconsolidated gravel to lateritic soils covering the basement with a thin sub-horizontal layer. Alluvial sediment is deposited forming terraces at both of the riverbank of less than 10m in height from the river floor, which consists of soft silt and loose sand. Alluvial sediment increases its thickness toward the downstream, especially from the boundary between Precambrian rocks and Mesozoic rocks. The width of the terraces is closely related to the width of the valleys.

Concerning geological structure, the course of the lower Vaza Barris River and the Jacare River coincides with the terrace caused by the Vaza Barris Fault. This is a large-scale thrust fault, separating gneissose member and phyllitic member within the Brazil Craton.