SUPPORTING REPORT F

WATER SUPPLY

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SUPPORTING REPORT F WATER SUPPLY

1. Introduction

Water supply in the Maritza river basin is managed by 7 Water Supply and Sewerage Companies (VIKs) of the Ministry of Regional Development and Urbanization and 5 VIKs of the municipalities as shown in Table F.1.1. In summary water supply companies in the river basin are as follows;

Region	WS Company	No. Municipality	Owner
Sofia	Sofia	5	State
Plovdiv	Plovdiv	13	State
	Pazardjik	8	State
	Smolian	5	State
	Peshtera	1	Municipality
	Batak	1	Municipality
	Velingrad	1	Municipality
Haskovo	Haskovo	7	State
	Stara Zagora	6	State
Burgas	Sliven	2	State

Only Plovdiv and Pazardjik Water Supply Companies have the whole responsible municipalities in the Maritza river basin.

Data on water supply from all water supply companies were collected by the interviews and questionnaires. However, data were available only from Sofia, Plovdiv, Pazardjik, Haskovo and Stara Zagora Water Supply Companies. Water supply networks from these Water Supply Companies are shown in Fig. F.1.1 and organization charts of these water supply companies are shown in Appendix F.

2. Existing Condition

2.1 Served Population

According to the data from water supply companies, the total population in charge by water supply companies is shown in Table F.2.1 and the served population is shown in Table F.2.2. The percentage of served population in 1996 can be summarized as follows:

WS company	Population (person)	Served Population (person)	Ratio (%)
Sofia	-	69,317	-
Plovdiv	733,025	733,025	100.0
Pazardjik	236,749	236,749	100.0
Strara Zagora	416,338	270,269	-
Haskovo	196,296	195,988	99.8

Source : Water Supply Companies' questionnaires

Ratio of the served population to total population in Sofia and Stara Zagora were not calculated because data on the served population referred to only the population in the Maritza river basin, not the whole municipalities of those water supply companies.
This result shows that water supply companies in the Maritza river basin are now serving almost all the population in the basin.

2.2 Water Supply Quantity

Water supply quantity was measured from the electricity used for pumping to the users. The quantity supplied by these companies in 1996 is shown below. From the served population, a unit water supply can be calculated as

WS company	WS quantity (m^3/y)	Served pop. (person)	Unit water supply (m^3/c/d)
Sofia	7,301,429	69,317	0.289
Plovdiv	100,171,000	733,025	0.374
Pazardjik	25,336,000	236,749	0.293
Strara Zagora	46,838,000	270,269	0.475
Haskovo	18,920,000	195,988	0.264
Total	198,566,429	1,505,348	
Average			0.339

Source : Water Supply Companies' questionnaires

It should be noted that unit water supply calculated from Sofia was not taken into consideration because the water supply quantity was not measured values.

2.3 Water Supply Use

Data on the water supply use was also collected from the water supply companies in the Maritza river basin. The water supply use is measured by a flow meter, but for the houses with no flow meter, water supply use is estimated by using a flat rate system. Total water use with and without flow meters is shown in Table F.2.3 and the unit water supply use is shown in Table F.2.4. Summary of the unit water supply use in 1996 is shown below

WS company	Served pop. (person)	WS use (m^3/y)	Actual unit water use (m^3/capita/day)
Sofia	69,317	5,111,000	0.202
Plovdiv	733,025	45,353,000	0.170
Pazardjik	236,749	11,858,000	0.137
Strara Zagora	270,269	20,509,000	0.208
Haskovo	195,988	10,878,000	0.152
Average			0.174

Source : Water Supply Companies' questionnaires

Water supply use is classified into the domestic use, the industrial use, the public services and others. Total water use in 1996 recorded from water supply companies for both with flow meter and without flow meter using the flat rate system is shown in Table F.2.5. The portion of water use is summarized as follows;

WS company	Water use			Total	
	Domestic (%)	Public serv. (%)	Ind., Agr. & others (%)	(%)	(m^3/y)
Sofia	39.1	52.2	8.7	100.0	5,111,000
Plovdiv	63.1	0.0	36.9	100.0	45,353,000
Pazardjik	65.1	18.4	16.4	100.0	11,858,000
Strara Zagora	42.4	28.2	29.3	100.0	20,509,000
Haskovo	58.2	10.8	31.1	100.0	10,878,000
Average	53.6	21.9	24.5	100.0	
Total					93,709,000

Source : Water Supply Companies' questionnaires

It can be seen that the major portion of water supply use is the domestic and the public services which occupy in average about 75 % while the industrial, the agricultural and other uses occupy about 25 %.

JICA Study Team also conducted a survey on water supply use in the whole Maritza river basin including Plovdiv, Pazardjik, Haskovo and Stara Zagora by questionnaires in 1997. A total number of about 300 samples was analyzed by classifying the regions into an urban, a semi-urban and a rural area. The domestic water use was different apparently during the summer and winter time, therefore, the calculation was done separately. The summer time was defined from June until August for 3 months, while the winter time was defined from September until May for 9 months. The water supply use from this survey is summarized as follows:

	Waster use (m^3/c/d)	
	Summer	Winter
Urban	0.116	0.079
Semi-urban	0.124	0.086
Rural	0.120	0.079
Average	0.120	0.081

Source : JICA Study Team's survey

However, the accuracy of this survey may not be high due to a few number of samples, therefore the data collected from water supply companies will be used in the water loss analysis.

2.4 Water Loss

Water loss is considered as the difference between the water supply quantity and the water use by each water supply companies. The water loss in 1996 can be calculated as follows:

WS company	WS quantity (m^3/y)	WS use (m^3/y)	Loss	
			(m^3/y)	(%)
Sofia	7,301,429	5,111,000	2,190,429	30.00
Plovdiv	100,171,000	45,353,000	54,818,000	54.72
Pazardjik	25,336,000	11,858,000	13,478,000	53.20
Stara Zagora	46,838,000	20,509,000	26,329,000	56.21
Haskovo	18,920,000	10,878,000	8,042,000	42.51
Average				51.66
			or	52 %

It should be noted that the loss in Sofia was not taken into consideration because the water supply quantity was calculated based on the information that the loss was about 30 %, not the actual measured water supply quantity.

This water loss is attributed to 2 major causes, those are

(1) Physical loss

The physical loss is considered as the leakage of water in the distribution system from treatment plants to the users.

(2) Administration loss

There are 2 types of charge managed by the water supply companies, those are the charge from a flow meter and the charge by using a flat rate system.

1) Water meter system

Water supply is provided through the house connections and the water use is recorded by the water meter setting at the connections.

2) Flat rate system

In the areas or houses that have no water meter, the water use is estimated from the population in those areas or houses by a flat rate system. According to Plovdiv Water Supply Company, a flat rate in general is estimated at 7.0 m^3/capita/month.

Collection of the bills for water charges is done normally once in a month, while the checking of water meter is done about once in 1 or 2 months.

Administration loss is considered as the loss from the following causes:

1) Non-payment
2) Inaccurate use of flat rate system
3) Others

There are also several causes for the water loss including

- Illegal connections in some area
- Incorrect bills
- Inefficient direct collection by cash

The concept of actual unit water use calculation is as shown below:

Actual unit water use = Unit water supply – Water loss
= Unit water supply – (Administration loss + Physical loss)

According to water supply companies, the administration loss is expected to be about 20 % of the total water loss, therefore, the water loss or so called the "Unaccounted for Water (UFW)" is as follows:

	%
Water loss (UFW)	52
Administration loss	20
Physical loss	32

2.5 Unit Water Demand

Unit water demand is normally considered from the quantity of water needed after the physical loss only, therefore the concept for the unit water demand calculation is as shown below

Unit water demand = Unit water supply – Physical loss

The calculation of unit water demand from water supply companies is summarized as follows:

WS Company	Unit water supply (m^3/c/d)	Unit water demand (m^3/c/d)
Sofia	0.289	0.193
Plovdiv	0.374	0.251
Pazardjik	0.293	0.196
Strara Zagora	0.475	0.318
Haskovo	0.264	0.177
Average	0.339	0.227

Average unit water demand = Unit water supply – Physical loss (32 %)

= 0.339 – 0.32×0.339

Average unit water demand = 0.227 m^3/capita/day

2.6 Water Sources

The water sources in the basin are surface water and groundwater, but the majority of water is from the groundwater. At present, the capacity of the existing facilities for groundwater and surface water utilization is shown in Table F.2.6 and can be summarized as follows;

WS company	Portion of water sources					
	Surface water		Groundwater		Total	
	(m^3/y)	(%)	(m^3/y)	(%)	(m^3/y)	(%)
Sofia	insufficient data					
Plovdiv	6,733,251	2.4	272,270,156	97.6	279,003,407	100.0
Pazardjik	4,540,000	6.5	65,332,000	93.5	69,872,000	100.0
Strara Zagora	0	0.0	62,587,100	100.0	62,587,100	100.0
Haskovo	5,487,264	11.6	41,913,170	88.4	47,400,434	100.0
Average		5.1		94.9		100.0
Total	16,760,515		442,102,426		458,862,941	

Source : Water Supply Companies' questionnaires

The quantity of supplied water from the sources (groundwater well and water supply treatment plants) compared to the water uses for the domestic, the industries, the public services, etc. estimated with and without flow meters by water supply companies is shown in Table F.2.7.

2.7 Water Quality

(1) In General

The drinking water quality has to be in the limit as required in the "Bulgarian Drinking Water Standard 2823" as shown in Table F.2.8.

The groundwater quality of production wells are examined regularly by the National Institute of Meteorology and Hydrology (NIMH), the National Center for Environment and Sustainable Development (NCESD) and the former Committee of Geology (COG). Raw water quality in general from the monitoring stations in the basin is shown in Table F.2.9. Data on the treated water quality are available only in Haskovo as shown in Table F.2.10. Summary of the water quality in comparison with the standard is as follows:

WQ item	unit	Drinking Standard (BDS2823)	Raw water			Treated water Haskovo
			Plovdiv	Pazardjik	Haskovo	
pH		6.5-8.5	6.8-8.3	6.9-8.6	7.6-8.3	6.5-7.0
Cl^-	mg/l	250	9-47	7-53	19-61	22-59
NO_2^-	mg/l	-	0-2.23	0-0.12	0-0.02	0
NO_3^-	mg/l	50	4-63	0-23	4-36	0.65-59
PO_4^{3-}	mg/l	0.5	0-1.2	0-1.2	0.4-1.4	0-0.04
NH_4^+	mg/l	-	0	0-0.002	0-0.01	0-0.4
Mg^{2+}	mg/l	80	8-38	8-26	12-63	0-51
Ca^{2+}	mg/l	150	10-188	51-101	66-113	0-128
Total Fe	mg/l	0.2	<0.1	<0.1	<0.1	0
Mn^{2+}	mg/l	0.1	<0.05	<0.05	0-0.4	0-0.75
Hardness	mg/Sq/l	12	2.4-11.7	3.1-6.4	4.3-10.8	4.5-10.6

Source : Committee of Geology and Ministry of Health, Bulgaria

For raw water, the groundwater quality of some production wells are good and under the standard, but those of a few wells are not so good. The concentration of Nitrate and Phosphate are comparatively high.

For treated water, only the data from Haskovo are available at present, it can be seen clearly that in general the treated water quality is good, only a few wells those raw water quality are originally bad have treated water quality higher than standard.

For surface water, the data on raw and treated surface water quality of the existing treatment plants are not available at present. However, as mentioned, these surface water sources occupy a minor portion in the water supply system in the basin.

JICA Study Team also conducted a field survey on water supply use including the comments on water quality in the Maritza river basin in 1997 by a sampling method as mentioned. The survey did not specify the technical details, only the level of satisfaction on the tab water quality. The results are as follows;

Satisfaction of water quality						
	Urban		Semi-Urban		Rural	
Quality	No. user	%	No. user	%	No. user	%
Good	29	26.4	17	13.6	23	33.3
Acceptable	27	24.5	34	27.2	15	21.7
Unacceptable	54	49.1	74	59.2	31	44.9
Total	110	100.0	125	100.0	69	100.0

Source : JICA Study Team's survey

The result shows that the majority of the users in all areas are not satisfied with the quality of water supply.

However, in comparison with the water quality data from the Committee of Geology and Ministry of Heath, it can be summarized that the water supply quality becomes worse in the distribution system or pipe networks.

(2) Identification of polluted sources

Water quality observed by the NCESD, as shown in Appendix F, is examined to identify the polluted groundwater sources. It is found that the groundwater contains high concentration of impurities as follows;

- NH_4, NO_2, NO_3
- Fe, Mn
- SO_4, PO_4
- Ca, Mg

The location of contaminated sources is identified as follows;

For high concentration of NH_4, NO_2, NO_3

Well no. : IV-001, IV-006, IV-009, IV0092, IV-01, IV-02, IV-04, IV-05, IV-07, IV-08, IV-10, IV-16, IV-27, IV-28, IV-29, IV-30, IV-32, IV-33, IV-36, IV-37, IV-43, IV-61, X-02, XI-02, XI-03, XI-09, XI-10, XI-13, XI-141, XII-05, XII-06, XIV-001, XIV-002, XIV-003, XIV-004, XIV-005, XIV-061.

For high concentration of Fe and Mn

Well no. : IV-005, IV-009, IV-07, IV-08, IV-26, IV-27, IV-29, IV-44, XI-10, IV-30, IV-32, XI-03, XI-13, XIV-001, XIV-002, XIV-004.

For high concentration of SO_4, PO_4

Well no. : IV-05, IV-08, IV-27, IV-29, IV-37, XI-09, XI-10, XI-13, XII-05, XIV-001, XIV-004.

For high concentration of Ca and Mg

Well no. : IV-43, XI-10, XI-13

The distribution of all these wells are shown in Fig. F.2.1.

NH_4, NO_2 and NO_3 are significantly high in the wells along the main river or in the flood plains (terrace deposit) and Talus (drift deposit). These substances are mainly from the domestic wastewater. In comparison with the surface water quality along the main river, it is summarized that the sources of contamination are from the surface water which recharges into the ground.

Fe and Mn are slightly high in LUD, PYA, MU2, STR, MM2, MM3, SAZ, HAR and MD major sub-basins. However, no serious contamination is found.

SO_4 and PO_4 are also significantly high in LUD and SAZ major sub-basins. Since there are several industries located in these areas including electricity generation plants, coal mines, chemicals industries, food processing industries, textile industries and it is evident that the proper wastewater treatment is not done before discharging to the river. The contamination of groundwater in these areas is attributed to the recharge of wastewater from these industries.

Ca and Mg are pretty high in LUD, MM1 and SAZ. These substances were not found in the effluent of industries in these areas and normally are not a composition in domestic wastewater. Therefore, it is summarized that these substances are from the soil layers underneath.

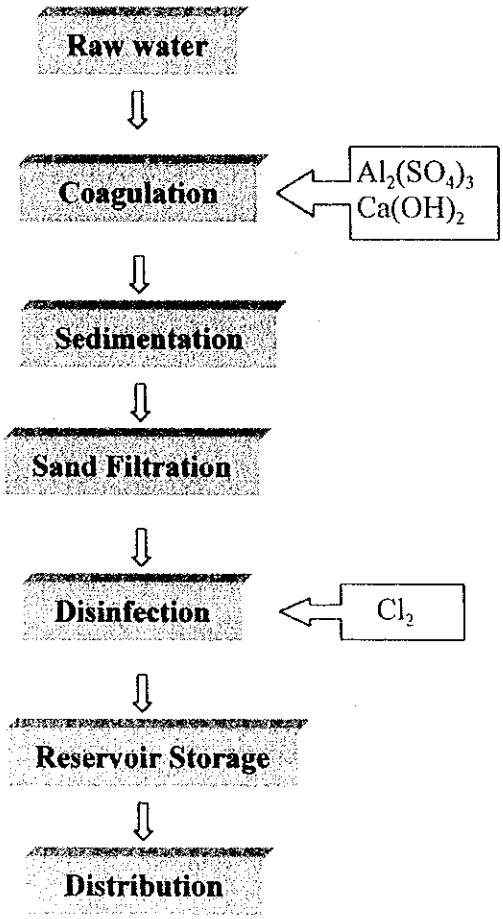
2.8 Existing Water Supply Facilities

Treatment of the raw water for water supply can be classified into 2 major types as follows;

(1) Treatment of the surface water or the groundwater by water supply treatment plants

(2) Treatment of the groundwater at well sites

The typical treatment process of ta water supply treatment plant is as follows:

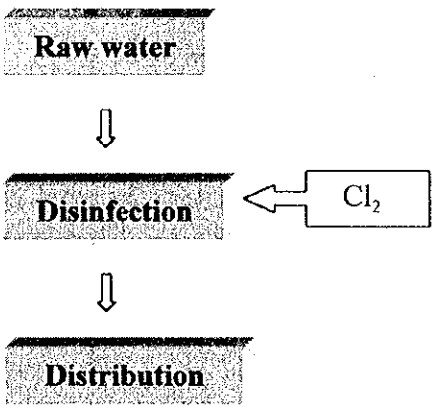


There are totally 25 water supply treatment plants managed by the State water supply companies as shown in Table F.2.11. The production capacity is as follows;

WS company	Total capacity of treatment plants (m^3/y)
Sofia	10,564,560
Plovdiv	6,717,168
Pazardjik	4,761,936
Haskovo	20,813,760
Strara Zagora	no treatment plant

Source : WS Companies' questionnaires

The groundwater quality is considered clean enough, therefore treatment of the groundwater is comparatively simple. The typical process for the groundwater treatment at a well site is as follows;



2.9 Distribution System

Pipeline networks of water supply companies are summarized in Table F.2.12.

Several types of pipes are being used in the basin, those are:

- Cast iron pipe
- Steel pipe
- Steel concrete pipe
- Asbestos cement pipe
- PVC pipe
- Galvanized pipe

The total length of pipes for different diameters are summarized briefly as follows:

Total length of pipes (km)						
Type	Water Supply Company					Total (km)
	Sofia	Plovdiv	Pazardjik	Strara Zagora	Haskovo	
Asbestos	242.5	3,191.1	1,431.8	1,716.4	1,062.7	7,644.5
Cast iron	-	72.0	17.4	44.6	7.8	141.7
PVC	-	11.7	15.4	2.7	37.9	67.7
Steel	33.9	526.8	398.6	404.4	241.2	1,604.8
Steel concrete	-	-	4.8	5.4	-	10.2
Galvanized	-	-	18.0	-	-	18.0
Total	276.4	3,801.6	1,885.9	2,173.4	1,349.7	9,487.0

Source : Water Supply Companies' questionnaires

The portion of the pipelines is as follows:

Type	Length	
	km	%
Asbestos	7,644.5	80.6
Cast iron	141.7	1.5
PVC	67.7	0.7
Steel	1,604.8	16.9
Steel concrete	10.2	0.1
Galvanized	18.0	0.2
Total	9,487.0	100.0

The major portion of the pipelines in the basin is Asbestos cement which occupies about 80% of the whole pipe length.

Details of the pipelines in each settlement are in Appendix F.

2.10 Operation and Maintenance

The operation and maintenance of water supply system are taken care by water supply companies. A list of municipalities in charge by each water supply companies and the organization charts are shown in the Appendix F. Main regular works are as follows:

- The control of water intake facilities
- The operation of the purification process
- The control of water quantity for delivery
- The repair of the equipment

The operation and maintenance of water supply system are in principle based on the water supply company's manual and local manual.

2.11 Water Supply Cost

Water supply cost is classified into 2 categories, those are

(1) Construction Cost

Data on the construction cost of the existing facilities are not available and reliable due to the economic change. However, the construction cost at present is estimated as follows:

1) A new production well including
   - pumping house
   - electricity system
   - 50 m well depth

   Construction = 35,000 US$/1 station

2) Groundwater exploitation including
   - casing
   - sampling
   - lodging
   - pumping test

   Construction = 100 US$/m depth

3) Water meter = 600 US$/unit

4) Pipelines construction

   Diameter of pipe >100 mm = 50,000 – 60,000 Lv/m

5) Pipe cost (by weight for diameter > 100 mm)
   - Steel pipe = 0.4 US$/kg
   - Galvanized pipe = 0.5 US$/kg

6) Pipe cost (by weight for diameter > 100 mm)

- Steel pipe = 0.6 US$/kg

7) Pipe cost (by length for diameter = 159 mm (17.1 kg/m))

- Steel pipe = 11 US$/m

(2) Operation and Maintenance Cost

Data on the operation and maintenance cost were collected from water supply companies. The expenditures of water supply system are classified into

1) Operation cost

The operation cost normally composes of the cost for

- Salary
- Consumption of chemicals
- Electricity
- Repair
- Depreciation
- Others

2) Non-operation cost

The non-operation cost normally composes of the cost for

- Interest
- Others

3) Extraordinary loss

The total expenditures including the break-down and the quantity of water supply are shown in Table F.2.13 (1) and Table F.2.13 (2). The summary in 1996 is shown as follows:

WS Company	WS quantity (m^3/y)	Expenditures (Lv/y)	Unit cost (Lv/m^3)
Sofia	7,301,429	41,210,978	5.64
Plovdiv	100,171,000	1,030,117,000	10.28
Pazardjik	25,336,000	347,185,000	13.70
Stara Zagora	63,331,000	782,496,000	12.36
Haskovo	20,059,000	459,774,000	22.92

Source : Water Supply Companies' questionnaires

It should be noted that the data from Sofia Water Supply Company is still not reliable and needs to be confirmed.

3. Water Supply Policy

3.1 National Policy on Water Supply

According to the national policy on water supply and the existing condition of water supply system in the basin, major concerns on the water supply planning are as follows:

(1) Served population or coverage areas for water supply
(2) Quantity or potential of water sources
(3) Losses including physical loss and administration loss
(4) Treated water quality

3.2 Water Supply Design Criteria

The National Center for Regional Development and Housing Policy has set up a water supply design criteria in the "Regulatory Act concerning the Design and Construction of Water Supply Systems" in 1986. According to this act, the main criteria can be summarized as follows:

- Populated areas are classified into 8 categories based on the population, land use and development plan as Capital city, Class I, II, III, IV, V, VI and VII.
- Average future water consumption for drinking and domestic needs are estimated as follows:

Class		Average water consumption (l/c/d)					Peak factor	
		1995	2000	2005	2010	2015	daily	hourly
Capital city		275	280	290	300	305	1.25	1.40
Class	I	250	260	265	270	275	1.30	1.45
Class	II	235	245	253	260	265	1.35	1.50
Class	III	205	215	218	220	225	1.40	1.55
Class	IV	180	190	195	200	205	1.45	1.65
Class	V	128	130	145	160	165	1.50	1.80
Class	VI	128	130	140	150	153	1.60	2.10
Class	VII	128	130	133	135	138	1.65	2.50

Source : National Center for Regional Development and Housing Policy

- Water loss from the water supply system is accepted at 10 % of the average daily consumption and should be added to the maximum daily and the maximum hourly water supply.
- Classification of some municipalities in the Maritza river basin is as follows:

  Class I

  Plovdiv and Stara Zagora

  Class II

  Pazardjik, Haskovo and Dimitrovgrad

  Class III

  Nova Zagora, Panagyurishte, Radnevo, Peshtera, Svilengrad, Ihtiman, Rakovski, Assennovgrad, Stamboliyski, Harmanli, Galabovo and Hissaria

  Class IV

  Simeonovgrad, Kritchim, Sadovo, Saedinenie, Belovo and others

4. Formulation of Water Supply Master Plan

From the present condition of water supply in the Maritza river basin, a water supply master plan should focus on the following items

(1) Future served population
(2) Future water demand
(3) Potential of water sources
(4) Water supply loss reduction
(5) Improvement of water quality
(6) Improvement of distribution system

4.1 Future Served Population

(1) At Present

Water supply companies can serve almost 100 % of the population in the basin, although the unit water use per capita per day is still low compared to the target plan.

(2) Future Population Growth

In future, the population increase will create more water supply use, therefore, a water supply improvement plan should focus on the increase of water demand from the population increase.

Future population is projected based on the urban development plan, land use, etc. The future population in urban centers are expected to increase as follows:

Urban center	Increase in1995 – 2015 (%)	Annual average (%)
Plovdiv	10	0.5
Pazardjik	20	1.0
Stara Zagora	10	0.5
Haskovo	15	0.75

Rural areas are expected to have an insignificant population growth.

(3) Future Served Population

Projection of the population based on the criteria as mentioned is shown in Table F.4.1. By considering 100 % coverage, the served population in future can be summarized as follows:

WS company	Future served population (person)				
	present	2000	2005	2010	2015
Sofia	66,585	67,735	68,914	70,123	72,282
Plovdiv	734,167	747,285	760,735	774,524	798,832
Pazardjik	238,535	245,165	252,134	259,458	270,601
Smolian	38,811	39,218	39,636	40,064	41,026
Bratzigovo	12,182	12,309	12,439	12,572	12,873
Peshtera	22,787	23,292	23,810	24,341	25,206
Batak	7,530	7,643	7,758	7,877	8,102
Velingrad	43,649	44,306	44,980	45,670	46,977
Strara Zagora	265,681	270,555	275,553	280,677	289,617
Haskovo	267,841	275,114	282,664	290,502	302,489
Sliven	49,566	50,229	50,909	51,606	52,995
Total	1,747,334	1,782,852	1,819,532	1,857,413	1,921,000

Therefore, the target of the future served population is as follows;

Master plan on the future served population:

- The water supply master plan should be formulated to serve 100% of the population in the basin by the year 2015.

4.2 Future Water Demand

Future water demand is forecast based on the present unit water demand, the future water consumption and the population as shown in Table F.4.2. Summary of the future water demand is shown below

WS company	Present demand (m^3/y)	Future water demand (m^3/y)			
		2000	2005	2010	2015
Sofia	5,603,964	6,922,514	7,294,544	7,678,441	7,944,380
Plovdiv	68,222,400	70,917,368	73,582,065	76,329,321	79,161,857
Pazardjik	17,358,449	21,923,910	23,283,304	24,622,555	25,840,618
Smolian	2,824,318	3,507,110	3,660,205	3,802,120	3,917,710
Bratzigovo	799,685	853,616	885,333	917,765	950,935
Peshtera	1,658,235	1,827,846	1,894,554	1,954,567	2,043,691
Batak	494,306	530,030	552,211	575,027	598,501
Velingrad	3,176,385	3,476,916	3,579,032	3,667,325	3,808,825
Strara Zagora	31,309,167	25,675,708	26,652,853	27,660,675	28,700,186
Haskovo	17,582,378	24,602,086	26,102,628	27,568,610	28,885,711
Sliven	3,606,971	4,491,737	4,701,186	4,897,405	5,060,706
Total	152,636,259	164,728,841	172,187,915	179,673,812	186,913,119

Therefore, the target on the water demand is as follows;

Master plan on future water demand:

- The water supply master plan should be formulated to produce a sufficient water quantity for the total water demand until the year 2015.

4.3 Potential of Water Sources

Water supply sources are the groundwater and the surface water, but the majority of water is the groundwater. It is found that the groundwater and the surface water potential are sufficient for all water supply systems in the basin.

The capacity of the existing facilities for groundwater and surface water utilization are compared to this water demand as follows;

Water sources (m^3/y)

Surface	Ground	Total
16,760,515	442,102,426	458,862,941

Future water demand (m^3/y)

2000	2005	2010	2015
164,728,841	172,187,915	179,673,812	186,913,119

It can be summarized that:

Master plan on water supply facilities:

- The existing facilities can produce sufficient water quantity for the future water demand in the basin until the target year 2015.
- The expansion or a new construction of water supply facilities is unnecessary.

4.4 Water Supply Loss Reduction

(1) Target of Water Loss Reduction

The water supply loss in the basin is significantly high at 52 %. A water supply master plan is to focus on the improvement of this loss.

Normally, the difficulty of physical loss reduction varies with the percentage of that loss to the quantity of water supply, high percentage of loss can be reduced easier than low percentage.

According to the design criteria as mentioned, the physical loss is to be reduced to 10 % and by considering the present condition, the reduction of administration loss to 10 % is proposed in this study. Therefore, the projection of water loss reduction is as follows:

Year	1995	2000	2005	2010	2015
Physical loss	32 %	27 %	21 %	16 %	10 %
Administration loss	20 %	18 %	15 %	13 %	10 %
Total loss (UFW)	52 %	45 %	36 %	29 %	20 %

Source : For physical loss, National Center for Regional Development and Housing Policy

(2) Improvement of the Unaccounted for Water (UFW)

1) Physical loss

At present, the data on physical loss or the leakage are not available. Therefore, a water supply master plan should focus at first on the leakage investigation in the urban and rural areas.

The physical loss is to be reduced to 10% in the year 2015 according to the national policy on water supply. Rehabilitation of the pipelines and the connections are considered as the main task to reduce this physical loss.

2) Administration loss

At present, the administration loss is expected to be 20% according to the water supply companies in the basin. The administration loss is considered as the losses from

I. Non-payment

The billing system allows the users to have a late payment for 2 months until the water supply is cut. Some public services users also still have unpaid bills. The public services should be at least equipped with water meters.

II. Inaccurate use of flat rate system

For the users or the areas with no flow meters, a flat rate system is used. The number of estimated users for this flat rate system is sometimes lower than the actual users.

III. Others

There are also several causes for the water loss including

- illegal connections in some areas
- incorrect billing
- Inefficient direct collection of cash

According to the target water loss reduction, a UFW improvement plan should consist of major items as follows:

- Renovation or rehabilitation of pipeline system
- Installation of some more water meters
- Replacement of inefficient water meters
- Improvement of billing and collection system
- Improvement of individual house connection
- Enforcement or revision of penalty regulation
- Revision of water tariff

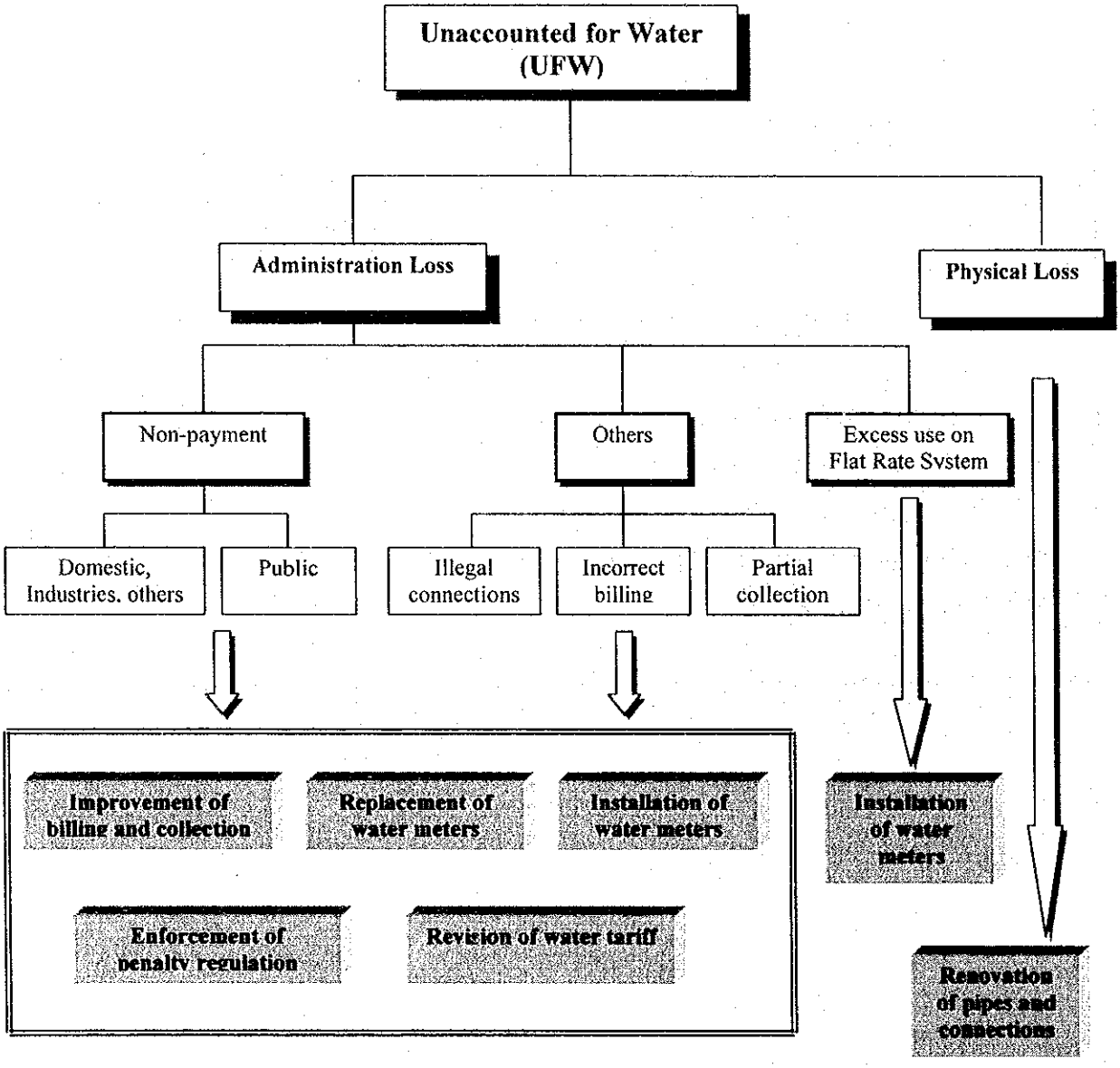
It can be summarized that the water loss countermeasures should be

Master plan for water loss:

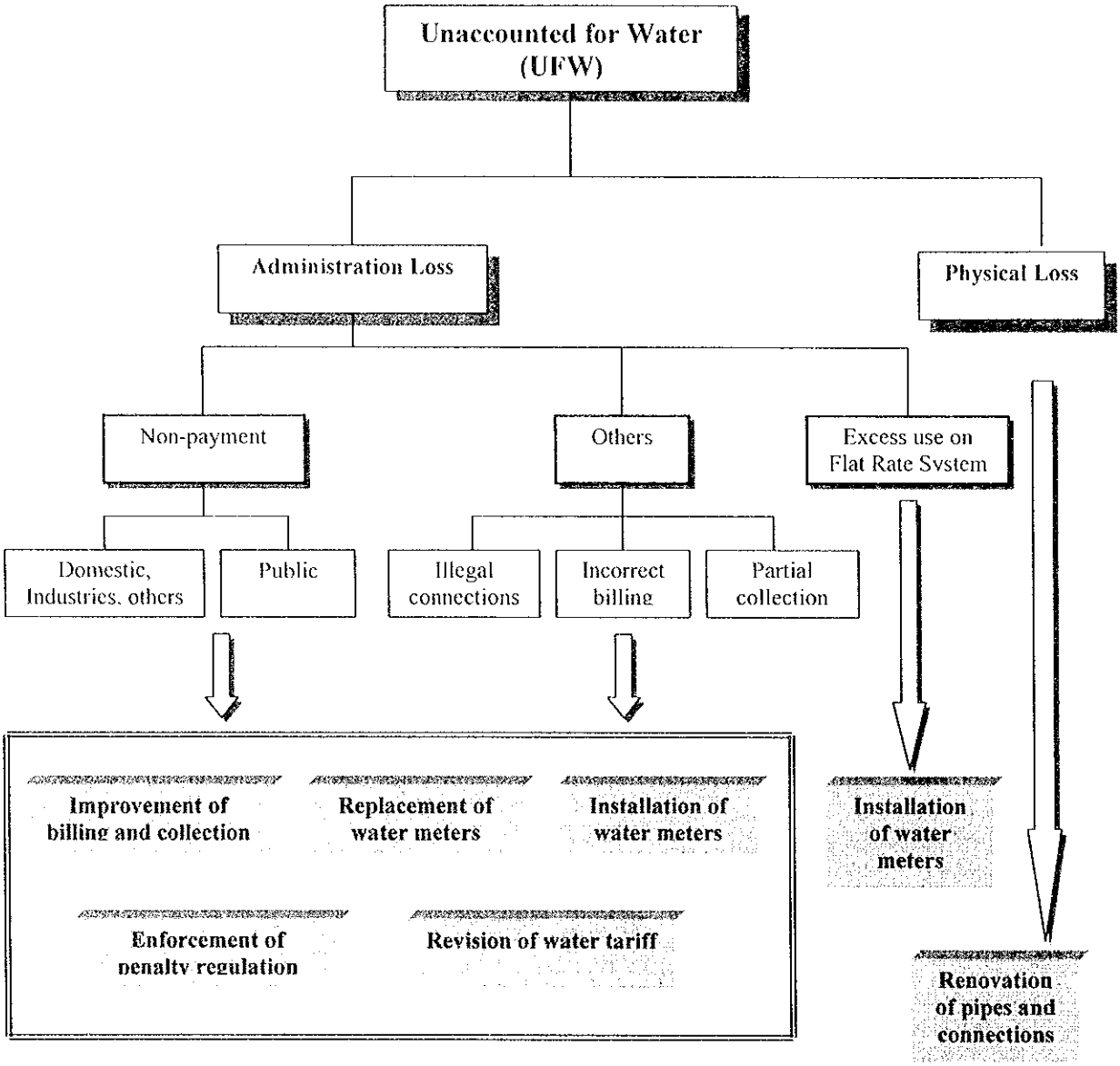
- The water loss or the Unaccounted for Water (UFW) should be reduced to 20 % by the target year 2015 by the proposed methods
- The water leakage investigation in details for the physical loss should be conducted
- To reduce the physical loss, the renovation or the rehabilitation of the distribution system is necessary.
- To reduce the administration loss, the following countermeasures should be done

(1) Installation of some more water meters
(2) Replacement of inefficient water meters
(3) Improvement of billing and collection system
(4) Improvement of individual house connection
(5) Enforcement or revision of penalty regulation
(6) Revision of water tariff

A schematic diagram of the improvement plan for water losses is shown below



A schematic diagram of the improvement plan for water losses is shown below



4.5 Improvement of Water Quality

(1) Existing Water Quality Condition

From the raw and the treated water quality as mentioned, the groundwater quality is generally good, although a high concentration of Ammonia, Nitrate and Nitrite are found along the river, a high concentration of Phosphate and Sulphate are found in SAZ major sub-basin and a slightly high concentration of Ferrous, Manganese, Calcium and Magnesium are found in almost the whole basin. But these organic substances are not a serious problem since these organic substances can be removed after the process of disinfection.

However, the wells with originally bad groundwater quality may make the treated water quality become higher than the drinking water standard. All these wells should be improved or relocated.

In addition, from a survey conducted by the JICA Study Team, the treated water was not acceptable for the users in the whole basin in contrast with the apparent treated water quality. The cause of this is attributed to the pipelines in the distribution system. Therefore, the improvement of pipelines is recommended.

Municipalities those groundwater are polluted are listed as follows:

In Sofia

Class IV	:	Pirdop

In Plovdiv

Class I	:	Plovdiv
Class III	:	Rakovski
Class IV	:	Saedinenie, , Parvomay

In Pazardjik

Class II	:	Pazardjik

Class III	:	Panagyurishte
Class IV	:	Belovo, Septemvri, Lessichevo

In Haskovo

Class II	:	Haskovo, Dimitrovgrad
Class III	:	Svilengrad
Class IV	:	Harmanly, , Simeonovgrad

In Stara Zagora

Class I	:	Stara Zagora
Class III	:	Radnevo, Galabovo
Class IV	:	Chirpan, Opan,

It should be noted that the water supply source in Pirdop is surface water, not groundwater, and Dimitrovgrad water supply system belongs to the municipality, not Haskovo water supply company.

(2) Improvement Plan

The improvement of water quality depends on the impurities in the water. In general the methods to treat all these substances are as follows;

- For NH_4, Chlorination process is normally used
- For NO_3 and PO_3, coagulation process and filtration process are normally used
- For Fe, aeration process is normally used
- For Mn, aeration process and filtration is normally used

However, for a significantly high concentration of these substances or some heavy metals, a treatment method by a municipal treatment plant may be necessary. Alternatives for heavily polluted water sources in general are summarized as follows:

- Treatment by a municipal water supply treatment plant

- Relocation of the existing water sources to new cleaner sources or a new exploitation of deep wells to avoid the pollutants from the surface water

Therefore, alternatives for the water quality improvement in the basin are proposed as follows:

- Improvement of the existing facilities
- Treatment of the raw water by a municipal water supply treatment plant
- Relocation of the groundwater sources
- Conservation of the surface water
- Protection of the groundwater sources from pollutants' intrusion
- Rehabilitation of the pipelines
- Detailed investigation of the polluted groundwater sources

1) Improvement of the existing facilities

The improvement of the existing facilities is comparatively less expensive.

NH_4 is found to be a major impurity in the groundwater. A slightly high concentration of NH_4 normally can be treated by a Chlorination process. However, for a high concentration of these substances (approximately higher than 3 mg/l), a high concentration of Chlorine is also needed, this will result in a strong odor and taste of the treated water. Therefore, the criteria on the improvement of the existing facilities are proposed as follows:

Wells	NH_4	Cl_2	Improvement
Shallow and deep	No	No	Not necessary
Shallow and deep	No	Yes	Not necessary
Shallow and deep	Slightly high	Yes	Not necessary
Shallow	High (but < 3 mg/l)	Yes	- Increase Cl_2 - Exploit deep wells - Conservation of water sources
Shallow and deep	High (> 3 mg/l)	Yes	- Relocation of wells - Conservation of water sources

It should be noted that the efficiency of the Chlorination process also depends on the age and the depreciation of the facilities.

The future water demand of the municipalities those have polluted groundwater are as follows:

WS Company	Municipality	No. Settlements	No. pumping station		Water demand in 2015 (m^3/d)	
Sofia	Pirdop	4	0	0	4,021	4,021
Plovdiv	Plovdiv	1	4		103,629	
	Parvomay	18	9		26,541	
	Rakovski	7	6		19,335	
	Saedinenie	9	6	25	9,546	159,050
Pazardjik	Pazardjik	29	25		85,043	
	Panagyurishte	11	7		19,420	
	Lessichevo	7	4		8,055	
	Septemvri	10	8		30,024	
	Belovo	7	2	46	8,950	151,493
Haskovo	Haskovo	27	24		48,734	
	Harmanly	21	8		17,431	
	Simeonovgra	7	3		6,653	
	Svilengrad	20	12	47	12,854	85,672
Dimitrovgra	Dimitrovgrad	1	1	1	38,075	38,075
St. Zagora	Galabovo	10	2		11,789	
	Opan	10	13		5,055	
	Radnevo	14	24		17,893	
	Stara Zagora	41	150		74,060	
	Chirpan	17	37	226	16,425	125,221
	Total	271	345	345	563,533	563,533

The amount of the Chlorine dosing rate is about 1 - 5 mg/l for a normal raw water. However, for the raw water with a high concentration of NH_4, a higher Chlorine dosing rate may be used as high as 10 mg/l.

In the basin, the average Chlorine dosing rate is 3.5 mg/l in 1997.

Because data on treated tab water are not available. It is assumed that the above mentioned water demand in 2015 needs to be improved by Chlorination process to reduce NH_4, the additional dosing rate should be about 5 mg/l.

2) Treatment by a municipal water supply treatment plant

The treatment of the raw water by a municipal wastewater treatment plant may not be practical because

- The water quality is still considered not in a serious condition
- The construction cost of a municipal wastewater treatment plant and pipe networks are comparatively high because the existing groundwater and surface water treatment facilities are distributed for almost all settlements in the whole basin

3) Relocation of the water sources

A high concentration of SO_3, PO_3, Fe, Mn and other heavy metals cannot be treated by the improvement of the existing facilities such as a Chlorination process. And also, data on groundwater quality showed that some areas were polluted by the domestic and the industrial wastewater as mentioned in the previous section.

It is recommended that the raw water sources should be relocated or deep groundwater wells should be exploited to avoid the pollutant's infiltration from the soil surface.

4) Conservation of the surface water

The surface water should be conserved because it is evident that the groundwater is contaminated from the contaminated surface water. Therefore, the improvement of surface water shall improve the groundwater quality as well.

5) Protection of the groundwater sources from pollutant's intrusion

The protection of the groundwater sources from the pollutants' intrusion is difficult because the major portion of water is the groundwater from both shallow and deep wells in the unconfined aquifers.

6) Rehabilitation of the pipelines

Although data on treated tab water are not available, the result of JICA Study Team's survey showed that the tab water quality was not satisfied mostly due to the taste and the odor. This is attributed to the intrusion of the impurities due to the leakage of pipelines. The rehabilitation of the pipelines is described in the next section.

7) Detailed investigation of the polluted groundwater sources

The location of polluted groundwater sources should be investigated in more details for the feasibility of the improvement.

Therefore, it can be summarized that

Master plan on the water quality improvement:

- The additional chlorine dosing rate is recommended for the municipalities those groundwater are contaminated to remove NH_4 and the odor
- The relocation of water sources in the contaminated areas is needed to the cleaner areas in order to avoid some impurities those cannot be removed by the existing facilities
- The conservation of the surface water is needed to improve the groundwater quality
- The rehabilitation of the pipelines is needed to protect the impurities' intrusion
- A detailed investigation of the polluted groundwater sources should be conducted to clarify the location and degree of contamination of groundwater sources

4.6 Improvement of Distribution System

(1) Improvement Consideration

It is found that the majority of pipe networks in the basin is the asbestos cement pipe which occupies about 80% of the total pipes or with a length of 7,645 km out of the total 9,487 km in the basin.

However, the asbestos cement pipe has demerits as follows:

- It has no ductility and can be simply broken by the water pressure at the joints.
- It is evident that the corrosion of this kind of pipe is seriously harmful to the human health.

Therefore, the replacement of these pipes is recommended in the master plan.

(2) Improvement Priority

The priority of the replacement is considered from

- National development plan
  According to the national development plan, municipalities are divided into Capital city and Class I – IV cities based on the economic and social development. Priority of the replacement should be set up to in accordance with this plan.

- Size of pipes
  Large pipes are normally used as the main pipes and subject to high water pressure, therefore, the priority is given to these pipes.

- Age of the pipes
  Old pipes have a higher priority to be replaced.

A total length of the asbestos pipes in the basin is summarized as follows:

Water Supply Company	Total length Asbestos pipe (km)
Sofia	243
Plovdiv	3,191
Pazardjik	1,432
Haskovo	1,063
Stara Zagora	1,716
Total	7,645

The priority of the replacement of pipes at present is assumed by classifying the municipalities into Class I, Class II and Class III and IV. Each class should be improved in accordance with the short term (2001-2005), mid term (2006-2010) and long term (2011-2015) plan.

Data from water supply companies show that the age of pipes varies in a wide range from 10 – 50 years and the condition of pipes is almost unknown. Therefore, detailed investigation on the condition of pipes including leakage, corrosion, workability and others is recommended.

Since the data on pipe length in the municipalities in any water supply companies are not available, the population is used for the consideration of priority. A portion of the population in each water supply companies are as follows:

Water Supply Company	Municipality		Population		
	Class	Name	Each	%	Total (100%)
Sofia	IV	Zlatitza	6,590	11.3	
	IV	Pirdop	9,320	16.1	
	IV	Kostenetz	16,006	27.6	
	IV	Dolna Bania	7,711	13.3	
	III	Ihtiman	18,438	31.8	58,065
Plovdiv	I	Plovdiv	341,058	45.6	
	IV	Trud	32,064	4.3	
	IV	Karlovo	76,369	10.2	
	III	Assenovgrad	67,873	9.1	
	IV	Brezovo	10,383	1.4	
	IV	Kaloyanovo	15,144	2.0	
	IV	Parvomay	35,571	4.8	
	III	Rakovski	28,522	3.8	
	IV	Rodoppi	78,802	10.5	
	IV	Stamboliysky	13,155	1.8	
	IV	Sadovo	17,007	2.3	
	IV	Saedinenie	13,348	1.8	
	III	Hisarya	17,960	2.4	747,256
Pazardjik	II	Pazardjik	132,392	54.5	
	IV	Strelcha	6,425	2.6	
	III	Panagyurishte	32,001	13.2	
	IV	Lessichevo	7,042	2.9	
	IV	Septemvri	32,965	13.6	
	IV	Belovo	11,422	4.7	
	IV	Bratzigovo	12,182	5.0	
	IV	Rakitovo	8,672	3.6	243,101
Batak	IV	Batak	7,530	100.0	7,530
Velingrad	IV	Velingrad	43,649	100.0	43,649
Peshtera	III	Peshtera	22,787	100.0	22,787
Smolian	IV	Borino	4,329	11.2	
	IV	Devin	16,575	42.7	
	IV	Lakki	5,199	13.4	
	IV	Chepelare	10,555	27.2	
	IV	Smolian	2,153	5.5	38,811
Haskovo	II	Haskovo	102,001	52.3	
	IV	Mineralniv Bani	7,583	3.9	
	IV	Stambolovo	5,409	2.8	
	III	Harmanli	31,029	15.9	
	IV	Simeonovgrad	11,949	6.1	
	IV	Lyubimetz	12,066	6.2	
	III	Svilengrad	24,986	12.8	195,023
Stara Zagora	IV	Bratya Daskalovi	11,707	4.5	
	III	Galabovo	17,273	6.6	
	IV	Opan	4,425	1.7	
	III	Radnevo	26,088	9.9	
	I	Stara Zagora	174,688	66.4	
	IV	Chirpan	28,834	11.0	263,015
Sliven	III	Nova Zagora	49,566		49,566

The portion of the population in water supply companies can be summarized as follows;

WS company	Class I	Class II	Class III	Class IV	Total
Sofia	0	0	31.8	68.2	100 %
Plodiv	45.6	0	15.3	39.1	100 %
Pazardjik	0	54.5	13.2	32.3	100 %
Haskovo	0	52.3	28.7	19.0	100 %
Stara Zagora	66.4	0	16.5	17.1	100 %

This portion is used in the phasing of the project later.

Therefore, the main items for the improvement of pipelines are

Master plan on rehabilitation of pipelines

- All Asbestos cement pipes should be replaced.
- A detailed investigation on the present condition of the pipes is recommended

In summary, the master plan for water supply should include non-structural and structural measures as follows:

Master plan for water supply

1). Non-structural measures

- The increase of the production of the existing facilities to meet the future water demand and to serve all population
- The investigation on the existing water supply facilities, the groundwater and surface water quality, the leakage, etc.
- The water loss reduction by the improvement of water supply administration
- The improvement of the water quality by water resources conservation

2). Structural measures

- The water loss reduction by the improvement of the physical loss
- The increase of the chemical dosing rate to improve treated water quality
- The rehabilitation of pipelines to increase the water quantity and to improve the water quality
- The relocation of the contaminated water sources to new cleaner sources
- The change of some shallow wells to deep wells to avoid the pollutants from surface water

5. Project Cost Estimation

The project cost estimation includes the cost

- For the improvement of existing facilities : Chlorine dosing rate increase
- For the pipelines rehabilitation : Replacement of asbestos pipes
- For the relocation of groundwater sources : Construction of new wells

5.1 Chlorine Dosing Rate Increase

Additional Chlorine dosing rate of 5 mg/l is proposed to remove the excess NH_4 and the odor for the water demand in 2015 in the contaminated areas.

It is reported that in Sofia city in 1997, the amount of produced water and Chlorine used are as follows:

Amount of produced water	=	195,200,000	m^3/year
Amount of Chlorine used	=	471,237,000	Leva/year
Average dosing rate	=	3.5	mg/l
Unit cost of Chlorine	=	690	Leva/Kg

Therefore, the unit cost of Chlorine is assumed approximately 1 US$/kg

Water demand in 2015 in those contaminated sources and the improvement cost by a Chlorine dosing rate increase are summarized as follows:

WS Company	Water Demand (m^3/d)	Improvement cost	
		US$/d	US$/year
Sofia	4,021	20	7,338
Plovdiv	159,050	795	290,266
Pazardjik	151,493	757	276,475
Haskovo	85,672	428	156,351
Dimitrovgra	38,075	190	69,487
Stara Zagora	125,221	626	228,528
Total	563,533	2,818	1,028,448

This work should be done in the short term plan (year 2001 – 2005) for all water supply companies.

5.2 Cost of Pipelines Rehabilitation

It is recommended that the Asbestos pipes should be replaced by the steel pipes because of its durability.

A unit cost of steel pipe approximately is 11 US$/m, so 15 US$/m is used.

The total cost for pipe replacement is shown as follows:

WS Company	Asbestos pipe (km)	Unit cost (US$/m)	Total cost (US$)
Sofia	243	15	3,645,000
Plovdiv	3,191	15	47,865,000
Pazardjik	1,432	15	21,480,000
Haskovo	1,063	15	15,945,000
Stara Zagora	1,716	15	25,740,000
Total	7,645		114,675,000

The rehabilitation cost can be classified by the class of municipalities in each water supply companies as follows:

WS Company	Total cost (US$)	Portion of municipalities %							
		Class I		Class II		Class III		Class IV	
		%	US$	%	US$	%	US$	%	US$
Sofia	3,645,000	0	0	0	0	31.8	1,159,110	68.2	2,485,890
Plovdiv	47,865,000	45.6	21,826,440	0	0	15.3	7,323,345	39.1	18,715,215
Pazardjik	21,480,000	0	0	54.5	11,706,600	13.2	2,835,360	32.3	6,938,040
Haskovo	15,945,000	0	0	52.3	8,339,235	28.7	4,576,215	19.0	3,029,550
Stara Zagora	25,740,000	66.4	17,091,360	0	0	16.5	4,247,100	17.1	4,401,540
Total	114,675,000		38,917,800		20,045,835		20,141,130		35,570,235

5.3 Cost of Relocation of Contaminated Groundwater Sources

The relocation cost is considered only the construction cost for new groundwater wells, the operation and maintenance cost are not taken in consideration because it is assumed that these are same as before the relocation.

A unit construction cost of a new production well is as follows:

1) A new production well including
   - pumping house
   - electricity system
   - 50 m well depth

   Construction = 35,000 US$/1 station

2) Groundwater exploitation including
   - casing
   - sampling
   - lodging
   - pumping test

   Construction = 100 US$/m depth

Therefore, it is assumed that the total unit cost for construction of a production well is 40,000 US$/station

The number of production wells and the construction cost are calculated as follows:

WS Company	No. of Station	Unit cost (US$/sta)	Total cost (US$)
Sofia	0	40,000	0
Plovdiv	25	40,000	1,000,000
Pazardjik	46	40,000	1,840,000
Haskovo	47	40,000	1,880,000
Dimitrovgrad	1	40,000	40,000
Stara Zagora	226	40,000	9,040,000
Total	345		13,800,000

It should be noted that in Sofia, only Pirdop municipality has polluted groundwater. But Pirdop municipality uses the surface water as a main source, therefore, there is no relocation.

The portion of the population in the municipalities with polluted groundwater sources is

WS Company	Class	Municipality	Population		
			each	by Class	% by Class
Sofia	IV	Pirdop	9,320	9,320	100.0
Plovdiv	I	Plovdiv	341,058	341,058	81.5
	III	Rakovski	28,522	28,522	6.8
	IV	Saedinenie	13,348	48,919	11.7
	IV	Parvomay	35,571		
Pazardjik	II	Pazardjik	132,392	132,392	61.3
	III	Panagyurishte	32,001	32,001	14.8
	IV	Belovo	11,422	51,429	23.8
	IV	Septemvri	32,965		
	IV	Lessichevo	7,042		
Haskovo	II	Haskovo	102,001	102,001	60.0
	III	Svilengrad	24,986	24,986	14.7
	IV	Harmanly	31,029	42,978	25.3
	IV	Simeonovgrad	11,949		
St. Zagora	I	Stara Zagora	174,688	174,688	69.5
	III	Radnevo	26,088	43,361	17.3
	III	Galabovo	17,273		
	IV	Chirpan	28,834	33,259	13.2
	IV	Opan	4,425		

The improvement priority should be done according to the class and population of the municipality, therefore a cost break down of this work is shown below:

Company	(US$)	Class I		Class II		Class III		Class IV	
		%	US$	%	US$	%	US$	%	US$
Sofia	0	0	0	0	0	0	0	0.0	0
Plovdiv	1,000,000	81.5	815,000	0	0	6.8	68,000	11.7	117,000
Pazardjik	1,840,000	0	0	61.3	1,127,920	14.8	272,320	23.8	437,920
Haskovo	1,880,000	0	0	60	1,128,000	14.7	276,360	25.3	475,640
Dimitrovgrad	40,000	0	0	100	40,000	0	0	0.0	0
Stara Zagora	9,040,000	69.5	6,282,800	0	0	17.3	1,563,920	13.2	1,193,280
Total	13,800,000		7,097,800		2,295,920		2,180,600		2,223,840

6. Phasing of Water Supply Improvement

The phasing of the master plan is divided into 4 parts, those are

1.	Preparation period	:	year 1999 – 2000
2.	Short term plan	:	year 2001 – 2005
3.	Medium term plan	:	year 2006 – 2010
4.	Long term plan	:	year 2011 – 2015

(1) Preparation Period

This period is to build up a firm foundation for the implementation program. The water supply improvement in this period should be focussed in the data collection on the existing condition of water supply facilities especially the pipelines, the condition of the raw water sources both groundwater and surface water and the treated water. The investigation in this period plays a crucial role in the water supply improvement plan in the next periods.

(2) Short Term Period

This period is the first stage for the implementation program. It is recommended that the implementation programs which can be carried out immediately with comparatively low budget should be done at first, these are

1) Increase of the production capacity to meet the future water demand
The existing facilities are capable to produce sufficient water supply for the future demand, but have not been fully utilized. Therefore, the production should be increased to meet the future water demand.

2) Water supply monitoring
The monitoring of water supply quantity should be done for the whole groundwater and surface water sources. Water meters and flow meters should be installed at the well sites and the water intakes in order to measure the quantity of the raw water.

3) Increase of the chemical dosing rate

The chlorine dosing rate should be increased in some polluted production wells and some areas those treated water quality is higher than the standard. The implementation should be done for all water supply companies based on the result of the investigation in the preparation period and should be completed in this period since the operation cost is also comparatively low.

4) Improvement of water loss

The target of water loss reduction is 45 % (physical loss 27 % and administration loss 18 %). Detailed implementation can also be done based on the result of the investigation in the preparation period. The administration loss can be improved by the management of water supply companies. The physical loss is expected to be improved after the replacement of the pipelines in this period and some rehabilitation of the pipes and the connections.

5) Replacement of pipelines

In this period, the pipelines in the Class I and II municipalities should be replaced. Since each water supply companies has a main municipality which is in either Class I or II, the improvement should be implemented in the main municipality first.

(3) Medium Term Period

This period is considered as the starting period for the full implementation program. All necessary items should be started or carried on in this period. The proposed programs are

1) Increase of the production capacity to meet future water demand

The production should be increase to meet the future water demand in this period.

2) Improvement of water loss

The target of water loss reduction is 29 % (physical loss 16 % and administration loss 13 %). The implementation should be compatible with the short term program. The improvement of water loss both physical and administration loss should be enhanced to meet the target in this period.

3) Replacement of pipelines

In this period, the pipelines in the Class III municipalities should be replaced. After the completion of the short term plan, the pipelines in the minor municipalities should be improved.

4) Relocation of contaminated wells

The relocation of the contaminated wells should be done based on the result of the detailed investigation. Some polluted wells may not be relocated if the treated water is still in the standard limit. However, in the case that polluted wells are necessary to be relocated, the priority should be put on the class of municipalities from the population and the economical growth aspects. Therefore, in this medium term plan, it is proposed that the relocation of wells should be done for the Class I and II first.

(4) Long Term Period

This period is considered as the last period that all the necessary implementation programs for the water supply improvement should be completed.

1) Increase of the production capacity to meet the future water demand

The production should be increased to meet the future water demand in the target year.

2) Improvement of water loss

The target of water loss reduction is 20 % (physical loss 10 % and administration loss 10 %). The implementation should also be compatible with the short term and the medium term program. It is expected that after this period, all water supply system in the basin will meet the requirement of international standard quantitatively and qualitatively.

3) Replacement of pipelines

In this period, the remaining pipelines in the Class IV municipalities should be replaced. After this period, the asbestos pipelines will be replaced completely and the

physical loss can be reduced to the target after the completion of the pipelines replacement as well.

4) Relocation of contaminated wells

The relocation of the contaminated wells in this period should also be based on the results of the investigation. If necessary, the relocation of wells in Class III and IV municipalities are to be completed in this period.

Therefore, the phasing of water supply improvement is summarized as follows:

Phasing of water supply improvement

1). Preparation period : 1999 – 2000

- Investigation on the existing water supply facilities, the groundwater and surface water quality, the leakage, etc. for all water supply companies

2). Short term plan : 2001-2005

- Increase of the production capacity to meet the water demand until 2005 for all water supply companies
- Monitoring of water supply quantity by the installation of water meters
- Increase of the chemical dosing rate to improve the treated water quality for all municipalities with contaminated groundwater sources (1)
- Improvement of water loss : Physical loss to 27%
  Administration loss to 18%
- Replacement of the pipelines in Class I and II municipalities (2)

Summary of Cost

(1) Increase Chemical dosing	=	1,028,448	US$/year
(2) Replacement of pipelines (class I and II)	=	38,917,800 + 20,045,835	
	=	58,963,635	US$

Note : Classification of municipalities are as follows:

Class I : Plovdiv and Stara Zagora

Class II : Pazardjik, Haskovo and Dimitrovgrad

Class III : Nova Zagora, Panagyurishte, Radnevo, Peshtera, Svilengrad, Ihtiman, Rakovski, Assennovgrad, Stamboliyski, Harmanli, Galabovo and Hissaria

Class IV : Simeonovgrad, Kritchim, Sadovo, Saedinenie, Belovo and others

3). Medium term plan : 2006-2010

- Increase of the production capacity to meet the water demand until 2010 for all water supply companies
- Improvement of water loss : Physical loss to 16%
  Administration loss to 13%
- Replacement of the pipelines in Class III municipalities [3]
- Relocation of the contaminated wells in Class I and II municipalities [4]

Summary of Cost

(3) Replacement of pipelines (class III)	=	20,141,130	US$/year
(4) Relocation of wells (class I and II)	=	7,097,800 + 2,295,920	
	=	9,393,720	US$

4). Long term plan : 2011-2015

- Increase of the production capacity to meet the water demand until 2015 for all water supply companies
- Improvement of water loss : Physical loss to 10%
  Administration loss to 10%
- Replacement of the pipelines in Class IV municipalities : The remaining municipalities in the basin [5]
- Relocation of the contaminated wells in class III and IV municipalities [6]

Summary of Cost

(5) Replacement of pipelines (class IV)	=	35,570,235	US$/year
(6) Relocation of wells (class III and IV)	=	2,180,600 + 2,223,840	
	=	4,404,440	US$

TABLE F.1.1 WATER SUPPLY COMPANIES, MUNICIPALITIES AND POPULATION IN THE MARITZA RIVER BASIN

Region	Water Supply Company	Owner	Municipality		Population in 1995		
					Urban	Rural	Total
Sofia	Sofia	State	1	Zlatitza	5,635	955	6,590
			2	Pirdop	8,373	947	9,320
			3	Kostenetz	10,641	5,365	16,006
			4	Dolna Bania	4,992	2,719	7,711
			5	Ihtiman	12,860	5,578	18,438
Plovdiv	Plovdiv	State	1	Plovdiv	341,058	0	341,058
			2	Trud	0	32,064	32,064
			3	Karlovo	45,243	31,126	76,369
			4	Assenovgrad	52,360	15,513	67,873
			5	Brezovo	2,280	8,103	10,383
			6	Kaloyanovo	0	15,144	15,144
			7	Parvomay	16,809	18,762	35,571
			8	Rakovski	15,799	12,723	28,522
			9	Rodoppi	27,362	51,440	78,802
			10	Stamboliysky	13,155	0	13,155
			11	Sadovo	2,647	14,360	17,007
			12	Saedinenie	6,801	6,547	13,348
			13	Hisarya	9,149	8,811	17,960
	Pazardjik	State	14	Pazardjik	80,921	51,471	132,392
			15	Strelcha	5,063	1,362	6,425
			16	Panagyurishte	20,944	11,057	32,001
			17	Lessichevo	0	7,042	7,042
			18	Septemvri	9,365	23,600	32,965
			19	Belovo	5,016	6,406	11,422
			20	Bratzigovo	5,022	7,160	12,182
			21	Rakitovo	8,672	0	8,672
	Batak	Municipality	22	Batak	4,468	3,062	7,530
	Velingrad	Municipality	23	Velingrad	26,020	17,629	43,649
	Peshtera	Municipality	24	Peshtera	20,002	2,785	22,787
	Smolian	State	25	Borino	0	4,329	4,329
			26	Devin	6,411	10,164	16,575
			27	Lakki	3,461	1,738	5,199
			28	Chepelare	6,264	4,291	10,555
			29	Smolian	0	2,153	2,153
Haskovo	Haskovo	State	1	Haskovo	80,700	21,301	102,001
			2	Mineralniv Bani	0	7,583	7,583
			3	Stambolovo	0	5,409	5,409
			4	Harmanli	21,349	9,680	31,029
			5	Simeonovgrad	8,294	3,655	11,949
			6	Lyubimetz (partly)	8,499	3,567	12,066
			7	Svilengrad	18,643	6,343	24,986
	Stara Zagora	State	8	Bratya Daskalovi	0	11,707	11,707
			9	Galabovo	9,473	7,800	17,273
			10	Opan	0	4,425	4,425
			11	Radnevo	14,203	11,885	26,088
			12	Stara Zagora	149,666	25,022	174,688
			13	Chirpan	19,694	9,140	28,834
Burgas	Sliven	State	1	Nova Zagora	26,260	23,306	49,566
			2	Tundja (partly)	-	-	-

TABLE F.2.1 TOTAL POPULATION IN WATER SUPPLY COMPANIES

Water Suppy Company	1996	1995	1994	1993	1992
Sofia	240,088	240,713	241,100	246,538	251,646
Plovdiv	733,025	733,025	-	-	-
Pazardjk	236,749	236,749	236,749	236,749	236,749
Stara Zagora	416,338	416,338	416,338	416,338	416,338
Haskovo	196,296	196,296	196,296	196,296	196,296

TABLE F.2.2 POPULATION SERVED BY WATER SUPPLY COMPANIES

Water Suppy Company	1996	1995	1994	1993	1992
Sofia	69,317	69,394	70,335	70,854	71,799
Plovdiv	733,025	733,025	-	-	-
Pazardjk	236,749	236,749	236,749	236,749	236,749
Stara Zagora	270,269	270,269	270,269	270,269	270,269
Haskovo	195,988	195,988	195,988	195,988	195,719

TABLE F.2.3 WATER SUPPLY USE WITH AND WITHOUT FLOW METER (m^3/y)

Water Suppy Company	1996	1995	1994	1993	1992
Sofia	5,111,000	7,193,000	7,963,000	7,859,000	-
Plovdiv	45,353,000	47,390,000	52,855,000	59,135,000	69,472,000
Pazardjk	11,858,000	11,802,000	15,222,000	15,968,000	19,072,000
Stara Zagora	20,509,000	22,188,000	23,904,000	26,996,000	30,310,000
Haskovo	10,878,000	11,768,000	12,414,000	14,938,000	21,645,000

TABLE F.2.4 UNIT WATER SUPPLY USE (m3/c/d)

Water Suppy Company	1996	1995	1994	1993	1992
Sofia	0.202	0.284	0.310	0.304	-
Plovdiv	0.170	0.177	-	-	-
Pazardjk	0.137	0.137	0.176	0.185	0.221
Stara Zagora	0.208	0.146	0.157	0.178	0.199
Haskovo	0.152	0.165	0.174	0.209	0.303

Note : Unit water supply use= WS use/Served population in Maritza river basin by WS company
(but for Stara Zagora, Unit water supply use= WS use/Served population by WS company)

TABLE F.2.5 PORTION OF WATER SUPPLY USE

Municipality	Water use in 1996							
	domestic		public services		indusry, agric., etc		Total	
	(m3/y)	%	(m3/y)	%	(m3/y)	%	(m3/y)	%
Sofia	1,998,401	39.1	2,667,942	52.2	444,657	8.7	5,111,000	100.0
Plovdiv	28,602,000	63.1	0	0.0	16,751,000	36.9	45,353,000	100.0
Pazardjik	7,723,000	65.1	2,185,000	18.4	1,950,000	16.4	11,858,000	100.0
Stara Zagora	8,704,000	42.4	5,790,000	28.2	6,015,000	29.3	20,509,000	100.0
Haskovo	6,327,000	58.2	1,170,000	10.8	3,381,000	31.1	10,878,000	100.0

TABLE F.2.6 CAPACITY OF EXISTING FACILITIES FOR SURFACE WATER AND GROUNDWATER UTILIZATION

Water Supply Company	Surface water		Groundwater		Total	
	(l/s)	(m3/y)	(l/s)	(m3/y)	(l/s)	(m3/y)
Sofia	no data					
Plovdiv	213.5	6,733,251	8,633.6	272,270,156	8,847.1	279,003,407
Pazardjik	144.0	4,540,000	2,071.7	65,332,000	2,215.6	69,872,000
Strara Zagora	0.0	0	1,984.6	62,587,100	1,984.6	62,587,100
Haskovo	174.0	5,487,264	1,329.1	41,913,170	1,503.1	47,400,434
Total	531.5	16,760,515	14,019.0	442,102,426	14,550.4	458,862,941

TABLE F.2.7 WATER SUPPLY QUANTITY AND USE IN 1996

Water Supply Company	**Qp** m3/y	**Qs** m3/y	**Qu** m3/y	Loss % (Qs-Qu/Qs)
Sofia	-	7,301,429	5,111,000	30.00
Plovdiv	279,003,407	100,171,000	45,353,000	54.72
Pazardjik	69,872,000	25,336,000	11,858,000	53.20
Strara Zagora	62,587,100	46,838,000	20,509,000	56.21
Haskovo	47,400,434	18,920,000	10,878,000	42.51
Total	458,862,941	198,566,429	93,709,000	

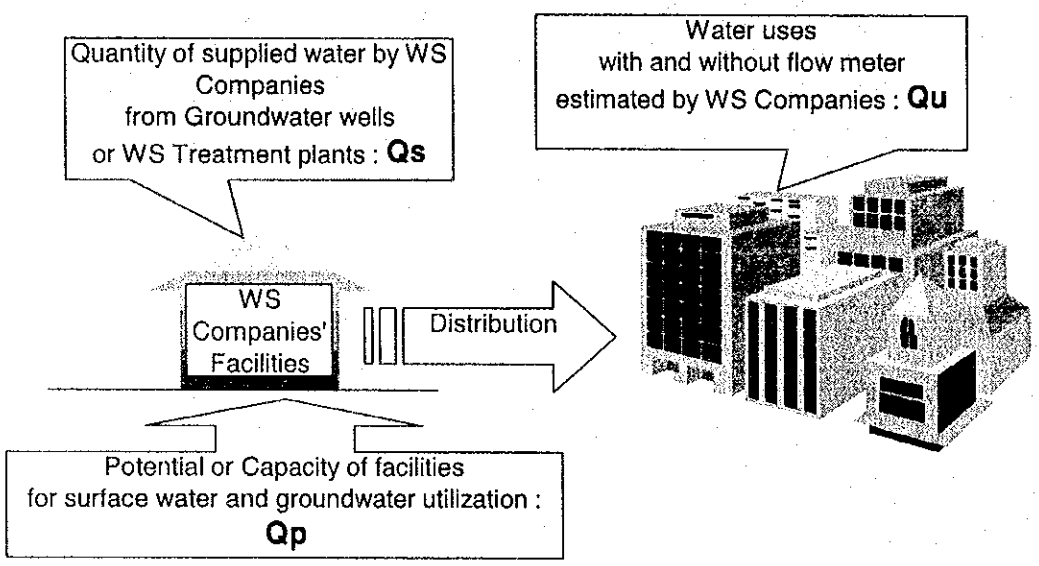


TABLE F.2.8(1) BULGARIAN DRINKING WATER STANDARD (BDS2823)

Bulgarian State Standard

POTABLE WATER

This standard applies ot potable water from central water sources, used for households and for potable water, as well as industrial consumers and in cases where water meeting the requirements for potable water is required. The standard defines the criteri

Contamination with toxic chemical substances, radioactive waste and pahogenic microorganisms is not permitted.

Potable water should meet the following criteria after treatment and decontamination:

1. ORGANOLEPTIC INDICES

	Index	Norm	Method of testing
1.	Color according to the Rublyov scale , in degrees , not more than	15	BDS - 8451-77
2.	Odour	2	BDS - 8451-77
3.	Taste	tasteless	BDS - 8451-77
4.	Turbidity in mg/dm3	1.5	BDS - 15149-80

TABLE F.2.8(2) BULGARIAN DRINKING WATER STANDARD (BDS2823)

2. PHYSICO-CHEMICAL INDICATORS

Index	Norm	Method of testing
1. Temperature °C	from 6 to 16	BDS - 8451-77
2. Total hardness , mg/Σqv/dm^3 *not more than*	12	BDS - 3775-81
3. Acidity /pH/	from 6,5 to 8,5	BDS 3424-81
4. Oxidability *In mg/dm3 Oxygen*	2.6	BDS 3413-77
5. Amonia /NH_4^+/	not permitted	BDS 3587-79
6. Nitrates /NO_2^-/	not permitted	BDS 3762-81
7. Nitrates /NO_3^-/ in mg/dm3, *not more than*	50	BDS 3758-76
8. Chlorides /Cl^-/ in mg/dm3 , *not more than*	250	BDS 3414-80
9. Dry resigue by 105 °C *in mg/dm3 , not more than*	1000	BDS 3546-77
10 Phosphates/PO_4^{3-}/ in mg/dm3 *not more than*	0.5	BDS 7210-75
11. Sulphates /SO_4^{2-}/ in mg/dm3 , *not more than*	250	BDS 3588-77
12. Magnezium /Mg^{2+}/ in mg/dm3 , *not more than*	80	BDS 7211-82
13. Calsium /Ca^{2+}/ in mg/dm3 , *not more than*	150	BDS 7207-82
14. Total iron /like Fe^{3+} + Fe^{2+}/ *in mg/dm3 , not more than*	0.2	BDS 3425-76
15. Zink /Zn2+/ in mg/dm3 , not more than	5	BDS 15107-80
16. Copper /Cu2+/ in mg/dm3 , not more than	0.2	BDS 3770-80
17. Manganese /Mn2+/ in mg/dm3 , not more than	0.1	BDS 3559-76
18. Fluorine /F-/ in mg/dm3 , not more than	1.5	BDS 3571-79
19. Barium /Ba2+/ in mg/dm3 , not more than	1	BDS 7208-75
20. Lead /Pb2+/ in mg/dm3 , not more than	0.05	BDS 15109-80
21. Arsenic /As3+/ in mg/dm3 , not more than	0.05	BDS 3570-79
22. Chromium six valency /Cr^{6+}/ in mg/dm3 , *not more than*	0.05	BDS 7212-78
23. Selenium /Se2+/ in mg/dm3 , less than	0.01	BDS 7213-78
24. Cadmium /Cd2+/ in mg/dm3 , not more than	0.01	BDS 7320-69
25. Uranium /U2+/ in mg/dm3 , not more than	0.6	BDS 12578-75
26. Resigue active chlorine after 30 minute contact of chlorine with the water , in mg/dm3	from 0,3 to 0,4	BDS 3560-81

Note:

1. Content of calcium and magnese permit in norm values but their sum should not exceed total
2. Permitted of manganese quantity /Mn^{2+}/ is up to 0.2 mg/dm^3 provided that the Manganese and Iron total quantities does not exceed 0.3 mg/dm^3
3. In cases of presence f one or two of the highly toxic elements: lead, cadmium, chromium and uraniumat the their concentration measured according to Formula (1) should be less or equal

   c1/C1 + c2/C2 +c3/C3 + c4/C4 <=1 **(1)**

   c1, c2, c3, c4 - established element concentrations in mg/dm^3

   C1, C2, C3, C4 - permitted element concentration in mg/dm^3
4. Admissible contents of other elements from industrial, agricultural and domestic polluters are

TABLE F.2.8(3) BULGARIAN DRINKING WATER STANDARD (BDS2823)

3. Radiologic indexes

	Index	Norm	Testing method
1.	Stronium-90 /Sr^{90}/ in mg/dm^3 no more than	3700	BDS 12576-75
2.	Radium-226 /Ra^{226}/ in mBq/dm^3 no more than	150	BDS 12575-75
3.	Total beta activity /mixture from radioactive substances with unidentified isotope and percentage composition/ in mBq/dm^3 no more than	750	BDS 12577-75

Note:
Content of stronium-90,radium-226 and mixture of radioactive substances with unidentified isotopecomposition /item 1,2,3/ is always determined for new water sources for central potable water supply and when operating them - in

4. Microbiological Indexes

	Indexes	Norm
1.	Microbal number /.../ no more than	50
2.	Coli-titre, in cm^3 more than	100

5. Biological Indexes

1.	Content of naked eye organisms	not permitted
2.	Content of the round worm representatives /Nematoda/	not permitted
3.	Content of phytoplankton cells, in nuber cells of cm^3, no more than	100
4.	Content of seston, in cm^3/m^3, no more than	1

Note:
determined by methods recommended from Hygiene and disease linked to uncertain

6. Water Quality Control

6.1 The sytematic production control of water quality is the responsibility of the water supply enterprises.

6.2 The Ministry of Health shall carry out periodic control, when informed of water quality problems by third parties, and in cases of existing disorders in hygiene proection and/or decontamination of

6.3 In cases of dispute, control tests of the water shall be carried out by the Hygiene Epidemiologic

6.4 Permits for usage of water for drinking which do not comply with this standard shall be issued only

6.5 The overall control of the execution of this standard whall be carried out by the Ministry of Construction and Architecture and the Ministry of Public Health.

TABLE F.2.9(1) GROUNDWATER QUALITY IN PLOVDIV REGION (RAW WATER)

W&S company	Pumping station	Raw water - mg/l														
		Data	pH	Cl^-	NO_2^-	NO_3^-	PO_4^{3-}	NH_4^+	Mg^{2+}	Ca^{2+}	Total Fe	Mn^{2+}	Hardnes	HCO_3^-	SO_4^{2-}	Zn^{2+}
Plovdiv		.V.1997	7.9	27	2.23	48	0.4	0	28	188	<0.1	<0.05	11.7	369	206	<0.05
	"KSM"	.X.1997	8	15	0	19	<0.2	0	12	98	<0.1	<0.05	5.9	270	49	<0.05
		.V.1997	7.9	14	0	8	0.2	0	8	69	<0.1	<0.05	4.1	188	41	<0.05
	"Katunitz	.X.1997	7.8	12	0	23	<0.2	0	11	84	<0.1	<0.05	5.1	223	33	<0.05
	"Plovdiv" - East I	.V.1997	7.9	16	0.04	9	1	0	16	56	<0.1	<0.05	4.1	232	34	<0.05
	"Plovdiv" - East II	.V.1997	7.5	47	0	61	0.6	0	30	98	<0.1	<0.05	7.4	217	116	<0.05
		.X.1997	7.6	46	0	63	0.2	0	29	102	<0.1	<0.05	7.5	220	119	<0.05
	"Plovdiv" -North	.V.1997	7.9	19	0.04	8	0.4	0	15	80	<0.1	<0.05	5.2	284	66	<0.05
		.X.1997	8	18	0	8	0.4	0	15	82	<0.1	<0.05	5.3	284	70	<0.05
	"Plovdiv" -South	.V.1997	7.8	10	0.01	5	0.6	0	14	52	<0.1	<0.05	3.8	203	29	<0.05
	"Parvoma y"-East	.V.1997	7.9	19	0.04	30	1.2	0	18	100	<0.1	<0.05	6.5	344	119	<0.05
		.X.1997	7.8	20	0	25	0.2	0	18	96	<0.1	<0.05	6.2	331	107	<0.05
	"Stoletov	.IX.1995	8.3	11	0	17	0.4	0	20	57	<0.1	<0.05	4.4	223	26	0.05
		.IV.1996	7.7	11	0	18		0	21	55	<0.1	<0.05	4.5	209	24	<0.05
		.X.1996	7.8	11	0	28	<0.05	0	21	59	<0.1	<0.05	4.7	224	27	<0.05
		.IV.1997	7.4	10	0	18	<0.2	0	22	56	<0.1	<0.05	4.6	215	28	<0.05
		.IX.1997	7.2	12	0	20	<0.2	0	22	60	<0.1	<0.05	4.8	237	27	<0.05
	"Bogdan"	.VI.1995	7.8	12	0	4	0.4	0	10	10	<0.1	<0.05	2.6	113	38	<0.05
		.IV.1996	7.1	14	0	17	0.6	0	11	11	<0.1	<0.05	2.7	98	37	<0.05
		.X.1996	7.7	16	0	24	0.1	0	13	13	<0.1	<0.05	3.2	117	46	<0.05
		.IV.1997	7	9	0	12	0.2	0	10	10	<0.1	<0.05	2.4	98	32	<0.05
		.IX.1997	6.8	14	0	19	0.4	0	38	38	<0.1	<0.05	2.8	120	40	<0.05
	"Dabene"	.VI.1995	7.8	13	0	22		0	11	33	<0.1	<0.05	2.6	91	33	<0.05
		.IV.1996	7.2	11	0	21	0.2	0	10	32	<0.1	<0.05	2.4	89	32	<0.05
		.X.1996	6.8	11	0	28	<0.05	0	10	34	<0.1	<0.05	2.6	90	37	<0.05
		.IV.1997	6.9	12	0	18	0.2	0	11	32	<0.1	<0.05	2.5	85	37	<0.05
		.IX.1997	6.8	10	0	25	0.2	0	10	32	<0.1	<0.05	2.4	94	38	<0.05

TABLE F.2.9(2) GROUNDWATER QUALITY IN PAZARDJIK REGION (RAW WATER)

W&S company	Pumping station	Raw water - mg/l													
		Data	pH	Cl^-	NO_2^-	NO_3^-	PO_4^{3-}	NH_4^+	Mg^{2+}	Ca^{2+}	Total Fe	Mn^{2+}	Hardnes	HCO_3^-	SO_4^{2-}	Zn^{2+}
Pazardjik	"Panaguri	.IX.1995	7.3	13	0.01	13	0	0	13	61	<0.1	<0.05	4.1	196	34	<0.05
		.V.1996	7.8	19	0	21	1.2	0	11	64	<0.1	<0.05	4.1	189	32	<0.05
		.IX.1996	6.9	16	0	14	0.1	0	12	63	<0.1	<0.05	4.2	199	35	<0.05
		.V.1997	8.2	16	0.01	14	0.4	0	13	62	<0.1	<0.05	4.2	190	39	<0.05
		VIII.1997	7.7	15	0	0	0.6	0	12	73	<0.1	<0.05	4.6	220	47	<0.05
	"Unatsite	.IX.1995	7.3	24	0	4	0.2	0	19	86	0.1	<0.05	5.8	199	134	<0.05
		.V.1996	8	26	0	6	0.6	0	26	89	<0.1	<0.05	6.6	201	129	<0.05
		.IX.1996	7.2	21	0	4	0.1	0.002	19	80	<0.1	<0.05	5.6	187	121	<0.05
		.V.1997	7.9	24	0	11	0.6	0	19	84	<0.1	<0.05	5.8	186	131	<0.05
		VIII.1997	7.5	25	0	0	0.6	0	18	84	<0.1	<0.05	5.7	192	135	<0.05
	"Karaman tepe"	.IX.1995	8.6	13	0	10	0	0	11	64	0.2	<0.05	4.1	177	45	<0.05
		.V.1996	7.3	15	0	21	1.2	0	8	66	<0.1	<0.05	4	199	35	<0.05
		.IX.1996	7.3	13	0	12	0.15	0	10	62	<0.1	0.05	4	199	38	<0.05
		.V.1997	7.8	13	0	17	0.6	0	10	64	<0.1	<0.05	4.1	208	41	<0.05
		VIII.1997	7.6	15	0	21	1.2	0	11	66	<0.1	<0.05	4.2	197	54	<0.05
	"Ogniano	.IX.1995	7.5	7	0	7	0.4	0	10	51	<0.1	<0.05	3.4	177	37	<0.05
		.V.1996	7.5	13	0.12	10	1.2	0.002	11	53	<0.1	<0.05	3.6	186	30	<0.05
		.IX.1996	7.6	11	0	6	<0.05	0	6	52	<0.1	<0.05	3.1	184	25	<0.05
		.V.1997	8	10	0	9	0.6	0	17	52	<0.1	<0.05	4	186	40	<0.05
		VIII.1997	7.7	10	0	8	1.2	0	12	52	<0.1	<0.05	3.6	178	41	<0.05
	"Kadievo -	.IX.1995	7.5	14	0	13	0	0	16	93	<0.1	<0.05	6	311	32	<0.05
		.V.1996	7.5	53	0	23	1	0.002	17	101	<0.1	<0.05	6.4	261	30	<0.05
		.IX.1996	7.4	16	0	13	0.05	0	15	96	<0.1	<0.05	6.1	323	33	<0.05
		.V.1997	7.7	16	0	14	0.6	0	14	95	<0.1	<0.05	5.6	309	29	<0.05
		VIII.1997	8.2	14	0.04	16	0.4	0	15	91	<0.1	<0.05	5.8	311	30	<0.05

TABLE F.2.9(3) GROUNDWATER QUALITY IN HASKOVO REGION (RAW WATER)

W&S company	Pumping station	Raw water - mg/l											
		Data	pH	Cl	NO_2	NO_3	PO_4^{3-}	NH_4^+	Mg^{2+}	Ca^{2+}	Total Fe	Mn^{2+}	Hardness
Haskovo	"North	.V.1995	8.0	61	0	36	0.5	0	63	113	<0.1	<0.05	10.8
	"Uzundjovo"	.V.1995	8.3	50	0.02	36	1.2	0.01	36	66	<0.1	<0.05	6.2
	"East	.V.1995	7.6	27	0.02	29	1.4	0.01	18	88	<0.1	<0.05	5.9
	"Haskovo"PS	.V.1995	7.8	19	0	14	1.2	0.005	12	67	<0.1	0.15	4.3
	"Bryagov	.V.1995	7.8	50	0	4	0.8	0.004	19	74	<0.1	0.40	5.2
	"Dinevo"	.V.1995	8.3	19	0	10	1.4	0.008	16	70	<0.1	<0.05	4.7
	"Knizhov	.V.1995	7.9	39	0.02	23	0.4	0	19	112	<0.1	<0.05	7.2

TABLE F.2.10 GROUNDWATER QUALITY IN HASKOVO REGION (TREATED WATER)

W&S company	Pumping station	Treated water- mg/l data	pH	Cl	NO_2	NO_3	PO_4^{3-}	NH_4^{+}	Mg^{2+}	Ca^{2+}	Total Fe	Mn^{2+}	Hardness
Haskovo	"North	.VI.1995	6.8	59	0	59.0	0.035	0	51.07	128.16	0	0	10.6
	"Uzundjovo"	.IV.1995	7.0	45	0	24.5	-	0	0				5.1
	"East	.IV.1995	7.0	25	0	23.0	-	0					5.3
	"Haskovo"PS	.V.1995	7.0	22	0	19.0		0					4.5
	"Bryagov	.V.1995	6.8	50	0	0.65		0.415				0.75	5.0
	"Dinevo"	.V.1995	6.5	40	0	20.0		0					5.0
	"Knizhov	.VI.1995	6.8	39	0	32.0		0					7.0

TABLE F.2.11 CAPACITY OF POTABLE TREATMENT PLANTS

WS company	Municipality	Potable water treatment plant (name/location)	Water Source		Capacity		Capacity in region (m3/y)
			Type	Name	(l/s)	(m3/y)	
Sofia	Zlatitza	Zlatitza	Surface	Zlatitza	35.0	1,103,760	
	Pirdop	Pirdop	Surface	Pirdopska	90.0	2,838,240	
	Pirdop	Koprivshtitza	Surface	Topolnitza	40.0	1,261,440	
	Dolna Banya	Raduil	Surface	Maritza	110.0	3,468,960	
	Kostenetz	Chavcha	Surface	Chavcha	40.0	1,261,440	
	Ihtiman	Gabra for Vakarel	Surface	Iskar Dam	20.0	630,720	10,564,560
Plovdiv	Plovdiv	Hrabrino	Surface	Tamrashka	100.0	3,153,600	
	Hisarya	Krastevich	Surface	Kalovashtitza	3.0	94,608	
	Hisarya	Starosel	Surface	Rakovitza	12.0	378,432	
	Rodopi	Stara river	Surface	Sed. Tank WEPS	60.0	1,892,160	
	Rodopi	Pepelash	Surface	Pepelasha	12.0	378,432	
	Karlovo	Kalofer	Surface	Ponitzite	20.0	630,720	
	Karlovo	Sushitza	Surface	Goliamata	6.0	189,216	6,717,168
Pazardjik	Strelcha	Strelca	Surface	St. Luda Iana	45.0	1,419,120	
	Panagyurishte	Panagyurishte	Surface	Mulevska	35.0	1,103,760	
	Panagyurishte	Panagyurski Koloni	Surface	Rogochovska	18.0	567,648	
	Panagyurishte	Oborishte	Surface	Panova	18.0	567,648	
	Panagyurishte	Elshitza	Surface	Elshishka	6.0	189,216	
	Belovo	Belovo	Surface	Iadenitza	3.0	94,608	
	Belovo	Momina Klisuru	Surface	Cherna	6.0	189,216	
	Belovo	Sestrimo	Surface	Kriva	20.0	630,720	4,761,936
Haskovo	Simeonovgrad	Simeonovgrad	Ground	-	90.0	Under Construction	
	Harmanli	Harmanli	Ground	-	140.0	Under Construction	
	Haskovo	Trakietz Dam	Surface	Trakietz	200.0	Under Construction	
	Haskovo	Iabalkovo	Ground	-	660.0	20,813,760	20,813,760
St.Zagora	No potable water treatment plant						

Note : - Sources from Water Supply Companies in 1997
- Capacity in m3/y is calculated from l/s*60*60*24*365/1,000

TABLE F.2.12 (1) PIPE SYSTEM BY SOFIA WATER SUPPLY COMPANY

1. Zlatitza

Diameter (mm)	ø60	ø80 ø89	ø100 ø108	ø125	ø150 ø159	ø200 ø219	ø250 ø273	ø300 ø325	ø350	ø400	ø475
Asbestos cement	11,5	46,0	5,8	8,0	8,4	-	-	-	-	-	-
Steel	-	-	22,9	-	2,5	2,5	-	3,2	-	-	-

2. Pirdop

Diameter (mm)	ø60	ø80 ø89	ø100 ø108	ø125	ø150 ø159	ø200 ø219	ø250 ø273	ø300 ø325	ø350	ø400	ø475
Asbestos cement	-	8,5	1,2	-	1,5	48,9	-	-	-	-	-
Steel	-	-	-	-	-	-	-	-	-	-	-

3. Ihtiman

Diameter (mm)	ø60	ø80 ø89	ø100 ø108	ø125	ø150 ø159	ø200 ø219	ø250 ø273	ø300 ø325	ø350	ø400	ø475
Asbestos cement	22,8	0,5	-	-	7,0	-	-	5,4	5,2	25,4	10,8
Steel	-	2,8	-	-	-	-	-	-	-	-	-

4. Kostenetz

Diameter (mm)	ø60	ø80 ø89	ø100 ø108	ø125	ø150 ø159	ø200 ø219	ø250 ø273	ø300 ø325	ø350	ø400	ø475
Asbestos cement	1,0	4,8	-	-	-	4,5	7,8	-	-	7,5	-
Steel	-	-	-	-	-	-	-	-	-	-	-

5. Dolna Banya (water mains which are exploited together with Kostenetz are included in Kostenetz)

Pump stations for the separate settlements in the region

1. Zlatitza

N	Name of the pump station	Length of the pressure pipeline	Diameter of the pressure pipeline	Geodesic displacement	Working capacity
		km	mm	m	l/s
1.	Bodyat	0.5	100	100	5.0
2.	Kamenitza	1.5	150	220	7.0
3.	Petrich	1.6	125	80	11.0
4.	Benkovski	1.1	80	110	5.0

2. Pirdop – no Pump station

TABLE F.2.12 (2) PIPE SYSTEM BY SOFIA WATER SUPPLY COMPANY

3. Ihtiman

N	Name of the pump station	Length of the pressure pipeline	Diameter of the pressure pipeline	Geodesic displacement	Working capacity
		km	mm	m	l/s
1.	Boeritza	1.5	89	115	5
2.	Stambolovo	2.5	159	110	20
3.	Verinsko	1.2	125	145	8
4.	Zhivkovo	5.4	159	60	11
5.	Paunovo	1.5	80	110	5
6.	Borika	2.1	89	70	4

4. Kostenetz

N	Name of the pump station	Length of the pressure pipeline	Diameter of the pressure pipeline	Geodesic displacement	Working capacity
		km	mm	m	l/s
1.	Gledjova	2.1	89	45	6
2.	Ochusha	2.0	159	120	8

5. Dolna Banya

N	Name of the pump station	Length of the pressure pipeline	Diameter of the pressure pipeline	Geodesic displacement	Working capacity
		km	mm	m	l/s
1.	Gutzal	3.5	108	160	5

TABLE F.2.12(3) PIPE SYSTEM BY PLOVDIV WS COMPANY

Diameter (mm)	Type of pipes	Length (km)
60	Manesman	31.00
	Asbestos cement	675.00
	Cast iron	2.00
70	Manesman	39.00
	Cast iron	1.50
75 (76)	Steel	0.10
80	Manesman	45.00
	Asbestos cement	1,251.00
	Cast iron	29.00
89	Steel	26.50
90	pVC	0.60
	Manesman	15.50
	Cast iron	0.50
100	Manesman	22.40
	Asbestos cement	348.00
	Cast iron	11.00
108	Steel	27.00
110	pVC	2.00
125	pVC	0.60
	Manesman	30.00
	Asbestos cement	211.00
	Cast iron	2.00
127	Steel	1.00
134	Steel	17.00
146	Steel	1.50
150	Manesman	9.00
	Asbestos cement	244.00
	Cast iron	2.30
159	Steel	50.00
175	Asbestos cement	0.60
	Cast iron	2.30
200	pVC	4.30
	Manesman	17.00
	Asbestos cement	158.00
	Cast iron	1.70
219	Steel	48.00
225	Steel	0.50
	Cast iron	0.80
250	Steel	2.00
	Manesman	6.00
	Asbestos cement	99.50
	Cast iron	1.00
273 (275)	Steel	29.50
300	pVC	4.20
	Steel	4.00
	Manesman	2.00
	Asbestos cement	50.00
	Cast iron	17.00
325	Steel	21.00
350	Steel	5.60
	Manesman	0.20
	Asbestos cement	25.00
377	Steel	2.00
400	Steel	3.30
	Manesman	0.20
	Asbestos cement	36.00
	Cast iron	0.20
426 (430)	Steel	9.80
	Manesman	1.00
475 (478)	Steel	1.70
	Asbestos cement	37.00
500	Steel	1.00
	Asbestos cement	1.00
	Cast iron	0.70
529 (530)	Steel	25.00
	Manesman	0,50
546	Asbestos cement	55.00
550	Steel	1.00
600	Steel	5.00
630	Steel	16.00
	Manesman	2.50
700	Steel	7.00

TABLE F.2.12 (4) PIPE SYSTEM BY PAZARDJIK WATER SUPPLY COMPANY

External water networks

	Length of pipeline according to the type of the pipe (m)					
Diameter (mm	*Asbestos cement*	*Steel concrete*	*Steel*	*Pig iron*	*Galvanized*	*PVC*
ø 1200		4795				
ø 900			2196			
ø 546	2100					
ø 475	2100		4230			
ø 400	290					
ø 300	15248		24378			2517
ø 250	31036		2891			
ø 200	36152		17749			3500
ø 150	59938		30710			2488
ø 125	43305		7361			
ø 100	36899		18613	35		2902
ø 80	46648		26431			
ø 60	18884		5156			
ø50			5083		710	
ø 40			2125			
Total	291600	4795	146823	35	710	11407

TABLE F.2.12 (5) PIPE SYSTEM BY PAZARDJIK WATER SUPPLY COMPANY

Internal water network

	Length of pipeline according to the type of the pipe (m)				
Diameter (mm)	*Asbestos cement*	*Steel*	*Pig iron*	*Galvanized*	*PVC*
Ø 450					
Ø 400	86860	1000			
Ø 350	35700				
Ø 300	29177	1500			
Ø 250	11696	1500			
Ø 200	140019	40574			1500
Ø 150	120019	48574			
Ø 125	37238				
Ø100	135013	28775	1384		2500
Ø 80	138862	17203			
Ø 60	125000	8153		17253	
Total	859581	147279	1384	17253	4000

3. Pipelines for pumping stations

	Pipe materials and length(m)				
	Asbestos cement	*Steel*	*Pig iron*	*Galvanized*	*PVC*
Diameter(mm)					
Ø 820		1900			
Ø 546	1886				
Ø 475	3786				
Ø425		4230			
Ø 350		2267			
Ø 300	11920	15315			
Ø 250	11756	2755			
Ø200	31544	12407			
Ø150	77563	24506			
Ø 125	49617	2600			
Ø 100	36700	13207			
Ø 80	47044	11524			
Ø 60	8840	13745			
Total	280656	104456			

TABLE F.2.12 (6) PIPE SYSTEM BY STRARA ZAGORA WATER SUPPLY COMPANY

1. Total pipelines (Main and distribution pipelines)

	Length of pipeline according to the type of the pipe (m)				
Diameter [mm]	Steel	Pig iron	Asbestos cement	Steel concrete	PVC
50	37072	13392	-	-	-
60	-	-	393558	-	-
80	77910	9853	437035	-	-
100	47409	8197	227196	-	2660
125	27083	3314	141818	-	-
150	44591	3302	200472	-	-
200	32700	3737	128280	-	-
250	16716	1935	39098	-	-
300	17924	840	35657	-	-
350	954	-	24960	-	-
400	20166	-	20509	-	-
475	-	-	17940	-	-
500	31265	-	-	-	-
546	-	-	52850	-	-
600	7078	-	-	-	-
700	29486	-	-	-	-
800	6572	-	-	-	-
1000	7434	-	-	5430	-
Total	404361	44570	1716373	5430	2660

TABLE F.2.12 (7) PIPE SYSTEM BY STRARA ZAGORA WATER SUPPLY COMPANY

2. Main pipelines

	Pipe materials and lenght [m]				
Diameter (mm)	Steel	Pig iron	Asbestos	Steel concrete	PVC
50	3962	1724	-	-	-
60	-	-	10300	-	-
80	19965	733	28860	-	-
100	31169	1050	55566	-	2660
125	19153	416	55910	-	-
150	30162	1620	126566	-	-
200	25760	762	83470	-	-
250	12658	520	24478	-	-
300	12920	420	29410	-	-
350	-	-	21820	-	-
400	16966	-	16805	-	-
475	-	-	10700	-	-
500	28675	-	-	-	-
546	-	-	46660	-	-
600	6200	-	-	-	-
700	29486	-	-	-	-
800	6272	-	-	-	-

3. Distrution pipelines

	Pipe [m]				
Diameter (mm)	Steel	Pig iron	Asbestos	Steel concrete	PVC
50	33110	11668	-	-	-
60	-	-	383258	-	-
80	57945	9120	408175	-	-
100	16240	7147	171630	-	-
125	7930	2898	85908	-	-
150	14429	1682	73906	-	-
200	6940	2975	41810	-	-
250	4058	1415	14620	-	-
300	5004	420	6247	-	-
350	954	-	3140	-	-
400	3200	-	3704	-	-
475	-	-	7240	-	-
500	2590	-	-	-	-
546	-	-	6190	-	-
600	878	-	-	-	-
800	300	-	-	-	-
Total	153578	37325	1205828	-	-

TABLE F.2.12(8) PIPE SYSTEM BY HASKOVO WS COMPANY

Main distribution system		
Diameter mm	Type of the pipes	Length (km)
60	Asbestos cement	26.42
80	Asbestos cement	114.88
80	Steel	5.93
80	pVC	3.88
100	Asbestos cement	91.15
100	Steel	12.55
100	Pig iron	2.39
100	PVC	15.09
125	Asbestos cement	96.69
125	Steel	5.02
125	Pig iron	1.50
133	Steel	5.08
150	Asbestos cement	85.52
150	Steel	10.80
200	Asbestos cement	41.42
200	Steel	10.78
250	Asbestos cement	39.72
250	Steel	5.49
300	Asbestos cement	14.64
300	Steel	8.43
350	Asbestos cement	27.63
350	Steel	19.36
400	Asbestos cement	6.51
400	Steel	14.07
450	Steel	5.67
500	Steel	4.02
800	Steel	5.60
850	Steel	0.81
900	Steel	5.10
1200	Steel	1.90

Number of service networks		
Diameter (mm)	Type of the pipes	Length (km)
60	Asbestos cement	26.42
80	Asbestos cement	114.88
80	Steel	5.93
80	PVC	3.88
100	Asbestos cement	91.15
100	Steel	12.55
100	Pig iron	2.39
100	PVC	15.09
125	Asbestos cement	96.69
125	Steel	5.02
125	Pig iron	1.50
133	Steel	5.08
150	Asbestos cement	85.52
150	Steel	10.80
200	Asbestos cement	41.42
200	Steel	10.78
250	Asbestos cement	39.72
250	Steel	5.49
300	Asbestos cement	14.64
300	Steel	8.43
350	Asbestos cement	27.63
350	Steel	19.36
400	Asbestos cement	6.51
400	Steel	14.07
450	Steel	5.67
500	Steel	4.02
800	Steel	5.60
850	Steel	0.81
900	Steel	5.10
1200	Steel	1.90

TABLE F.2.13(1) WATER SUPPLY QUANTITY AND EXPENDITURES OF WATER SUPPLY COMPANIES

	1996			1995			1994		
Municipality	Q- m^3/y	expenditures-Lv/y	Lv/m^3	Q- m^3/y	expenditures-Lv/y	Lv/m^3	Q- m^3/y	expenditures-Lv/y	Lv/m^3
Sofia	7,301,429	41,210,978	5.64	6,378,571	24,661,978	3.87	10,535,250	17,297,859	1.64
Plovdiv	100,171,000	1,030,117,000	10.28	98,930,000	494,430,000	5.00	107,500,000	324,903,000	3.02
Pazardjik	25,336,000	347,185,000	13.70	19,325,000	152,010,000	7.87	30,760,000	94,427,000	3.07
Stara Zagora	63,331,000	782,496,000	12.36	66,638,000	262,352,000	3.94	69,926,000	284,904,000	4.07
Haskovo	20,059,000	459,774,000	22.92	20,508,000	185,436,000	9.04	19,675,000	115,663,000	5.88

	1993			1992		
Municipality	Q- m^3/y	expenditures-Lv/y	Lv/m^3	Q- m^3/y	expenditures-Lv/y	Lv/m^3
Sofia	no data	0	0.00	no data	0	0.00
Plovdiv	110,700,000	218,831,000	1.98	118,100,000	156,676,000	1.33
Pazardjik	37,648,000	65,157,000	1.73	30,338,000	38,200,000	1.26
Stara Zagora	76,465,000	153,148,000	2.00	77,635,000	85,180,000	1.10
Haskovo	21,542,000	85,492,000	3.97	31,254,000	57,300,000	1.83

TABLE F.2.13(2) WATER SUPPLY QUANTITY AND EXPENDITURES OF WATER SUPPLY COMPANIES (BREAK-DOWN)

W&S company	Production [thousand m3/y]				
	1,996	1,995	1,994	1,993	1,992
Sofia	7,301,429	6,378,571	7,000,000	7,221,429	0
Plovdiv	100,171,000	98,930,000	107,500,000	110,700,000	118,100,000
Pazardjik	25,336,000	19,325,000	30,760,000	37,648,000	30,338,000
Stara Zagora	63,331,000	66,638,000	69,926,000	76,456,000	77,635,000
Haskovo	20,059,000	20,508,000	19,675,000	21,542,000	31,254,000
Staff (Lv/y)					
Sofia	28,536,952	15,482,180	8,930,121	8,840,400	0
Plovdiv	178,470,000	92,103,732	60,749,304	39,634,008	24,149,520
Pazardjik	68,974,470	30,322,930	19,503,482	12,799,578	0
Stara Zagora	171,090,000	82,364,184	45,044,064	28,742,340	16,447,860
Haskovo	80,369,544	44,334,300	27,019,548	19,876,320	12,168,816
Chemicals-coagulants,chlorination,others (Lv/y)					
Sofia	3,124,450	1,325,933	840,832	0	0
Plovdiv	0	0	0	0	0
Pazardjik	0	0	0	0	0
Stara Zagora	0	0	0	0	0
Haskovo	0	0	0	0	0
Electricity (Lv/y)					
Sofia	7,874,462	3,786,521	2,302,599	0	0
Plovdiv	395,722,000	87,887,000	63,209,000	50,958,000	37,937,000
Pazardjik	84,945,000	30,486,000	18,477,000	16,696,000	37,850,000
Stara Zagora	286,055,000	84,584,000	59,515,000	48,275,000	0
Haskovo	0	0	0	0	0
Repair (Lv/y)					
Sofia	1,822,366	612,000	0	0	0
Plovdiv	79,980,000	83,000,000	30,108,000	21,362,000	14,875,000
Pazardjik	0	0	0	0	0
Stara Zagora	14,040,000	17,842,000	12,214,000	0	0
Haskovo	0	0	0	0	0
Others (Lv/y)					
Sofia	0	0	0	0	0
Plovdiv	0	0	0	0	0
Pazardjik	9,532,000	3,379,000	185,000	1,456,000	1,149,000
Stara Zagora	74,404,000	18,505,000	7,679,000	4,778,000	2,495,000
Haskovo	62,001,000	16,048,000	8,258,000	4,236,000	2,204,000

Note : "0" means data are not available

TABLE F.4.1 PROJECTION OF FUTURE POPULATION

Region	Water Supply Company	Owner	Annual pop. increase in Urban (%)	Population (person) at present		
				Urban	Rural	Total
Sofia	Sofia	State	0.50	45,541	21,044	66,585
Plovdiv	Plovdiv	State	0.50	519,508	214,659	734,167
	Pazardjik	State	1.00	129,981	108,554	238,535
	Smolian	State	0.50	16,136	22,675	38,811
	Bratzigovo	Municipality	0.50	5,022	7,160	12,182
	Peshtera	Municipality	0.50	20,002	2,785	22,787
	Batak	Municipality	0.50	4,468	3,062	7,530
	Velingrad	Municipality	0.50	26,020	17,629	43,649
Haskovo	Strara Zagora	State	0.50	193,036	72,645	265,681
	Haskovo	State	0.75	191,064	76,777	267,841
Burgas	Sliven	State	0.50	26,260	23,306	49,566

WS Company	Population (person)					
	in 2000			in 2005		
	Urban	Rural	Total	Urban	Rural	Total
Sofia	46,691	21,044	67,735	47,870	21,044	68,914
Plovdiv	532,626	214,659	747,285	546,076	214,659	760,735
Pazardjik	136,611	108,554	245,165	143,580	108,554	252,134
Smolian	16,543	22,675	39,218	16,961	22,675	39,636
Bratzigovo	5,149	7,160	12,309	5,279	7,160	12,439
Peshtera	20,507	2,785	23,292	21,025	2,785	23,810
Batak	4,581	3,062	7,643	4,696	3,062	7,758
Velingrad	26,677	17,629	44,306	27,351	17,629	44,980
St. Zagora	197,910	72,645	270,555	202,908	72,645	275,553
Haskovo	198,337	76,777	275,114	205,887	76,777	282,664
Sliven	26,923	23,306	50,229	27,603	23,306	50,909

WS Company	Population (person)					
	in 2010			in 2015		
	Urban	Rural	Total	Urban	Rural	Total
Sofia	49,079	21,044	70,123	50,318	21,044	71,362
Plovdiv	559,865	214,659	774,524	574,002	214,659	788,661
Pazardjik	150,904	108,554	259,458	158,602	108,554	267,156
Smolian	17,389	22,675	40,064	17,829	22,675	40,504
Bratzigovo	5,412	7,160	12,572	5,549	7,160	12,709
Peshtera	21,556	2,785	24,341	22,100	2,785	24,885
Batak	4,815	3,062	7,877	4,937	3,062	7,999
Velingrad	28,041	17,629	45,670	28,749	17,629	46,378
St. Zagora	208,032	72,645	280,677	213,285	72,645	285,930
Haskovo	213,725	76,777	290,502	221,860	76,777	298,637
Sliven	28,300	23,306	51,606	29,015	23,306	52,321

TABLE F.4.2 FUTURE WATER DEMAND

Region	Water Suppl Company	Class	Present unit water demand in 1995 (l/c/d)	Unit water demand (l/c/d)			
				2000	2005	2010	2015
Sofia	Sofia	Capital	0.231	280	290	300	305
Plovdiv	Plovdiv	I	0.255	260	265	270	275
	Pazardjik	II	0.199	245	253	260	265
	Smolian	II	0.199	245	253	260	265
	Bratzigovo	IV	0.180	190	195	200	205
	Peshtera	III	0.199	215	218	220	225
	Batak	IV	0.180	190	195	200	205
	Velingrad	III	0.199	215	218	220	225
Haskovo	Strara Zagora	I	0.323	260	265	270	275
	Haskovo	II	0.180	245	253	260	265
Burgas	Sliven	II	0.199	245	253	260	265

WS Company	Total projected population (person)			
	2000	2005	2010	2015
Sofia	67,735	68,914	70,123	71,362
Plovdiv	747,285	760,735	774,524	788,661
Pazardjik	245,165	252,134	259,458	267,156
Smolian	39,218	39,636	40,064	40,504
Bratzigovo	12,309	12,439	12,572	12,709
Peshtera	23,292	23,810	24,341	24,885
Batak	7,643	7,758	7,877	7,999
Velingrad	44,306	44,980	45,670	46,378
St. Zagora	270,555	275,553	280,677	285,930
Haskovo	275,114	282,664	290,502	298,637
Sliven	50,229	50,909	51,606	52,321
Total	1,782,852	1,819,532	1,857,413	1,896,541

WS Company	Total water demand (m^3/d)			
	2000	2005	2010	2015
Sofia	18,966	19,985	21,037	21,765
Plovdiv	194,294	201,595	209,121	216,882
Pazardjik	60,066	63,790	67,459	70,796
Smolian	9,609	10,028	10,417	10,733
Bratzigovo	2,339	2,426	2,514	2,605
Peshtera	5,008	5,191	5,355	5,599
Batak	1,452	1,513	1,575	1,640
Velingrad	9,526	9,806	10,047	10,435
St. Zagora	70,344	73,022	75,783	78,631
Haskovo	67,403	71,514	75,530	79,139
Sliven	12,306	12,880	13,418	13,865
Total	451,312	471,748	492,257	512,091

WS Company	Total water demand (m^3/y)			
	2000	2005	2010	2015
Sofia	6,922,514	7,294,544	7,678,441	7,944,380
Plovdiv	70,917,368	73,582,065	76,329,321	79,161,857
Pazardjik	21,923,910	23,283,304	24,622,555	25,840,618
Smolian	3,507,110	3,660,205	3,802,120	3,917,710
Bratzigovo	853,616	885,333	917,765	950,935
Peshtera	1,827,846	1,894,554	1,954,567	2,043,691
Batak	530,030	552,211	575,027	598,501
Velingrad	3,476,916	3,579,032	3,667,325	3,808,825
St. Zagora	25,675,708	26,652,853	27,660,675	28,700,186
Haskovo	24,602,086	26,102,628	27,568,610	28,885,711
Sliven	4,491,737	4,701,186	4,897,405	5,060,706
Total	164,728,841	172,187,915	179,673,812	186,913,119

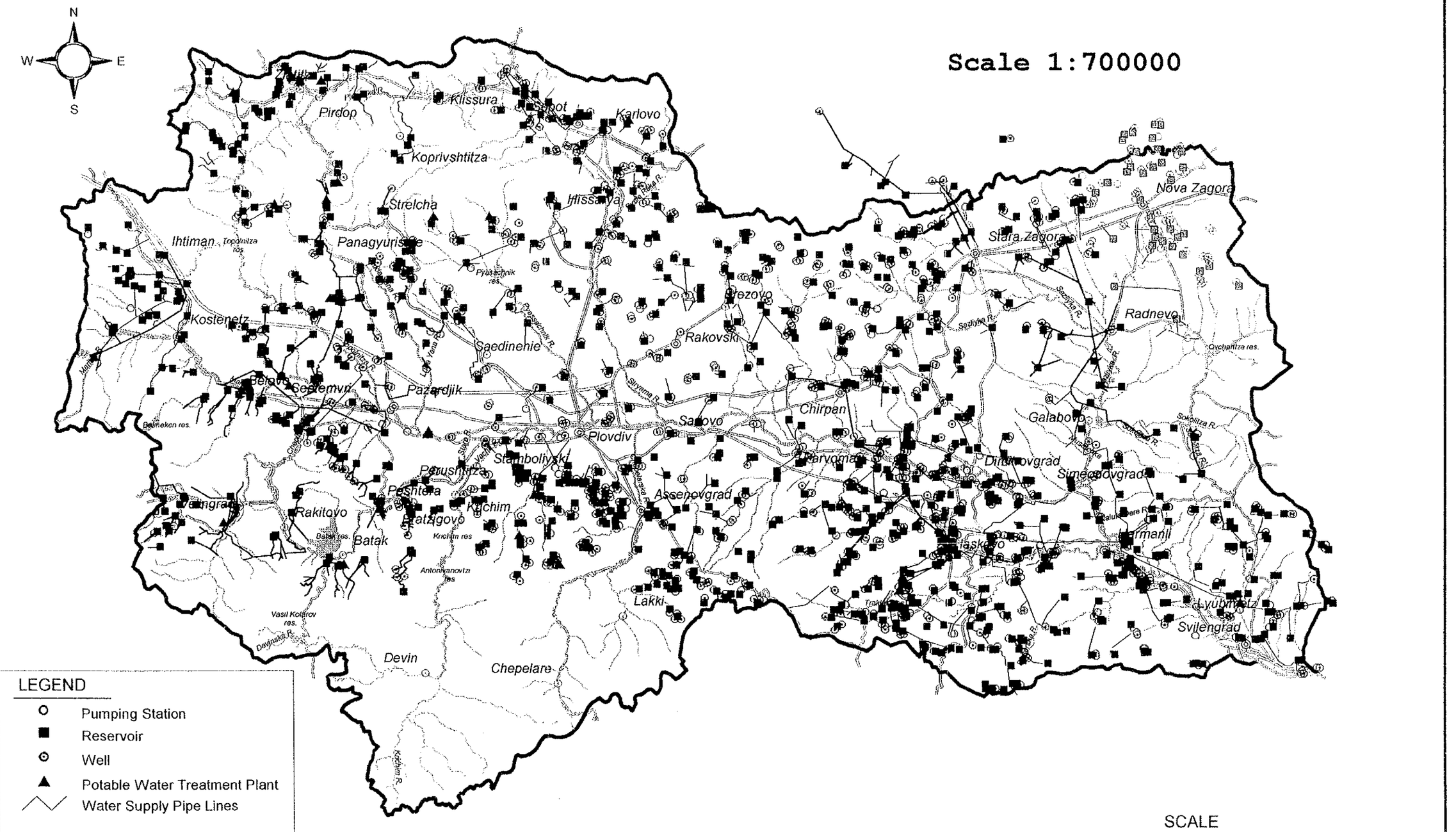
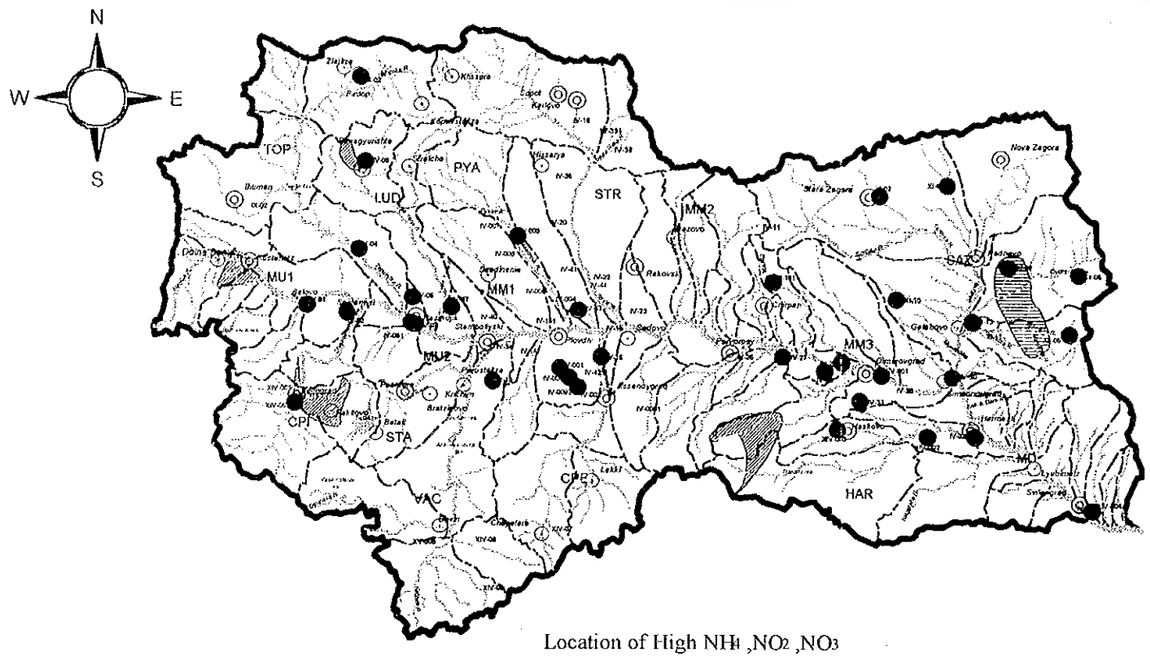
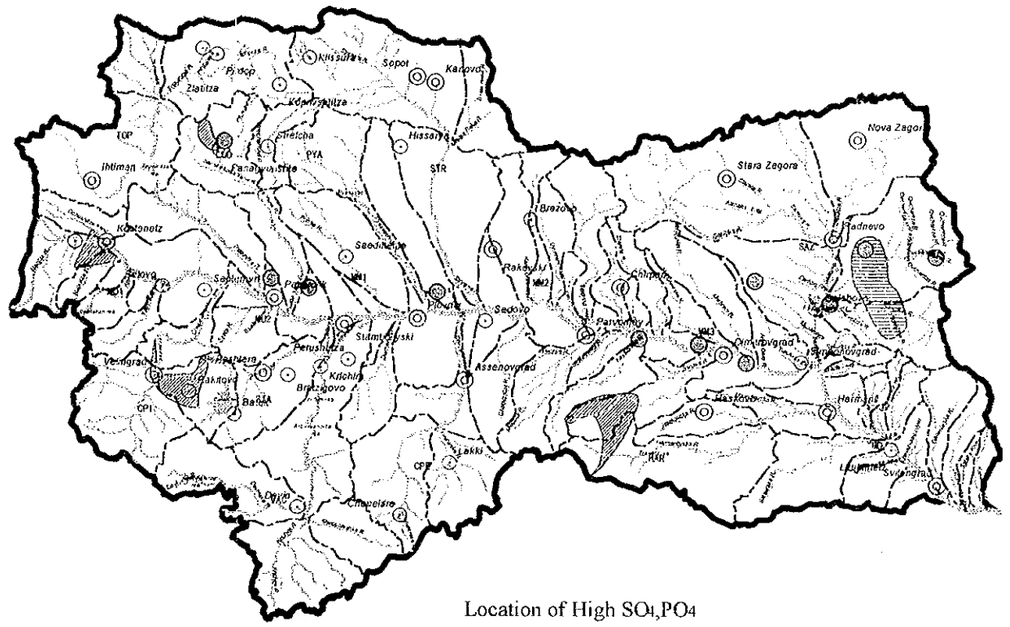


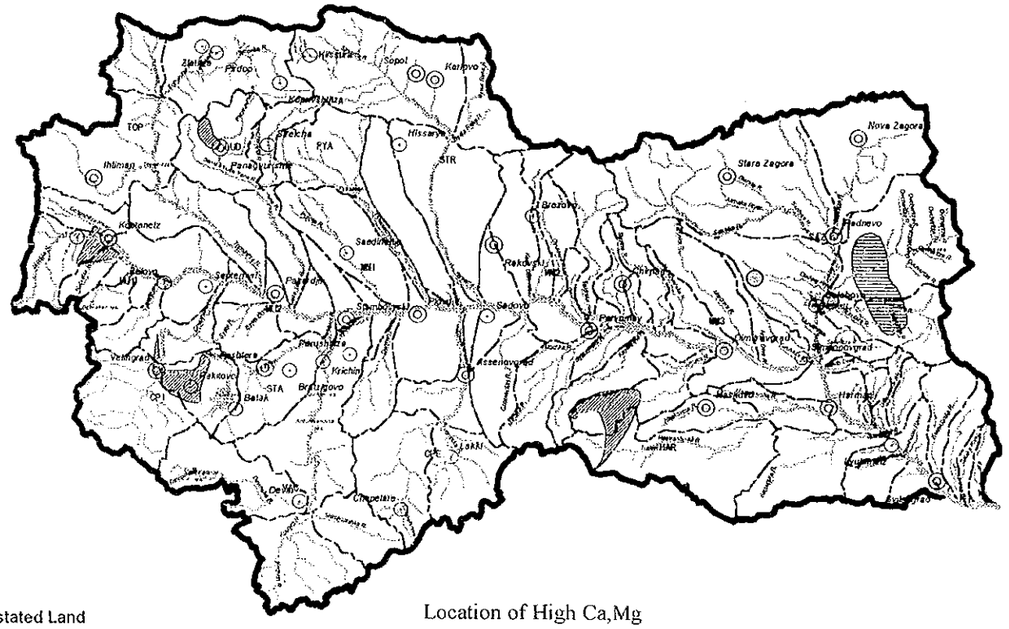
FIG. F.1. 1 WATER SUPPLY SYSTEMS IN THE MARITZA RIVER BASIN



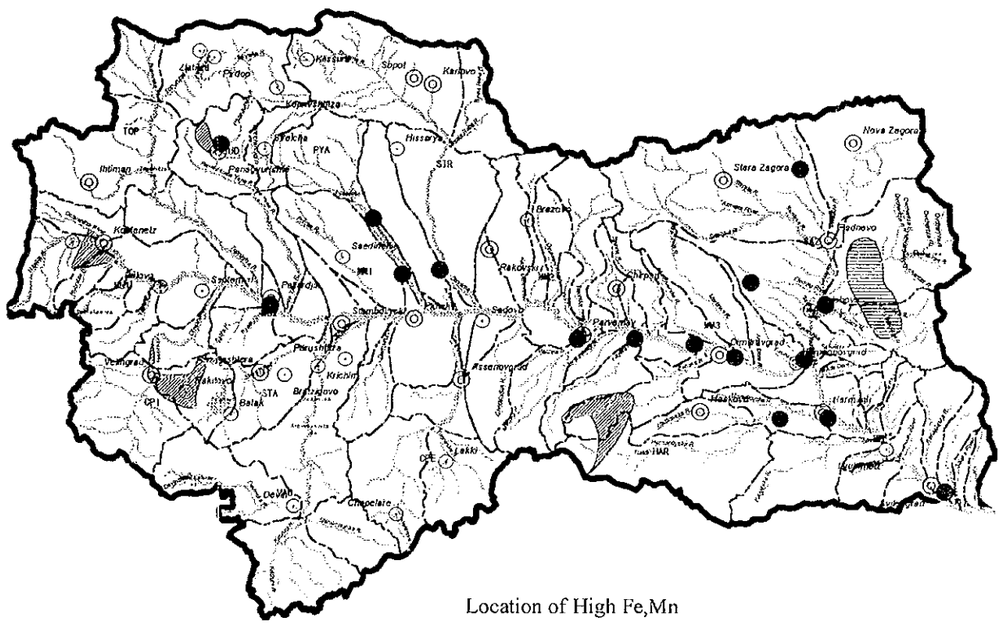
Location of High NH_4 ,NO_2 ,NO_3



Location of High SO_4,PO_4



Location of High Ca,Mg



Location of High Fe,Mn

LEGEND

- Devastated Land (By Landsat Image)
- High NH_4,NO_2,NO_3
- High SO_4,PO_4
- High Ca,Mg
- High Fe,Mn

FIG. F.2.1 POLLUTED GROUNDWATER SOURCES IN THE BASIN