COUNTRY POLICY SUPPORT PROGRAMME
(CPSP)

WATER ASSESSMENT IN JIAODONG PENINSULA

(draft)

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1. Introduction

1.1 Basin Features

Jiaodong Peninsula, which includes Yantai Municipality and Weihai Municipality, lies between Latitude 36°12'North to 38°24'North and Longitude 119°33'East to 122°42'East, farthest to the east of Shandong Peninsula. It's a well-developed coastal area and forward position of external development in Shandong Province. It borders on the Yellow Sea and Bohai Sea in the east, south and north, and Weifang and Qingdao municipalities in the west. Out of the total area of 19182 Km^2, 13746 Km^2 falls within Yantai Municipality and 5436 Km^2 falls within Weihai Municipality. The total length of its coastline is 1688.5 Km.

Based on the *Water Resources Zones in China* issued by Ministry of Water Resources, Yantai and Weihai municipalities are located in Shandong Peninsula (second-level zone) of Huai River Basin (first-level zone). Of which, Yantai Municipality is divided into Jiaodong Peninsula and Jiaolaidagu two zones (third-level zone), while the all of Weihai Municipality is located in the zone of Jiaodong Peninsula (third-level zone).

The middle of Yantai Municipality is rolling area traversing from east to west from which the watershed divide between south and north is formed. Most of the coastal areas in the south and north are plains and rivers run north and south respectively until they flow into the sea. There are Daze Mountain, Luo Mountain, Ya Mountain, Ai Mountain and Kunyu Mountain in this municipality, of which, Kunyu Mountain is the highest where the highest peak is 922.8 meters height above sea level. The area of plains and low lands, including Lailong Plain and Hailai Plain, is 1796.1 Km^2, accounting for 13.1% of the total and the area of hilly regions is 11949.4 Km^2, accounting for 86.9%.

Viewed from geological formation, Weihai Municipality is located in the elevated areas of Jiaodong Peninsula. There are a chain of undulating hills in this municipality, including 10 mountains whose absolute elevation is over 400 meters (Kuyu Mountain is the highest). The area of mountainous regions is 1469 Km^2, accounting for 27% of the total, rolling regions 2811 Km^2, accounting for 51.7% and pediment and beach plain 1156 Km^2, accounting for 21.3%. Three sides of this municipality are surrounded by the sea with winding coastlines, crisscrossing capes and bends and numerous islands. Its exceptional advantages in nature provide more convenient conditions for exploitation of marine resources and development of sea transportation. Up to now, 5 ports have been constructed in this municipality, of which Weihai Harbor and Shidao Harbor have become the most important trading ports of China to foreign countries.

1.2 River System

All of the rivers in Yantai Municipality belong to monsoon-rain originating mountain torrents. There are totally 4320 rivers in this municipality and the average river density is 0.3 Km/Sq. Km, including Wulong River, Dagujia River, Huangshui River, Jie River, Wang River, Xin'an River, and Dagu River that flows to Qingdao Municipality totally

seven rivers whose catchment area is over 300 Km^2, Wulong River, whose catchment area is 2652 Km^2 and mainstream length is 124 Km., is the largest one. Dagujia River, whose catchment area is 2220 Km^2 and mainstream length is 75 Km., is the second one. Huanshui River, whose catchment area is 983 Km^2 and mainstream length is 53 Km., is the third one.

The rivers in Weihai Municipality, most are season rivers, belong to coastal marginal river systems. Because Kunyu Mountain, Zhengqi Mountain and Weide Mountain pass through the middle of this municipality from east to west, all of the rivers runs south and north respectively until they flows into the sea. There are 10 rivers whose catchment area is over 100 Km^2 and 3 rivers whose catchment area is over 300 Km^2, including the largest one in Wendeng City, Muzhu River whose catchment area is 954 Km^2 and mainstream length is 65 Km., and the second one, Huanglei River whose catchment area is 652 Km^2 and mainstream length is 69 Km. All of the rivers are characterized by obvious rain-originating pattern.

1.3 Hydrometeorology

The entire Jiaodong Peninsula comes under temperate continental monsoon climate. Affected by sea, it's also characterized by ocean climate.

The average annual temperature in Yantai Municipality is 11.5□, –1.6□ in the coldest month and 25.6□ in the hottest month. The annual temperature difference is very low. There are totally 200□220 days of frost-free periods and the average annual sunshine index is 2489 hours. The average annual rainfall of the basin, which has a great disparity between wet year and dry year and unevenly distributes spatially and temporally, is 677.7 mm. Continuous wet year or dry year occur frequently. The average annual evaporation is 1080.5 mm.

1.4 Social Economy

Jiaodong Peninsula has a long history of development. It's recorded from textual research that human being had lived here in a compact community early in the New Stone Age and more developed agriculture, husbandry and handicraft had been established here in Xia and Shang Dynasty (c. 21^{st} – c. 11^{th} century B. C.). The open of trading ports and introduction of advanced techniques and facilities abroad due to Westernization Movement in the latter half of the 19^{th} century further promoted the development of local machine building, transportation and finance. Up to the early of this century, Yantai and Weihai municipalities have become one of the more socio-economically developed regions in China.

Yantai Municipality is one of the 14 municipalities open to foreigners in China and 4 districts (Zhifu, Fushan, Laishan and Muping), 7 cities at county level (Laizhou, Longkou, Laiyang, Zhaoyuan, Penglai, Qixia and Haiyang), 1 island county (Chang Island) and 1 economic development center are under its jurisdiction. There are totally 6.4581 million populations by year 2000, including 2.04 million of non-agricultural populations and 3.0369 million of urban populations and the urbanization level is 47.0%, higher than the average of the whole province. The GDP of this municipality in year 2000 was RMB 87.959 billion (US$ 10.65 billion) and the average per capita was RMB 13620 (US$ 1645). In the composition of GDP, the first industry accounts for

14.4%, the second industry 51.8% and the third industry 33.8%. Its total gross value of agricultural output in year 2000 was RMB 23.026 billion (US$2.79 billion), gross value of industrial output RMB 157.611 billion (US$ 19.08 billion), increased by RMB 42.247 billion (US$ 5.12 billion), and thermal power installed capacity 1.577 million Kw. Yantai Municipality has been listed in the 18th in the national GDP and 33rd in the national comprehensive economic strength where 7 counties/cities have been entered into the economically-powered counties in China.

Weihai Municipality, which was founded in year 1987, is the first health town in China and had been chosen as the most favourable city inhabited by human being by the United Nation. Presently 1 district (Huancui District) and three cities at county level (Wendeng, Rongcheng and Rushan) are under its jurisdiction. Its total population was 2.4695 million by year 2000, including 0.9046 million of non-agricultural populations and 1.2912 million of urban populations and its urbanization level was 52.3%, higher than the average of the whole province. The GDP of this municipality in year 2000 was RMB 56.089 billion (US$ 6.79 billion) and the average per capita was RMB 22713 (US$ 2750). In the composition of GDP, the first industry accounts for 15.3%, the second industry 52.6% and the third industry 32.1%. Its industrial structure is changing from agriculture to industry and the contribution to economic growth from the third industry is further increased. Its gross value of agricultural output in year 2000 was RMB 14.473 billion (US$1.75 billion), gross value of industrial output RMB 116.168 billion (US$ 14.06 billion), increased by RMB 26.7891 billion (US$ 3.24 billion), and thermal power installed capacity 0.968 million Kw.

The main economic and social norms in Yantai and Weihai are shown in Table 1-1.

1.5 Land Use

The total area of Yantai Municipality is 13746 Km^2. Its cultivated area was 0.4439 Mha and others 0.9307 Mha by the end of 2000, the cultivated rate was 32.3%. Out of the cultivated land, vegetable land was 0.0335 Mha and dry land 0.4104 Mha. The cultivated area of cereals was 0.4717 Mha, oil crops 0.1138 Mha and forestry 0.0048 Mha, including 0.0005 Mha of timber forest, 0.0035 Mha of cash forest and 0.0008 Mha of shelter forest.

Table 1-1 Main Economic and Social Norms in Yantai and Weihai in Year 2000

(Population in million, GDP and output value RMB in billion)

Municipality	Population			GDP	Gross value of agricultural output	Thermal Installed Capacity (Kw.)	Gross value of industrial output	Increased Industrial Value
	Total	Of which						
		Non-agri	Urban					
Yantai	6.4581	3.0369	2.040	87.959	23.026	15.77	157.611	42.247
Weihai	2.4695	1.2912	0.9046	56.089	14.473	9.68	116.168	27.681
Total	8.9276	4.3281	2.9446	144.048	37.499	25.45	273.779	69.928

The total area of Weihai Municipality is 5436 Km^2. Its cultivated area was 0.1722 Mha and others 0.3714 Mha by year 2000, the cultivated rate was 31.7%. Out of the cultivated land, vegetable land was 0.0099 Mha and dry land 0.1623 Mha. The cultivated area of cereals was 0.2087 Mha, oil crops 0.0679 Mha and forestry 0.0062 Mha, including 0.04 thousand ha of timber forest, 4.25 thousand ha of cash forest and

1.87 thousand ha of shelter forest.

1.6 Irrigation

In the end of 2000, the effective irrigated area of Yantai Municipality was 0.2815 Mha, accounting for 63.4% of the total cultivated area. Presently there are 1 large irrigation district (Menlou Reservoir Irrigation District) and 14 medium and small irrigation districts. The actual irrigated area in 2000 was 0.2240 Mha, including 0.1904 Mha of irrigated land and 0.0036 Mha of vegetable land. The irrigated area of forest and fruit trees was 0.0688 Mha. The total water consumption in irrigation was 612 million m^3 and the water use efficiency was 0.50.

In the end of 2000, the effective irrigated area of Weihai Municipality was 0.1199 Mha, accounting for 69.6% of the total cultivated area. Presently there is 1 large irrigation district (Mishan Reservoir Irrigation District) whose design irrigated area is 0.0207 Mha and corollary area 0.0140 Mha. The actual irrigated area in 2000 was 0.0752 Mha, including 0.0654 Mha of irrigated land and 0.0098 Mha of vegetable land. The irrigated area of forest and fruit trees was 0.0228 Mha. The total water consumption in irrigation was 163 million m^3 and the water use efficiency was 0.52.

1.7 Urban Centers

The active urbanization strategy implemented in Jiaodong Peninsula in recent decade optimized the layout and strengthened the functions of the city, and promoted the migration of populations from rural areas to urban centers and the coordinated development of urban and rural economies. A town system with mutual complement, rational distribution and methodical scale has successfully been set up in the two municipalities in the light of the overall strategy of *rational development of large cities, focal development of medium cities and active development of small cities*. The total population in the two municipalities in year 2000 was 3.0369 million and the urbanization level was 47.0%, higher than the average 38% of the whole province. There are totally 8 cities in the administrative area of Yantai Municipality, including one large city, Yantai City and seven small cities at county level. The total urban area of Yantai Municipality is 210.6 Km^2 including 121.8 Km^2 in Yantai City, and the total urban populations is 1.749 million including 0.913 million in Yantai City. Details are shown in Table 1-2.

1 district, Huancui District, 3 cities at county level (Wendeng, Rongcheng and Rushan), 9 subdistrict offices and 68 towns are under the jurisdiction of Weihai Municipality. The total urban populations in Weihai Municipality is 1.2912 million and the urbanization level is 52.3%, higher than the average 38% of the whole province. There are totally 4 cities (Weihai City and three cities at county level) in the administrative area of Weihai Municipality. The total urban area of Weihai Municipality is 97.6 Km^2 including 43.7 Km^2 in Weihai City, and the total urban populations is 0.923 million including 0.382 million in Weihai City. Details are shown in Table 1-2.

Table 1-2 Urban Status in Yantai and Weihai

Municipality	City Name	Urban Area (Km^2)	Population (in million)	Gross value of industrial output (in billion)	Increased industrial value (in billion)

Yantai	Yantai	121.8	0.913	17.28	4.75
	Laizhou	15.2	0.130	3.78	1.04
	Longkou	17.1	0.161	6.78	1.87
	Laiyang	17.0	0.153	2.78	0.77
	Zhaoyuan	13.6	0.129	4.93	1.36
	Penglai	10.0	0.116	3.09	0.85
	Qixia	8.9	0.070	2.27	0.62
	Haiyang	7.0	0.076	2.23	0.61
	Subtotal	210.6	1.748	43.14	11.87
Weihai	Weihai	43.7	0.382	22.08	5.38
	Wendeng	19.8	0.205	26.00	6.31
	Rongcheng	20.2	0.232	8.09	1.96
	Rushan	13.9	0.104	9.75	2.36
	Subtoal	97.6	0.923	65.92	16.01

1.8 Industries

Jiaodong Peninsula has established a well-diversified industrial complex with its rich industrial resources and occupied an important place in Shandong Province. In 2000, it has accomplished totally RMB 273.7 billion (US$33.13 billion) of gross value of industrial output, accounting for 22% of the total of the province. The industry develops rapidly in the recent decade and its average annual increase rate is over 15%, ranking forefront of the province. With the adjustment of industrial structure and the combination between reform of traditional industry and development of advanced and new technological industry, the extension of pillar industry and industrialization of advanced and new technology are being accomplished for the optimization, promotion and sustainable development of the whole industry.

Eight pillar industries, including electronics, automobile, machine, textile, building materials, medicine, food and gold have been formed and a well-diversified and sustainable-developed industrial complex has been set up in Yantai Municipality. It had accomplished totally RMB 157.611 billion (US$19.08 billion) of gross value of industrial output, accounting for 48% of its GDP, and increased industrial value RMB 42.247 billion (US$5.11 billion). There are 1624 industries whose income from sales is over RMB 50 million and their total increased industrial value is RMB 27.901 billion. The thermal installed capacity in Yantai Municipality is 1.577 million Kw.

A more diversified industrial complex composed of electronics, machine, textile, rubber, medicine and food has been formed in Weihai Municipality. It had accomplished totally RMB 116.168 billion (US$ 14.06 billion) of gross value of industrial output, accounting for 49% of its GDP and increased industrial value RMB 27.681 billion (US$ 3.35 billion). There are 1120 industries whose income from sales is over RMB 50 million and their total increased industrial value is RMB 23.446 billion. The thermal installed capacity in Weihai Municipality is 0.968 million Kw.

The industries whose income from sales is over RMB 50 million are detailed in Table 1-3.

1.9 Flood & Drainage

A more perfect flood and drainage system has been established in Jiaodong Peninsula. Totally 6855 flood control and drainage works with 190316 m^3 of storage capacity and 97408 m^3 of live storage, including 3 large reservoirs with 53309 m^3 of storage capacity, 24 medium reservoirs with 61076 m^3 of storage capacity, 1085 of small reservoirs with 61068 m^3 of storage capacity, 5718 ponds with 14863 m^3 of storage capacity and 25 water gates had been constructed in Yantai Municipality by year 2000.

Totally 3758 flood control and drainage works with 100030 m^3 of storage capacity, including 2 large reservoirs with 38520 m^3 of storage capacity, 12 medium reservoirs with 31150 m^3 of storage capacity, 428 of small reservoirs with 23840 m^3 of storage, 3307 ponds with 6520 m^3 of storage capacity, 1 water gate and 2312 pumping stations with 63217 Kw. of installed capacity had been constructed in Weihai Municipality by year 2000.

Except the more perfect flood control and drainage system, many problems, such as aging, disrepair and poor corollary facilities of works, and existing ill-conditioned and out-of-the-design-standard reservoirs, are still exerting serious influence to local flood control and drainage systems.

Table 1-3 Main Economic Norms of Industries in Yantai and Weihai in 2000

Municip	Number of Industries				Gross Value of Industrial Output (in billion)				Incred Indust Value (in billion)	Profits Tax (in billion)	Average annual employees (in million)
	Larg indus	Medi indus	Smal indus	Sub Total	Domes indus	HK, Macaw and Taipei indus	Foreign indus	subtotal			
Yantai	128	166	1330	1624	80.404	9.520	11.404	101.328	27.901	10.030	0.5684
Weihai	74	141	905	1120	82.554	1.741	12.373	96.667	23.436	8.464	0.3039
Total	202	307	2235	2744	162.958	11.261	23.777	197.995	51.337	18.494	0.8723

1.10 Fisheries

The output value from fisheries in Yantai Municipality had reached RMB 7.869 billion by year 2000, including RMB 7.745 billion from marine products (RMB 3.08 billion from seawater aquiculture) and RMB 0.124 billion from fresh and brackish water products (RMB 0.122 billion from freshwater aquiculture).

The output value from fisheries in Weihai Municipality had reached RMB 9.223 billion by year 2000, including RMB 9.000 billion from marine products (RMB 4.20 billion from seawater aquiculture) and RMB 0.223 billion from fresh water products (RMB 0.223 billion from freshwater aquiculture).

1.11 Water Pollution

The lower reaches of Laiyang City in the main stream of Wulong River, Bailong River and Heishan River are seriously polluted by organic substances where the water quality is poorer than Class V and out of the standard for agricultural irrigation and industrial uses. All of the rivers and reservoirs are polluted by nitrate and the content of total nitrogen in all of the reservoirs are out of the standard. The discharge of effluents and some main pollutants in Yantai and Weihai municipalities are shown in Table 1-4. The discharge and treatment of effluents in urban areas are shown in Table 1-5 and the main conditions of area-source pollution are shown in Table 1-6.

1.11.1 Water Quality of Rivers and Reservoirs

According to the monitoring data of rivers in Jiaodong Peninsula in year 2000, 31.7% of the water accords with Class II of water quality, 34.1% Class III, 2.4% respectively Class IV and Class V, and 29.4% poorer than Class V. All of the monitoring items of water quality in reservoirs conform to the water quality standard of Class III except 100% of the water is out of standard in content of total nitrogen. The water quality in the drinking water source is good, while it's poor in the industrial and agricultural areas, particularly in the content of COD together with organic substance. The water quality conditions of some main rivers and reservoirs are as follows:

Dagujia River

The water quality in most of the upper reaches of Dagujia River and Menlou and Yanli reservoirs accords with the demand for drinking water. However, it's a little poor and out of the standard of Class III in COD and PH value in the lower reaches.

Wulong River

The water quality in Muyu and Longmenkou riversoirs and upper reaches of Wulong River is good and can meet the demand for drinking water. However, the tributary of Wulong River, Bailong River and its main stream in urban areas of Laiyang City is seriously polluted, even out of the standard of Class V. 60% of the river accords with Class III of water quality, 10% Class IV, 10% Class V, and 20% poorer than Class V. The main pollutants are COD and potassium permanganate.

Jie River

Jie River is the most seriously polluted river in Yantai Municipality where 100% of the water is out of standard of Class V in COD and potassium permanganate.

Huangshui River

The water quality of all of the cross sections of Huangshui River, except Yijiagou, accords with the water quality standard of surface water.

Xin'an River

The water quality of five monitoring cross sections of Xin'an River accords with the standard of Class II and accords with Class III in Gaoling Reservoir.

1.11.2 Groundwater Quality

No pollution from industrial sewage is found in the groundwater of Yantai and Weihai municipalities, where the main pollutants that are total hardness, muriate, nitrate nitrogen and ammonia nitrogen, are related with seawater encroachment and domestic wastes. The water quality of all of the centralized domestic water sources accords with the *Sanitation Standard for Drinking Water*.

Table 1-4 Discharge of Effluents and Pollutants in Yantai and Weihai in 2000

Municip	Annual Effluent Discharge (million m^3)			Annual Pollutant Discharge					
	Domes	Indus	Total	COD (t)	BOD (t)	SS (t)	Ammonia Nitrogen (t)	Volatile phenol (kg)	Total phosphorus (kg)
Yantai	51.746	56.016	108.103	38932.2	2679	4700.6	1497.1	740	17000
Weihai	18.20	24.42	42.62	20466.9					
Total	69.946	80.436	150.723	59399.1					

Table 1-5 Discharge and Treatment of Effluents in Yantai and Weihai in 2000

Municipality	Discharge (million m^3)			Mass of Main Pollutants (ten thousand ton)		Centralized Treatment (million m^3)
	Industrial	Domestic	Total	COD	Ammonia niotrigen	
Yantai	44.414	42.578	87.173	3.11	0.26	7.170
Weihai	21.00	16.00	37.00	1.73	0.22	31.00
Total	65.414	58.578	124.173	4.84	0.48	38.17

Table 1-6 Main Area-Source Pollution in Yantai and Weihai in 2000

Municipality	Fertilizer			Pesticide	
	Total Consumption (t)	Nitrogen Content (t)	Phosphorus Content (t)	Total consumption (t)	Organic Phosphorus Content (kg)
Yantai	976000	172340	82710	18489	12020
Weihai	383700	50024	42502	10122	6580
Total	1359700	222364	125212	28611	18600

2. Water Resources

Water crisis frequently occurred in Jiaodong Peninsula since 1980's and severely influenced the social and economic development. Even though the per capita water resources is a little higher than the average of Shandong Province, contradictions between water supply and demand and socio-economic development become more and more serious due to the uneven distribution annually and interannually and waste and pollution of water resources, and has become the main factor that restrict the sustainable socio-economic development of the two municipalities.

The main purpose of the assessment is to find out the status quo of development, utilization and protection of water resources, increase the water use efficiency, and support the sustainable socio-economic development with the sustainable use of water resources.

2.1 Precipitation

In the principle of water recycle, atmospheric precipitation is the main source of surface water and groundwater and its change reflects the volume and features of surface water and groundwater to a certain extent.

According to the statistical data from 43 rainfall stations from 1956 to 1999, the mean annual precipitation in Yantai Municipality is 677.7 mm, amounting to 9.31 billion m^3. It's 663.7 mm, 557.1 mm and 425.1 mm respectively with 50%, 75% and 95% assurance coefficient. Details are shown in Table 2-1.

According to the statistical data from 1956 to 1999, the mean annual precipitation in Weihai Municipality is 756.3 mm, amounting to 4.11 billion m^3. It's 739.3 mm, 616.0 mm and 464.1 mm respectively with 50%, 75% and 95% assurance coefficient. Details are shown in Table 2-1.

Table 2-1 Precipitation in Yantai and Weihai Municipalities

Municipality	Average (mm)	Precipitation with Different Assurance Coefficient (mm)			
		20%	50%	75%	95%
Yantai	677.7	814.6	663.7	557.1	425.1
Weihai	756.3	914.8	739.3	616	464.4
Average	700.0	843.0	685.1	573.8	436.2

Influenced by topography and climate, the precipitation is unevenly distributed spatially. It decreases progressively from southeast to northwest and from mountainous area to plain area in the general trend.

Local precipitation is mainly formed by typhoon and changes remarkably annually and interannually. It unevenly distributes annually and accounts for 70% of the total in flood season (from June to September), particularly in July and August and even in one to two catastrophic storms in some years. Spring drought is frequent occurs and the possibilities for continuous spring, summer and autumn droughts are very high in dry years.

2.2 Surface Water Resources

Surface water resources represent the dynamic water resources of rivers and lakes etc., surface water bodies, i.e. the natural river runoff that has not been influenced by human activities. To eliminate the influence of human activities to runoff and keep the consensus of runoff series, reducing calculation was done to the observed data and the river runoff without artificial intervention and consumption, that is the surface water resources are found.

The surface water resources in Yantai Municipality are calculated through reducing

calculation to the observed data in each hydrological station from 1956 to 1999, ascertaining the runoff depth in each rainfall station, and drawing the runoff-depth contour of the whole municipality between 1956 and 1999 on the basis of which the solution is found. The mean annual surface water resources in Yantai Municipality are 2.58 billion m^3 and the mean annual runoff depth is 191 mm. The surface water resources with 50%, 75% and 95% of assurance coefficient are 2.22 billion m^3, 1.29 billion m^3, and 0.516 billion m^3 respectively. Details are shown in Table 2-2.

The surface water resources in Weihai Municipality are calculated through reducing calculation to the observed data in Mishan, Longjiaoshan and Baocun three hydrological stations, interpolation and prolongation to the series, and getting the natural runoff in each hydrological station between 1956 and 1999. The mean annual surface water resources in Weihai Municipality are 1.43 billion m^3 and the mean annual runoff depth is 263.5 mm. The surface water resources with 50%, 75% and 95% of assurance coefficient are 1.23 billion m^3, 0.715 billion m^3, and 0.286 billion m^3 respectively. Details are shown in Table 2-2.

Table 2-2 Surface Water Resources in Yantai and Weihai Municipalities

Unit: billion m^3

Municipality	Mean Annual	Assurance Coefficient			
		20%	50%	75%	95%
Yantai	2.58	3.82	2.22	1.29	0.516
Weihai	1.43	2.12	1.23	0.715	0.286
Total	4.01	5.94	3.45	2.005	0.802

2.3 Groundwater Resources

The groundwater resources represent the fresh shallow groundwater relating immediately with atmospheric rainfall and surface water body and involving in water circulation. Influenced by topography, geomorphy, lithologic character, geological structure, human activities, together with atmospheric rainfall, the groundwater table varies dynamically. In one year, it decreases from January to June, increases from July to September and slowly decreases again from October to December. Its amplitude of variation is higher in rolling area and lower in plain area. The assessment contents and approaches are different due to different recharge and data conditions. Predominated respectively with pore water and crevice water, each sub-zone is divided into plain area and rolling area two hydrogeological units.

The average groundwater resources in plain areas and rolling areas from 1956 to 1999 are calculated respectively.

2.3.1 Groundwater Resources in Plain Area

Recharge method is adopted in the calculation of groundwater resources in plain area. The total recharging amount from rainfall infiltration, side piedmont infiltration and surface water body (infiltration from river courses and canal irrigation) deducting return water from well irrigation is the groundwater resources in plain area.

The annual recharge from rainfall infiltration can be derived on the basis of the drafted relations between annual precipitation and annual recharging amount from rainfall

infiltration in piedmont plain area, and the known precipitation.

The calculating method of recharging amount from side piedmont infiltration is the same as that from rolling area and their values are equal.

The recharge from river infiltration represents the water in rivers and canals recharging the groundwater in a way of infiltration with the action of gravity, particularly in some areas newly developed along rivers where the water table is higher than groundwater table that aggravates the infiltration.

The recharging amount from infiltration of canal irrigation and return water of well irrigation are very low and can be neglected.

The area of plains in Yantai Municipality is 1796 Km^2 and the total recharging amount is 251 million m^3. Its groundwater resources are 237 million m^3 and groundwater resources modulus is 132 thousand m^3/Km^2.

2.3.2 Groundwater Resources in Rolling Area

It's hard to determine the parameter of recharge in rolling area owning to the complicated stratum, lithologic character and structure and much different hydrogeological conditions. According to the balance principle between recharging and discharging, the discharging amount can be regarded as the groundwater resources.

Groundwater resources = Base flow of rivers + Outflow from side piedmont infiltration + Spring output + Net consumption from artificial exploitation

The area of rolling regions in Yantai Municipality is 11949 Km^2. The mean annual groundwater resources between 1956 and 1999 are 705 million m^3 and resources modulus is 59 thousand m^3/Km^2.

The area of rolling regions in Weihai Municipality is 5436 Km^2. The mean annual groundwater resources between 1956 and 1999 are 399 million m^3 and resources modulus is 74 thousand m^3/Km^2.

2.3.3 Total Groundwater Resources

The sum of groundwater resources in plain area and rolling area deducting their repeated amount is the total groundwater resources. The repeated amount are mainly composed of two parts, the first is side piedmont infiltration, i.e. side outflow in rolling area that originates from rainfall infiltration and recharges the plain area in a way of groundwater runoff. It has been included in the groundwater resources in rolling area as a discharging item and plain area as a recharging one, therefore it should be deducted from the total groundwater resources; the second is the recharging amount to the groundwater in plain area from the base flow of rivers in rolling area.

According to the calculation, the total groundwater resources in Yantai Municipality are 895 million m^3 and the resources modulus is 67 thousand m^3/Km^2. The ground water availability is 735 million m^3 and the available modulus is 55 thousand m^3/Km^2. The total groundwater resources in Weihai Municipality are 399 million m^3 and the

resources modulus is 74 thousand m^3/Km^2. The ground water availability is 239 million m^3 and the available modulus is 44 thousand m^3/Km^2. Details are shown in Table 2-3.

Table 2-3 Groundwater Resources in Yantai and Weihai Municipalities

Unit: water amount in million m^3, modulus in thousand m^3/Km^2

Municip	Ground in rolling area	Ground in plain area	Repeated amount	Total ground	Resources modulus	Ground availability	Available modulus
Yantai	705	237	47	895	67	735	55
Weihai	399	0	0	399	74	239	44
Total	1104	237	47	1294	69	974	52

2.4 Total Water Resources

The total water resources is the sum of surface water resources and shallow groundwater resources deducting the repeated amount in mutual transition.
The mean annual water resources in Yantai Municipality between 1956 and 1999 are 2.865 billion m^3 and the water yield modulus is 212 thousand m^3/Km^2. In the light of the total population and cultivated area in 2000, the per capita water resources is 443.63 m^3 and per hectare water resources is 6454 m^3. Details are shown in Table 2-4.

The mean annual water resources in Weihai Municipality between 1956 and 1999 are 1.529 billion m^3 and the water yield modulus is 282 thousand m^3/Km^2. In the light of the total population and cultivated area in 2000, the per capita water resources is 619.15 m^3 and per hectare water resources is 8880 m^3. Details are shown in Table 2-4.

Table 2-4 Total Water Resources in Yantai and Weihai Municipalities

Unit: water amount in million m^3, per capita and per ha in m^3

Municipality	Surface Water	Ground Water	Repeated Amount	Total Water	Per capita Water	Per ha Water
Yantai	25.8	8.95	6.10	28.65	443.63	6454
Weihai	14.3	3.99	3.00	15.29	619.15	8880
Total or Average	40.1	12.94	9.1	43.94	492.18	7132

The per capita water resources in Jiaodong Peninsula (Yantai and Weihai municipalities) is 492 m^3, far lower than the critical value, 1000 m^3 to maintain local economic and social development generally recognized by international organizations. The per hectare water resources is 7132 m^3, only one forth of the national average. Therefore, it belongs to serious water scarcity area. The water shortage and low per capita and per hectare water resources are the main causes to local severe contradiction between water supply and demand. However, the per capita and per hectare water resources are a little higher than the average of the whole province, which is 344 m^3 and 4605 m^3 respectively.

2.5 Overview for Water Resources Development and Planning

2.5.1 Status Quo of Water Supply Projects

The development and utilization of water resources grows with human activities. A lot of hydro projects have been constructed since the foundation of P. R. China in 1949 to meet the increasing demand for productive and domestic uses.

2.5.1.1 Status Quo of Water Supply Projects in Yantai Municipality

Surface Water Source Projects

Great achievements have been made in the construction of hydro projects in Yantai Municipality. Totally 1105 various surface water source projects with 1.7516 billion m^3 of storage capacity for 0.0985 Mha of effective irrigated area, including 3 large reservoirs with 533.1 million m^3 of storage capacity, 24 medium reservoirs with 610.1 million m^3 of storage capacity, 1078 small reservoirs with 608.5 million m^3 of storage capacity, and 5704 ponds with 148.4 million m^3 of storage capacity, had been constructed by year 2000. The water source projects in urban centers were mainly withdrawing groundwater near urban areas in 1970's. With the growth of population, economic development and increase of water consumption in urban areas, a large quantity of groundwater was exploited for domestic and industrial uses after 1980's from which many environmental and ecological issues resulted and severe unbalance between groundwater supply and recharge occurred. Hereinafter, many reservoirs simply used for agricultural irrigation were changed to supplying water to domestic and industrial uses. Menlou, Wangwu, Muyu, Zhaojia, Yinmachi, Miaobuhe, Goushan, Pingshan, Zhanshan, Longmenkou, Gaoling, Beixingjia and Chijiagou totally 13 reservoirs had been used to supply water to urban centers by year 2000 and Chengzi, Yanli and Lidian reservoirs are now under construction.

Ground Water Source Projects

One underground reservoir, Huangshuihe Reservoir with 53.59 million m^3 of storage capacity and 25.51 million m^3 of regulating storage had been constructed in Yantai Municipality by year 2000. Meanwhile, 50842 various driven wells (including 288 deep wells) and 42331 corollary driven wells had been constructed to irrigate 0.1844 Mha of area.

2.5.1.2 Status Quo of Water Supply Projects in Weihai Municipality

Surface Water Source Projects

The main development patterns of surface water resources in Weihai Municipality are reservoirs, ponds, together with a few pumping stations and river water diversion works. Totally 3740 reservoirs and ponds (including 2 large reservoirs with 385.2 million m^3 of storage capacity, 14 medium reservoirs with 360.9 million m^3 of storage capacity, 403 small reservoirs with 227.4 million m^3 of storage capacity and 3307 ponds with 65.1 million m^3 of storage capacity), 2312 fixed pumping stations with 63217 Kw. of installed capacity and 2 diversion works had been constructed by year 2000.

Ground Water Source Projects

Weihai Municipality has a long history in the exploitation of groundwater that is the main water source for human's life from the inhabitation by human being to the foundation of China and the main exploitation patterns were only limited to scattered excavation and carrying with shoulders and hands, together with the more advanced water raising machinery, water wheel in the early stages of the foundation of China

when the groundwater withdrawal is much less. Large-scale groundwater exploitation was originated from 1960's. In 1963, 18 wells were first driven in Rushan County and totally 583 wells had been driven in the whole municipality by 1972. After the well-driving and drought-resisting meeting in the north of China in 1973, the construction of wells sped up greatly and 6281 wells, including 162 wells predominated in exploiting bedrock pore water and depth is higher than 100 m, 4646 large open wells predominated in exploiting Quaternary crevice water and diameter is higher than 5 m, and other 1503 wells exploiting the crevice water of Quaternary overlaying stratum, had been constructed by year 2000 when the well irrigated area had reached 0.0328 Mha and the annual groundwater withdrawal 170 million m^3.

2.5.2 Analysis on Water Supply

The water supply mainly represents the sum of surface water supply, ground water supply, sewage treatment and reuse, and substitute amount of freshwater with sea water. The surface water supply mainly includes the water amount supplying from water storage works, water diversion works and water lifting works. The total water supply in Yantai and Weihai municipalities in the base year 2000 was 1433 million m^3, including 493 million m^3 of surface water supply amounting to 34.4% of the total, 898 million m^3 of ground water supply amounting to 62.7% of the total, and 30 million m^3 of sewage treatment and reuse and 236 million m^3 of sea water consumption substituting 12 million m^3 of freshwater amounting to 2.9% of the total. Detailed water supplies are shown in Table 2-5.

Table 2-5 Actual Water Supply in Yantai and Weihai Municipalities in Year 2000

Unit: million m^3

Municipalities	Surface Water Supply				Ground Water Supply				Sewage Treatment and Reuse	Sea Water Use		Total Water Supply
	Storage works	Diversion works	Lifting works	Sub-total	Shallow groundwater	Deep groundwater	Bedrock fissure water	Sub-total		Sea water	Substitute Freshwater	
Yantai	261	23	14	297	734	29	6	769	27	219	11	1105
Weihai	171	18	7	196	125	4	0	129	3	17	1	328
Total	432	41	21	493	859	33	6	898	30	236	12	1433

2.5.3 Existing Problems in Water Resources Development and Utilization

(a) Water scarcity restricted the sustainable social development

Jiaodong Peninsula belongs to severe water short areas in the north of China where the per capita and per hectare water resources are all lower than the national and world average. Water resources have become the main factor restricting local sustainable socio-economic development.

(b) Low impoundment level and more ill-conditioned and dangerous reservoirs

Most of the large and medium reservoirs were constructed from the end of 1950's to the early of 1960's and problems of quality in varying degrees were existed, which resulted in that these works can't be used in impoundment as design standard and reduced the impounded surface water amount.

(c) Overexploitation of groundwater and deterioration of environment

Overexploitation of groundwater in plain areas together with the continuous drought from 1998 to now has resulted in large areas of sea water intrusion in coastal areas, which not only reduced the industrial output value by over RMB one billion, but also caused difficulties in drinking water to lots of people and livestock, and seriously influenced industrial and agricultural production and people's life.

(d) Aggravation of contradiction in water use between urban and rural areas

With the change of some large and medium reservoirs and most of the groundwater resources near urban areas supplying water to urban centers, agricultural water supply is reduced and aggravates the contradiction of water supply and demand between urban and rural areas.

(e) Unreasonable water management mechanism made the limited water resources can't be fully used

At present, water resources are managed by various sectors where mutual restrictions, overlapping functions and unclear power etc., problems exist. Lack of overall planning in water resources development and utilization made the water resources can't be optimally allocated and fully used.

2.5.4 Planning of Water Resources Development and Utilization

2.5.4 Guiding Ideas and Target for Overall Planning of Water Resources Development

The guiding ideas for the overall planning of water resources development are some recommendations about the *tenth-five-year plan* approved by the Fifth Plenary Session of the Fifteenth Central Committee that include: construction of hydraulic infrastructure should be strengthened to realize the change from traditional water conservancy to the one of resources-type and sustainable development; the principle of overall management, optimal allocation, efficient use, saving water, and effective protection should be adhered to in the planning; water savings, increase of water use efficiency, active impoundment of surface water, rational exploitation of groundwater, full use of the water in Yellow River, active transfer of the water in the Yangtze River etc., should be fully promoted; and the bearing capacity of water resources should be taken into account in the planning for city development and industrial and agricultural production so as to realize the balance between water supply and water demand and support local sustainable and stable socio-economic development.

The target for planning is to make the water supply meet the demand for the development of the national economy and society in both quality and quantity, realize the balance between water supply and water demand, and guarantee the sustainable and stable development of the national economy and society with the implementation of water resources development, water savings, water resources protection, reform of water management mechanism, adjustment of water price, and overall planning and integrated management of water resources etc., structural and non-structural measures.

2.5.4.2 Main Structural Measures in the Planning

- **Development and Utilization of Surface Water**

Yantai Municipality

Currently the development and utilization rate of water resources in Yantai Municipality, which is only 36.6% in normal year and around 30% in annual average, is very low. However, it's still has some potentials in the development and one large reservoir, four medium reservoirs and many small reservoirs are planned to be constructed.

(a) Large reservoir – Laolan Reservoir

Laolan Reservoir, which is to be constructed on Waijia River of Yantai Municipality.in year 2005 and completed in year 2010 with the purpose of flood control, water supply and irrigation, is a large hydro project with 200 million m^3 of storage capacity and 120 million m^3 of live storage. The construction of Laolan Reservoir is the most effective structural measure to make full use of the water resources in Waijia River. Its regulating pondage is 46 million m^3, daily water supply to urban centers 117 thousand tons, and irrigated area 0.0020 Mha.

(b) Four medium reservoirs

Zhanjiagou Reservoir: to be completed on Wulong River of Laiyang City between year 2010 and 2020, its control area is 140 Km^2, storage capacity 74.5 million m^3 and live storage 34 million m^3.
Gaogezhuang Reservoir: to be completed on Qinshui River of Muping District after year 2010, its control area is 140 Km^2, storage capacity 45.0 million m^3 and live storage 30.0 million m^3.
Wolong Reservoir: to be completed on Huangshui River of Penglai City after year 2010, its control area is 240 Km^2 and live storage 16 million m^3.
Daming Reservoir: to be completed on Wulong River of Laiyang City between year 2021 and 2030, its control area is 80 Km^2, storage capacity 18 million m^3 and live storage 12 million m^3.

(c) Small reservoirs

Small hydro projects are the main water sources for agricultural irrigation. Totally 2436 small reservoirs and 379 ponds are planned to be constructed by year 2005; 1994 small reservoirs and 339 ponds between year 2006 and 2010; and 88 small reservoirs and 620 ponds between year 2010 and 2030.

Weihai Municipality

One medium reservoir, Boyu Reservoir is to be constructed, one existing medium reservoir, Bahe Reservoir is to be extended to a large one, and Kunlongxing, Mishan and Longjiaoshan three reservoirs are to be reinforced.

Boyu Reservoir: located in the downstream of Shijia River of Huancui District, it's a

medium reservoir with the main purpose of urban water supply together with some agricultural irrigation. Its catchment area is 204 Km^2, storage capacity 55.2 million m^3 and live storage 43.5 million m^3.

Bahe Reservoir: located in the downstream of Xiaoluo River of Rongcheng City, its catchment area is 56 Km^2. The dam is planned to be heightened before 2005 to increase water storage and improve water quality for water supply to Stone Island. Its design storage capacity is 104.1 million m^3 and live storage 71.05 million m^3.

Kunlongxing Reservoir: located in the upstream of Gaocun River, originally it's a medium reservoir with the main purpose of agricultural irrigation. The dam is to be reinforced and gates are to be increased before 2005 for the main purpose of urban water supply together with some agricultural irrigation. Its live storage will be increased from 7.91 million m^3 to 32.0 million m^3.

Mishan Reservoir: located in the upstream of Muzhu River, its catchment area is 440 Km^2 and its live storage will be increased from 107.0 million m^3 to 131.0 million m^3 after reconstruction.

Longjiaoshan Reservoir: located in the upstream of Rushan River, its catchment area is 277 Km^2 and its live storage will be increased from 29.12 million m^3 to 59.16 million m^3 after reconstruction before 2005.

- **Development and Utilization of Ground Water**

The groundwater in plain areas of Yantai Municipality has been overexploited due to continuous drought, but there are still some potentials in the development of groundwater resources in rolling areas. Proper exploitation can be done predicted on the adoption of source-recharging measures.

Yantai Municipality

(a) Planning for underground reservoirs

A lot of underground reservoirs mainly including Jia River, Qinshui, Wang River, Huangzhuang, Laiyang, and Pingchang River etc., underground reservoirs are to be constructed at the ocean outfalls of downstreams of some rivers where the groundwater is overexploited and are intruded by sea water.

(b) Planning for source-recharging and water diversion projects

Lots of low-head water retaining structures and percolation pits, ditches and canals are to be constructed to transform the surface water that can't be impounded into groundwater. Totally 93 river weirs, 3320 percolation pits and 2957 wells are to be constructed in Yantai Municipality by year 2005; 55 river weirs, 700 percolation pits and 2871 wells are to be constructed between year 2006 and year 2010; and 60 river weirs are to be constructed between year 2010 and year 2030.

- **Sewage Reuse**

Sewage reuse is a comprehensive strategy to alleviate the water shortage and control water pollution.

The quantity of effluent discharge in Yantai Municipality is not very high due to the small size of towns and simple geological location and environmental demand. Therefore, it's better to construct the effluent plants individually. Laishan Effluent Plant with 40 thousand tons of daily sewage treatment and Muping Effluent Plant with 80 thousand tons of daily sewage treatment are to be constructed, and Laizhou, Zhaoyuan, Laiyang, Penglai, Qixia, Haiyang and Changdao etc., effluent plants are to be extended before year 2005.

A second-stage project with 500 thousand tons of design daily sewage treatment will be constructed based on the current first-stage project of Taoziwan Effluent Plant with 250 thousand tons of sewage treatment per day, and Laizhou, Zhaoyuan, Laiyang, Penglai, Qixia, Haiyang and Changdao etc., effluent plants are to be further improved before year 2010.

The construction of effluent plants in Yantai Municipality can remarkably increase the sewage reuse rate. It's planed that the sewage reuse rate will reach 30% and the reuse amount 98 million m^3 by year 2005, 50% and 154 million m^3 by year 2010, and 60% and 278 million m^3 by year 2030.

There are three central effluent plants in Weihai Municipality, including two in the urban centers of Weihai City with 95 thousand tons of daily treatment capacity and 35 thousand tons of actual daily treatment capacity and one in Rongcheng City with 20 thousand tons of daily treatment capacity, and the current sewage treatment rate is around 50% together with various sewage treatment facilities scattered in each industry. But the secondary sewage treatment capacity is only 15 thousand tons per day.

According to the planning for city development and development of ecological demonstration city in Weihai Municipality, each effluent plant with 40 thousand tons of daily treatment capacity will be constructed respectively in Wendeng City and Rushan City, and the effluent plant in Rongcheng City will be extended from 20 thousand tons of treatment capacity to 40 thousand tons of treatment capacity. The third effluent plant in Weihai City is being constructed in the advanced and new technology development center. In the planning, the sewage treatment rate will reach 60%, 70% and 75% and sewage reuse amount 10 million tons, 30 million tons and 52.5 million tons respectively in the whole municipality in different normal years.

- **Rainwater Utilization**

Planning for Rainwater Utilization in Urban Centers

With the increasing extension of urban centers, the rainfall-runoff modulus increases remarkably and peak flow increases correspondingly. The following measures are adopted in rainwater utilization:

Rainwater utilization of roofs
The rainwater on roofs is collected with the link of pipes and down spouts and diverted into percolation pits to recharge groundwater, or artificial lakes after filtration.

Rainwater utilization of roads
The ground surfaces of parking areas, squares and pavements are constructed with permeable materials to reduce runoff loss. The collected runoff can be used to recharge groundwater or irrigate grasses or trees on road sides after treatment.

Rainwater impoundment of grasslands and lawns
The lawn are lower than the road surface and enclosures 10-15 centimeters higher than the lawn should be constructed around the lawn to increase the rainfall infiltration of grassland.

Planning for Rainwater Utilization in Plain Areas

600 kilometers long of rivers and drains are to be excavated and 2 million square kilometers area of ponds are to be dredged in Yantai Municipality by year 2005 that can increase the groundwater recharge by 5 million m^3, and 800 kilometers long of rivers and drains and 2 million square kilometers area of ponds by year 2010 that can increase the groundwater recharge by 10 million m^3.

In Weihai Municipality, 30 kilometers long of rivers (Muzhu River and Rushan River) are to be excavated and 120 ponds and 10 dams (including rubber dams) are to be constructed by year 2005, and 60 ponds and 120 dams are to be constructed by year 2010 to increase the recharge from surface water to groundwater and meanwhile increase the available surface water supply.

Planning for Rainwater Utilization in Rolling Areas

Barren hills and ditches, road surfaces and courts are to be used to collect rainwater, and small ponds, water tanks and water cellars are to be used as rainwater storage facilities.

- **Sea Water Utilization**

Yantai Municipality borders the sea on both south and north and has abundant sea water resources. However, restricted by economy and technology, the development and use of sea water resources is very low. Currently some sea water resources are only used in the urban center of Yantai City, Laizhou City, Longkou City, Penglai City and Chang Island.

In the planning, sea water should be used in power industries as cooling water, and newly constructed industrial and mining enterprises in any possible conditions. Any practical and feasible measures should be taken to use sea water in the constructed industrial and mining enterprises.

The cooling water used in gasworks, synthetic leather plant, chemical plant, chloric soda plant and smeltery in Zhifu District, cold storage plant in Muping District and the planned Power Plant in Muping District are to be progressively changed with sea water. Other cities/counties/districts that plan to use sea water include salt chemical industries in Laizhou District, Laizhou Chemical Plant, third-stage project of Longkou Power Plant, cold storage and chemical plants in coastal areas, cold storage and chemical plants in Peilai City, and cold storage plants in Chang Island etc.

28 million m^3 of sea water is to be used in Yantai Municipality by year 2005 and 73 million m^3 by year 2010.

Sea water in Weihai Municipality is mainly used as cooling water in some industries and washing water of raw materials in food processing industries and its annual consumption is only about 10 million m^3. Two ways including toilet flushing and cooling water are to be adopted to expand sea water consumption. The immediate sea water consumption will reach 20 million m^3 amounting to 1 million m^3 of fresh water by year 2005, 50 million m^3 amounting to 2.5 million m^3 of fresh water by year 2010, and 100 million m^3 amounting to 5 million m^3 of freshwater by year 2030.

3. Water for Agricultural Use

Agriculture is the biggest water consumption sector whose water consumption amounts to 60% of the total. Water use for agriculture mainly includes farm irrigation and water use for forests and fisheries. Farm irrigation can be divided into water uses for paddy field, irrigated land and vegetable garden, and water uses for forests and fisheries mainly include irrigation of forests and fruit trees and water supply to fish ponds in freshwater aquiculture.

The cultivated area in Yantai Municipality in year 2000 was 0.4439 Mha and the effective irrigated area 0.2815 Mha, accounting for 64.37% of the cultivated area. The actual irrigated area in year 2000 was 0.2239 Mha including 0.1904 Mha of paddy field and 0.0335 Mha of vegetable garden, the irrigated area of forests and fruit trees was 0.0688 Mha, and the water supply area of fish ponds was 0.0053 Mha. The water consumption in irrigation in Yantai Municipality in year 2000 was 612 million m^3, including 37 million m^3 in forest and fruit tree irrigation. The total water supply to fish ponds was 35 million m^3 and the total water consumption in agriculture was 684 million m^3. Details are shown in Table 3-1.

The cultivated area in Weihai Municipality in year 2000 was 0.1722 Mha and effective irrigated area 0.1199 Mha, accounting for 69.6% of the cultivated area. The actual irrigated area in year 2000 was 0.0752 Mha including 0.0654 Mha of paddy field and 0.0098 Mha of vegetable garden, and the irrigated area of forests and fruit trees was 0.3421 million mu. The water consumption in irrigation in Yantai Municipality in year 2000 was 163 million m^3, including 128 million m^3 of water consumption in paddy field and 35 million m^3 in vegetable garden. The total water supply to fish ponds and water consumption in forests and fisheries was 13 million m^3 and the total water consumption in agriculture was 176 million m^3. Details are shown in Table 3-1.

Table 3-1 Water for Agricultural Use in Yantai and Weihai in Year 2000

Unit: million m^3

Municipa	Water Consumption in Irrigation				Water Consumption in Forests and Fisheries			Water Consumption in Agriculture
	Paddy field	Irrigat Land	Veget Garden	Sub-total	Irrig of forests and fruits	Water supply to fish ponds	Sub-total	

Yantai	0	463	149	612	37	35	72	684
Weihai	0	128	35	163	13	0	13	176
Total	0	591	184	775	50	35	85	86

4. Water for Domestic Use

4.1 Urban Population

The total population in Yantai Municipality in year 2000 was 6.4581 million, including 2.04 million of non-agricultural population and 3.0369 million of urban population, the urbanization level was 47.0%.

The total population in Weihai Municipality in year 2000 was 2.4695 million, including 0.9046 million of non-agricultural population and 1.2912 million of urban population, the urbanization level was 52.3%.

4.2 Status Quo of Domestic Water Use and Sewage Discharge

Domestic water use can be divided into water use in urban centers and rural areas. Domestic water use in urban centers mainly includes water use in residence and public works, the later include commerce, tourism, organizations, schools, troops, medical and health institutions, tree plantation in gardens, and water spraying on roads. Domestic water use in rural areas includes water use for residence and livestock.

The domestic water consumption in Yantai Municipality in year 2000 was 154 million m^3, including 68 million m^3 in urban centers and 86 million m^3 in rural areas. In domestic water consumption in urban centers, 49 million m^3 was used for residence and 19 million m^3 for public works. In rural areas, 65 million m^3 was used for residence and 21 million m^3 for livestock. Details are given in Table 4-1.

The domestic water consumption in Weihai Municipality in year 2000 was 57 million m^3, including 28 million m^3 in urban centers and 29 million m^3 in rural areas. In domestic water consumption in urban centers, 18 million m^3 was used for residence and 10 million m^3 for public works. In rural areas, 17 million m^3 was used for residence and 12 million m^3 for livestock. Details are given in Table 4-1.

The total domestic sewage discharge in year 2000 was 51.75 million m^3 including 42.58 million m^3 from urban centers in Yantai Municipality, and 18.20 million m^3 including 16.00 million m^3 from urban centers in Weihai Municipality.

4.3 Status Quo of Domestic Water Supply

The total domestic water supply in Yantai Municipality in year 2000 was 154 million m^3, including 35 million m^3 from surface water and 119 million m^3 from ground water, their proportion was 23%:77%. The total domestic water supply in Weihai Municipality in year 2000 was 57 million m^3, including 24 million m^3 from surface water and 33 million m^3 from ground water, their proportion was 42%:58%.

Table 4-1 Water for Domestic Use in Yantai and Weihai Municipalities in 2000

Unit: million m^3

Municipa	Domestic Water Consumption in Urban Centers				Domestic Water Consumption in Rural Areas				Domestic Water Consumption	
	resident	Public works	Sub-total	from ground water	resident	livestock	Sub-total	From ground water	Total	From Ground Water
Yantai	49	19	68	49	65	21	86	70	154	119
Weihai	18	10	28	6	17	12	29	27	57	33
Total	67	29	96	55	82	33	115	97	211	152

5. Water for Industrial Use

5.1 Overview of Industries

Both Yantai and Weihai municipalities have rich industrial foundation where a well-diversified industrial complex has been respectively set up, and occupy an important position in the whole province. Their gross value from industrial output in year 2000 was RMB 273.8 billion, accounting for 22% of the total of Shandong Province.

Eight pillar industries, including electronics, automobile, machine, textile, building materials, medicine, food and gold have been formed in Yantai Municipality. It had accomplished totally RMB 157.611 billion (US$19.08 billion) of gross value of industrial output, accounting for 48% of its GDP, and increased industrial value RMB 42.247 billion (US$5.11 billion).

A more diversified industrial complex composed of electronics, machine, textile, rubber, medicine and food has been formed in Weihai Municipality. It had accomplished totally RMB 116.168 billion (US$ 14.06 billion) of gross value of industrial output, accounting for 49% of its GDP and increased industrial value RMB 27.681 billion (US$ 3.35 billion).

5.2 Industrial Water Use and Sewage Discharge

The industrial water consumption in Yantai Municipality in year 2000 was 237 million m^3, including 109 million m^3 from ordinary industries, 115 million m^3 from township industries and 13 million m^3 from thermal power plants. The industrial water consumption in Weihai Municipality in year 2000 was 76 million m^3, including 47 million m^3 from ordinary industries, 26 million m^3 from township industries and 3 million m^3 from thermal power plants. Details are shown in Table 5-1.

Table 5-1 Industrial Water Consumption in Yantai and Weihai in year 2000

Unit: million m^3

Municipality	Ordinary Industry	Township Industry	Thermal Power Plant	Total	From Groundwater
Yantai	109	115	13	237	184
Weihai	47	26	3	76	44
Total	156	141	16	313	228

The total sewage discharge from industries in year 2000 was 56.02 million m^3 including 44.41 million m^3 from urban areas in Yantai Municipality, and 24.42 million m^3 including 21.00 million m^3 from urban areas in Weihai Municipality.

5.3 Status Quo of Industrial Water Supply

The total industrial water supply in Yantai Municipality is 237 million m^3, including 42 million m^3 of surface water, 184 million m^3 of groundwater, and 220 million m^3 of sea water amounting to 11 million m^3 of fresh water. The total industrial water supply in Weihai Municipality is 76 million m^3, including 31 million m^3 of surface water, 44 million m^3 of groundwater, and 17 million m^3 of sea water amounting to 8.5 million m^3 of fresh water.

6. Water Use for Eco-System

Broadly speaking, all of the water consumed to keep the ecological balance of the earth, such as water-heat balance, biotic balance, water-sand balance, and water-salt balance are all eco-environmental water use. In a narrow sense, eco-environmental water use represents the total amount of surface water and ground water consumed to improve and protect the eco-environmental quality from further deterioration that mainly include all of the water used to maintain the base flow of rivers, necessary water areas of lakes and swamps and a proper groundwater table, and all of the water used in soil and water conservation, dilution and rejuvenation of polluted water bodies, and rivers and lakes in urban centers.

The rapid development of agriculture and industry in Yantai and Weihai municipalities in the conditions of drought and water shortage since 1980's is at the cost of the damage to the environment. The water resources development and utilization in the future should meet the basic demand for the ecological environment, namely improve and not deteriorate the environment. Ecological water demand mainly includes water supply to rivers, water recharge to groundwater, water use in soil and water conservation, water use in swamps, water supply to rivers and lakes in urban centers, and water use to maintain the water-salt balance of land. Water supply to rivers indicates the water amount to maintain the base flow of the eco-system of rivers. To guarantee the eco-environmental water demand contributes to the renewable water circulation in river basins and regions and is an important foundation to accomplish the sustainable use of water resources.

The socio-economic development level in Yantai and Weihai municipalities was still very low before 1970's when the water consumption was less than one third of the present and the ecological water use could be guaranteed. River cut-off seldom occurred even in dry seasons. The water quality and the eco-environmental conditions were good.

With the agricultural and industrial development, growth of population and increase of urbanization level since 1980's, it has become very hard to guarantee the ecological water use in Jiaodong Peninsula due to the increase of water consumption in various sectors as well as reduction of rainfall. Deterioration of the eco-system, such as overexploitation of groundwater, sea water and salt water intrusion, water pollution, river cut-off and shrivel, and decline of river functions have become increasingly serious. The conditions of river cut-off in Yantai Municipality are given in Table 6-1.

Table 6-1 Investigation on River Cut-off in Yantai Municipality

Name of Cut-off River	Cut-off Year	Location of the Longest Cut-off River Reach	Length of the Longest Cut-off River Reach (KM)	Cut-off Times	Cut-off Days
Dagujia River	1973, 1978, 1981-1995, 1997	Dashafu Village, Fushan District	3.0□4.0	56	5148 days□including the whole years between 1999 and 2000
Qinshui River	1981-1997, 1999-2002	Upstream of the river weir	8.0□10.0	54	3103 days□including 308 days in 1999
Chengdong River	1981-1997	Tangqian Village, Zhaocheng Township	12.0□15.0	42	4779 days□including the whole year of 1984, 1989 and1991
Qingyang River	1982, 1984, 1987-1990, 1992, 1994, 1996-2002	Zangjiazhuang Village, Zangjiazhuang Township	6.0□8.0	16	922 days□including 211 days in 1989
Dongcun River	1978-1979, 1981-1986, 1988, 1992, 1994, 1996-2002	Urban area in Haiyang City	4.0□5.0	30	1225 days□including 190 days in 1979
Dongwulong River	1978, 1981-1982, 1984, 1992, 1994, 1999, 2001-2002	Nanligezhuang Village of Tuanwang Township	5.0□6.0	24	365 days□including 121 days in 1982

All of the rivers in Weihai Municipality are seasonal streams and will all be cut off in dry seasons. The severe water shortage exerted a great influence to the ecological environment of rivers and resulted in many ecological problems. For instance, the water shortage for ecology has reduced the sewage dilution capacity and aggravated water pollution; aquatic organisms are destroyed; the eco-system of swamps are destroyed and swamps are withered; low inflow to seas has resulted in sedimentation at estuaries and sea water intrusion etc.

7. Past Situation

The situations of social economy and ecological water use in year 1965, which is used as the typical year in 1960's in this report, are briefly introduced as follows. The total population in Yantai Municipality in year 1965 was 4.776 million, GDP RMB 760 million, gross value of industrial output RMB 460 million, gross value of agricultural, forest and husbandry output RMB 640 million. The cultivated area was 0.5885 Mha, effective irrigated area was 0.1365 Mha and the total yield of cereals was 1.428 million tons. The total population in Weihai Municipality in year 1965 was 1.9553 million, GDP RMB 290 million, gross value of industrial output RMB 100 million, gross value of agricultural, forest and husbandry output RMB 280 million. The cultivated area was 0.2350 Mha, effective irrigated area was 0.0341 Mha and the total yield of cereals was 0.51 million tons. Details are shown in Table 7-1.

Table 7-1 Economic and Social Norms in Yantai and Weihai in Year 1965

Municip	Population	GDP	Gross value of	Gross value of	Cultivated area	Effective irrigated	Area under	Cereal yield

	(million)	(RMB million)	industrial output (million)	agri, fore and husbandry (million)	(million mu)	area (million mu)	crops (million mu)	(million tons)
Yantai	4.7763	760	460	640	0.5885	0.1365	0.5200	1.428
Weihai	1.9553	290	100	280	0.2350	0.0341	0.3290	0.51
Total	6.7316	1050	560	920	0.8235	0.1706	0.849	1.938

The water for ecological use could be guaranteed in Jiaodong Peninsula in year 1965 when the ecological conditions were well, river cut-off seldom occurred and the water quality that was usually better than Class III was very good. It's estimated that the ecological water consumption in year 1965 was 250 million m^3 in Yantai Municipality and 140 million m^3 in Weihai Municipality.

8. Future Case

8.1 Projection of Economic and Social Norms

The economic and social norms of the future 2005, 2015 and 2025 scenarios in Yantai and Weihai Municipalities are projected and the economic and social norms in the base year 2000 are presented in Table 8-1 and Table 8-2.

Table 8-1 Main Economic and Social Norms in Yantai and Weihai in Year 2000

(Population in million, GDP and output value RMB in billion)

Municipality	Population			GDP	Gross value of agricultural output	Gross value of industrial output	Increased Industrial Value
	Total	Of which					
		Non-agri	Urban				
Yantai	6.4581	3.0369	2.040	87.959	23.026	157.611	42.247
Weihai	2.4695	1.2912	0.9046	56.089	14.473	116.168	27.681
Total	8.9276	4.3281	2.9446	144.048	37.499	273.779	69.928

Table 8-2 Main Economic and Social Norms in Yantai and Weihai in Year 2000

Unit: area in Mha

Mucip	Cultiv area	Area under crops			Effec irriga area	Yield of cereal	Actual irrigated area			Irrig area of forest and fruit	Live-Stock (mill)
		Cerea	Cash crops	Sub-total			Padd field	Veget garden	Sub-total		
Yantai	0.4439	0.4681	0.1837	0.6552	0.2815	1.997	0.1904	0.0335	0.2239	0.0687	2.849
Weih	0.1722	0.2087	0.0906	0.2993	0.1199	0.939	0.0654	0.0099	0.0753	0.0228	1.460
Total	0.6161	0.6767	0.2743	0.9547	0.4013	2.936	0.2558	0.0434	0.2992	0.0915	4.309

In the light of the *Outline for Economic and Social Development in Yantai Municipality in the Tenth Fiver-Year Plan (draft), Outline for Economic and Social Development in Weihai Municipality in the Tenth Fiver-Year Plan (draft)* and projections from related departments, the early stage of the 21st century will become the key period for the

economic and social development of the two municipalities when the extensive and rate-type economy will be changed to intensive and beneficial economy and the people's life will be greatly improved. The salient features of these are:

- Actively implementing the urbanization strategy, optimizing the layout of cities, promoting the migration of populations from rural areas to urban centers and the coordinated economic development in rural areas and urban centers, optimizing the economic structure, and boosting the economic growth.
- Actively promoting the adjustment of agricultural structure and industrialization of agriculture. Reducing the production of normal cereals and expanding quality cereals, reducing the plantation of normal crops and expanding production of quality and high-value green products; expanding production of famous, special, quality, rare and new strains and processing of fruit trees and predominantly developing grass-eating and cereal-saving hunbandry and milk processing industry; expanding fresh water aquaculture of rare aquatic products.
- Actively advancing adjustment of industrial structure, promoting reform of traditional industries and industrialization of advanced technology, and accelerating the process of information.

The main economic and social norms in 2005, 2015 and 2025 scenarios are detailed in Table 8-3 and Table 8-4.

8.2 Projection of Water Demand

Water Demand for Agriculture: the water demand for agriculture is projected on the basis of the water-saving level and irrigated area in various scenario years.

Water Demand for Domestic Use: the water duties in various scenario years are drafted considering the increase of water consumption and the water demand for domestic uses in urban centers and rural areas are projected.

- The water demand for domestic use in urban centers is mainly drafted based on the development of urban centers, and water duties in cities and counties are determined on the basis of the climate, living habit and living level in various scenario years. Details are shown in Table 8-5.
- The water demand for domestic use in rural areas will be increased constantly with the improvement of people's life and development of tap water. The water duties in various scenario years are determined as 60 per capita per day, 65 per capita per day and 70 per capita per day respectively in the light of those in other prefectures and municipalities of Shandong Province.

Water Demand for Industry: the water demand for industry include those of town industries and township industries and the water demand for town industries are predicted as normal industries and thermal plants two types.

Table 8-5 Water Duties for Domestic Uses in Cities and Counties in Various Scenario Years

Municipality	Water Duties in Cities □liter/capita, day□			Water Duties in Counties □liter/capita, day□		
	2005	2015	2025	2005	2015	2025

Yantai	168	190	210	130	145	175
Weihai	183	200	220	140	160	180

9. Water Balance

The water balance is analyzed considering the current available water supply (including surface water and ground water), implementation of water-source protection, soil and water conservation and water-saving measures, implementation of water resources development, sewage water reuse, rainwater harvesting, sea water utilization and conjunctive use of surface water and groundwater water etc., structural and non-structural measures, and reduction of water demand and increase of water supply in various scenario years.

Analysis on the water demand and available water supply in Yantai and Weihai municipalities in various scenario years are detailed in Table 9-1 and Table 9-2 and the results of water balance are detailed in Table 9-3.

Table 9-3 indicated that even various structural and non-structural water-saving measures have been taken in each sector, there is still a huge difference between water supply and water demand. The water shortage rate will be 8.4%-12.0% in normal year and 44.6%-49.3% in catastrophic dry year. Jiaodong Peninsula will still face the challenges of water shortage in the early stage of the 21st century.

To guarantee the sustainable economic and social development with the sustainable water resources utilization and reach the water balance in Jiaodong Peninsula in various scenario years, the rational development, utilization, improvement, allocation, saving and protection of water resources should be further strengthened and a series of structural and non-structural measures should be adopted to realize the optimal allocation and high-efficient use of local water resources. On the other side, implementation of the South-to-North Water Project is the inevitable choice and fundamental measure to solve the water shortage in Jiaodong Peninsula.

Munip	Scenario Year	Population (million)			Agriculture, Forest, Husbandry, Fishery										
		Urban centers	Rural areas	Total	Effective irrigated area of farmland (million mu)				Area of forest, husbandry and fishery (million mu)				Livestock (million)		
					Paddy	Rain-fed	Vegetable	Sub-total	Forest, fruit	Husbandry	Fish pond	Sub-total	Big	Small	Total
Yantai	2005	3.3219	3.3219	6.6438	0	0.2693	0.0302	0.2996	0.0783	0	0.0069	0.0568	0.0987	1.93	3.411
	2015	4.4433	2.5361	6.9792	0	0.2837	0.0407	0.3245	0.0851	0	0.0075	0.0617	0.1317	2.252	4.227
	2025	4.7835	2.2150	6.9985	0	0.2876	0.0374	0.3251	0.0828	0	0.0073	0.0600	0.1214	2.2118	4.0320
Weihai	2005	1.4887	1.0484	2.5371	0	0.1104	0.0160	0.1264	0.0247	0	0.0039	0.0191	0.0041	2.031	2.092
	2015	1.8167	0.8486	2.6653	0	0.1167	0.0196	0.1364	0.0301	0	0.0045	0.0231	0.0049	2.371	2.444
	2025	2.0791	0.5935	2.6726	0	0.1164	0.0187	0.1352	0.0279	0	0.0043	0.0215	0.0048	2.3278	2.3993
Total	2005	4.8106	4.3703	9.1809	0	0.3797	0.0462	0.4260	0.1030	0	0.0109	0.0759	0.1028	3.961	5.503
	2015	6.26	3.3847	9.6445	0	0.4004	0.0603	0.4609	0.1152	0	0.0120	0.0848	0.1365	4.623	6.671
	2025	6.8626	2.8085	9.6711	0	0.4040	0.0561	0.4603	0.1106	0	0.0117	0.0815	0.1261	4.5396	6.4313

Table 8-3 Prediction on Economic and Social Norms in Various Scenario Years

Table 8-4 Prediction on Economic and Social Norms in Various Scenario Years

Unit: value in RMB billion

Municip	Scenario Year	Industry (constant price in 1990)									GDP	Per Capita Income (Yuan/Capita/Year)		
		Thermal Plant			Normal Industry		Township Industry		Gross Value of Industrial Output	Increased Industrial Value		Town	Township	Average
		Installed capacity (million Kw)	Output Value	Increased Value	Output Value	Increased Value	Output Value	Increased Value						
Yantai	2005	2.207	1.607	0.766	126.737	38.206	139.924	31.039	268.269	70.012	129.335	8337	4667	6502
	2015	2.207	3.477	1.548	274.119	77.222	302.64	62.737	580.233	141.506	250.735	13975	7825	11588
	2025	3.407	7.353	2.822	579.784	140.726	640.110	114.327	1227.246	257.875	425.673	21123	11825	18335
Weihai	2005	0.962	1.019	0.486	137.082	30.196	41.438	8.968	179.54	39.649	80.729	9220	5257	7120
	2015	0.962	2.205	0.982	296.492	61.03	89.626	18.126	388.324	80.139	156.507	15458	8813	12678
	2025	0.9620	4.663	1.789	627.108	111.220	189.568	33.031	821.339	146.041	265.701	23362	13321	20224
Total	2005	3.169	2.626	1.252	263.819	68.402	181.362	40.007	447.809	109.661	210.064	8610	4809	6673
	2015	3.169	5.682	2.53	570.611	138.252	392.266	80.863	968.557	221.645	407.242	14405	8073	11889
	2025	4.369	12.016	4.611	1206.892	251.946	829.678	147.358	2048.585	403.916	691.374	21801	12141	18857

Table 9-1 Prediction on Water Demand in Yantai and Weihai Municipalities in Various Scenario Years

Unit: billion m^3

Municipality	Year	Water Demand for Irrigation		Water Demand for Forest, Husbandry, Fishery		Water Demand for Town Industries			Water Demand for Township Industries	Water Demand for Domestic Use in Urban Centers			Water Demafor Domestic Use in Rural Areas	Water Demand for Ecology	Total Water Demand	
		50%	75%□95%□	50%	75%□95%□	Norm industries	Thermal Plant	Sub-total		Resid	Publi	Sub-total			50%	75%□95%□
Yantai	2000	1.113	1.113	0.205	0.205	0.133	0.014	0.147	0.102	0.103	0.052	0.155	0.11	0.12	1.952	1.952
	2005	1.056	1.056	0.249	0.249	0.154	0.025	0.179	0.119	0.113	0.06	0.173	0.116	0.12	2.012	2.012
	2015	1.022	1.022	0.271	0.271	0.188	0.018	0.206	0.148	0.183	0.101	0.284	0.127	0.156	2.214	2.214
	2025	0.986	0.986	0.264	0.264	0.208	0.032	0.24	0.169	0.198	0.127	0.325	0.112	0.23	2.326	2.326
Weihai	2000	0.403	0.403	0.082	0.082	0.064	0.006	0.07	0.021	0.045	0.027	0.071	0.042	0.051	0.74	0.74
	2005	0.413	0.413	0.1	0.1	0.073	0.005	0.077	0.025	0.041	0.026	0.067	0.047	0.051	0.78	0.78
	2015	0.411	0.411	0.118	0.118	0.084	0.003	0.087	0.029	0.069	0.047	0.116	0.05	0.067	0.878	0.878
	2025	0.387	0.387	0.111	0.111	0.09	0.003	0.093	0.032	0.077	0.057	0.134	0.044	0.12	0.921	0.921
Total	2000	1.516	1.516	0.287	0.287	0.197	0.02	0.217	0.123	0.148	0.079	0.226	0.152	0.171	2.692	2.692
	2005	1.469	1.469	0.349	0.349	0.227	0.029	0.256	0.144	0.155	0.086	0.24	0.163	0.171	2.792	2.792
	2015	1.433	1.433	0.389	0.389	0.272	0.021	0.294	0.176	0.253	0.147	0.4	0.177	0.223	3.092	3.092
	2025	1.372	1.372	0.375	0.375	0.298	0.035	0.333	0.201	0.275	0.184	0.459	0.156	0.349	3.245	3.245

Table 9-2 Prediction on Available Water Supply in Yantai and Weihai Municipalities in Various Scenario Years

Unit: billion m^3

Municipality	Year	Surface Water			Groundwater		Water transfer from the Yellow River	Sewage Reuse	Sea Water Utilization	Available Water Supply		
		50%	75%	95%	freshwater	Salt water				50%	75%	95%
Yantai	2000	0.932	0.608	0.223	0.735	0.003	0	0.0228	0.022	1.715	1.391	1.006
	2005	0.9668	0.6263	0.2331	0.737	0.003	0	0.0458	0.024	1.777	1.436	1.043
	2015	1.1276	0.7281	0.3239	0.737	0.003	0	0.1338	0.0408	2.042	1.643	1.239
	2025	1.108	0.723	0.309	0.737	0.003	0	0.183	0.044	2.075	1.69	1.276
Weihai	2000	0.414	0.298	0.132	0.165	0	0	0.0082	0.0006	0.588	0.472	0.306
	2005	0.4689	0.3418	0.16	0.19	0	0	0.0192	0.0026	0.681	0.554	0.372
	2015	0.4837	0.354	0.1676	0.238	0	0	0.0572	0.0126	0.792	0.662	0.475
	2025	0.503	0.368	0.177	0.233	0	0	0.076	0.017	0.829	0.694	0.503
Total	2000	1.346	0.906	0.355	0.9	0.003	0	0.031	0.0226	2.303	1.863	1.312
	2005	1.436	0.968	0.393	0.927	0.003	0	0.065	0.027	2.457	1.99	1.415
	2015	1.611	1.082	0.492	0.975	0.003	0	0.191	0.053	2.834	2.305	1.714
	2025	1.611	1.091	0.487	0.97	0.003	0	0.259	0.061	2.904	2.384	1.779

Table 9-3 Water Balance Analysis in Yantai and Weihai Municipalities in Various Scenario Years

Unit: billion m^3

Municipality	Item	2000			2005			2015			2025		
		50%	75%	95%	50%	75%	95%	50%	75%	95%	50%	75%	95%
Yantai	Water supply	1.715	1.391	1.006	1.777	1.436	1.043	2.042	1.643	1.239	2.075	1.69	1.276
	Water demand	1.952	1.952	1.952	2.012	2.012	2.012	2.214	2.214	2.214	2.326	2.326	2.326
	Surplus or deficit water	-0.237	-0.561	-0.946	-0.235	-0.576	-0.969	-0.172	-0.571	-0.976	-0.251	-0.636	-1.05
	Shortage rate□%□	1.22	2.88	4.85	1.17	2.86	4.82	0.78	2.58	4.41	1.08	2.73	4.51
Weihai	Water supply	0.588	0.472	0.306	0.681	0.554	0.372	0.792	0.662	0.475	0.829	0.694	0.503
	Water demand	0.74	0.74	0.74	0.78	0.78	0.78	0.878	0.878	0.878	0.921	0.921	0.921
	Surplus or deficit water	-0.152	-0.268	-0.434	-0.099	-0.226	-0.408	-0.086	-0.216	-0.403	-0.092	-0.227	-0.418
	Shortage rate□%□	2.06	3.62	5.87	1.27	2.9	5.23	0.99	2.46	4.59	1	2.46	4.54
Total	Water supply	2.303	1.863	1.312	2.457	1.99	1.415	2.834	2.305	1.714	2.904	2.384	1.779
	Water demand	2.692	2.692	2.692	2.792	2.792	2.792	3.092	3.092	3.092	3.247	3.247	3.247
	Surplus or deficit water	-0.389	-0.829	-1.38	-0.335	-0.802	-1.377	-0.258	-0.788	-1.378	-0.343	-0.863	-1.468
	Shortage rate□%□	1.45	3.08	5.13	1.2	2.87	4.93	0.84	2.55	4.46	1.06	2.66	4.52