Prospects of Efficient Wastewater Management and Water Reuse in Turkey

Country Study Turkey

Prepared within the Framework of the EMWater Project

"Efficient Management of Wastewater, its Treatment and Reuse in the Mediterranean Countries"

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SUMMARY

Turkey plays an important role as a bridge between Europe and the Middle East. Historically Turkey has been a strong agricultural country with favorable climate amenable to the cultivation of all types of crops. It is one of the rare countries which still is self sufficient in food production today.

Although agriculture has played a significant role in the economy, in recent years Turkey has changed from being an agricultural country to a modern industrial country especially in the Western and Northwestern parts of the country. The industry was modernized as well as the agriculture. Accompanying this development, the water demand has increased for agricultural and for industrial purposes.

The ongoing industrialization and the rapid urbanization in recent years have resulted in a conglomeration of environmental problems especially in the fast growing peri urban areas of big cities like Istanbul. Presently, about 85% of the population is supplied with drinking water in rural areas and in the cities almost 100%. Drinking water demand is constantly increasing, among other reasons due to migration from rural to urban areas.

In recent years, modern WWTPs have been erected and put into operation. However, there are huge accumulated needs in the field of wastewater treatment. Based on data from 2001, about 50% of the population is connected to sewage networks and less than 10% of all sewage is treated biologically or otherwise according to EU standards.

With regards to joining the EU, Turkey continues to make efforts to adapt its environmental regulations to EU guidelines and norms. For implementing WWT, all materials, mechanical and electric equipment are produced within the country. In the water and wastewater sector there are many well educated engineers, engineering, consulting and construction companies.

The major systematic aspect of water related activities in Turkey is central planning in terms of 5-year plans. A large number of ministries and institutions is responsible for water issues which easily leads to interface problems with decision making. This fact may render it difficult to realize decentralized and small scale alternative solutions as well as new solutions like water reuse technology.

There is little public awareness concerning water issues, water saving and reuse is not a popular public concern. Missing popularity combined with the cultural background hinders authorities from charging people cost covering tariffs for water and wastewater, which would offer an incentive for water saving. The reuse of treated wastewater is not accepted neither by the people nor the authorities, as such obtaining approval for reuse of treated wastewater is rather difficult.

The **EMWATER-Project** aims at improving wastewater management, treatment and reuse in Turkey mainly by the means of training courses and demonstration pilot projects.

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Abbreviations and Acronyms

AOX	Absorbable Organic Halogens
BOD_x	Biological Oxygen Demand in x days
COD	Chemical Oxygen Demand
DIE	State Statistics Organisation
DSI	General Directorate of State Water Works
EIA	Environmental Impact Assessment
EIEI	Directorate of Electric Works and Investigation
EC	European Commission
EPA	Environmental Protection Agency (USA)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDRS	General Directorate of Rural Services
ISKI	İstanbul Water and Sewage Administration
NGO	Non-governmental organisation
PE	Population equivalent
SSF	Slow sand filtration
UASB	Upflow Anaerobic Sludge Blanket
WHO	World Health Organization
WWT	Wastewater treatment
WWTP	Wastewater treatment plant

1. INTRODUCTION

Water shortage is currently one of the biggest concerns of human beings world wide. It is a global problem that seriously affects the lives of significant proportions of the world population. According to the Kyoto summit in 2003, two billion people will not have access to safe drinking water supplies in the year 2015. The Mediterranean countries belong to the regions most affected by water scarcity.

Water is a scarce and precious resource in the Middle East. Population growth, rising living standards and urbanization increase the pressure on the resource, leading to increasing costs of water supply. Physical and commercial losses are high; water is often supplied only for a few hours per day or even per week; tariffs are low so that the operation and maintenance costs of the utilities are often not recovered; and wastewater is in most cases not adequately treated, leading to environmental and health hazards.

The aim of the **EMWATER-Project** “Efficient Management of Wastewater, its Treatment and Reuse in the Mediterranean Countries” is to create public awareness of innovative solutions in wastewater treatment and its reuse and support the installation of new technologies of wastewater management in the targeted countries Turkey, Jordan, Palestine and Lebanon. Additionally, the project aims at strengthening capacity building through local and regional training programmes, the development of regional policy guidelines for wastewater treatment and reuse in the region.

The improvement of the security and safety of water supply in the Mediterranean countries is the best recipe for social, economic and political stability in the region and is thus, the foremost goal of the project.

As baseline document for the EMWATER-Project a **country study** is prepared by each participating Mediterranean partner country. The objective of the studies is to analyse the present state of water and wastewater management and reuse in each country. Therefore relevant data are collected in different fields, such as

- national institutions, policies, guidelines and standards in the water sector,
- situation of the water resources (quantity, quality, demand, consumption)
- rural and urban water distribution systems,
- wastewater quantity, composition and disposal systems
- status of wastewater treatment and reuse, existing wastewater treatment facilities

This study provides an insight into the situation of the water sector in Turkey and gives an overview on possible partners and contact persons in the country. It will be one of the baseline documents within the EMWATER-Project for all further activities, like the development and construction of pilot plants, the formulation of wastewater treatment and reuse guidelines and the implementation of different training programmes.

2. COUNTRY PROFILE

2.1 Geography

Turkey has a total area of 779,452 km^2, of which 14,300 km^2 is water. Turkey has influential geo-political status because its location serves as a natural bridge between Europe and Asia. It is surrounded by the Black sea in the north, the Mediterranean sea in the south and the Aegean sea in the west. (Fig. 1).

Figure 1: Geographical map of Turkey

Turkey is a predominantly mountainous country, and true lowland is confined to the coastal fringes. About one-fourth of the surface has an elevation above 4,000 feet (1,219 m), and less than two-fifths lies below 1,500 feet. Mountain crests exceed 7,500 feet in many places, particularly in the east, where Turkey's highest mountain, Mount Ararat (Ağrı) reaches 16,853 feet (5,137 m) close to the borders with Armenia and Iran. Steep slopes are common throughout the country, while flat or gently sloping land makes up barely one-sixth of the total area. These relief features affect other aspects of the physical environment, producing climates often much harsher than might be expected for a country of Turkey's latitude and reducing the availability and productivity of agricultural land. Structurally, the country lies within the geologically young folded-mountain zone of Eurasia, which in Turkey tends predominantly east to west. The geology of Turkey is complex, with sedimentary rocks ranging from Paleozoic to Quaternary, numerous intrusions, and extensive areas of volcanic material. Four main regions can be identified:

the northern folded zone, the southern folded zone, the central massif, and the Arabian platform.

As the majority of Turkey is covered with mountains, the major mountain chains present at the northern and southern regions generally draw wide arches, which are parallel to the shore. The mountains in the north are the Northern Anatolia Mountains and the mountains in the south are the Toros (Taurus) Mountains. These mountain chains are separated from each other by the wide plain areas, which are at the central parts of Anatolia. The mountain chains are more frequent in the eastern parts of the country and form high altitude peaks while the altitude at the Western part decreases. Mountain chains are uncommon in the Aegean and Marmara Regions, this regions mostly display the property of being hollow. There are wide plains in Southeastern Anatolia, as displayed in the central parts of the country, because this region is far from the reach of the expansions of the Toros (Taurus) Mountain chain. The highest mountains of Turkey are the Great Ağrı Mountain (5137 ms) and the Süphan Mountain, the latter is an extinct volcano located inside the borders of Eastern Anatolia Region. Karacadağ, Raman and Sof Mountains are the major mountains of Southeastern Anatolian Region.

There are numerous rivers in Turkey. The majority of the rivers are used in energy production processes. Fırat and Dicle rivers flowing in Eastern Anatolia reaches and joins the Basra Gulf; Yeşilırmak, Kızılırmak and Sakarya rivers flowing in Central Anatolia reaches and joins Black Sea; Susurluk Creek in the west the Biga and Gönen creeks reach and join Marmara Sea; the Gediz, Big and Small Menderes rivers reaches and joins Aegean Sea.

The total surface area of the lakes in Turkey reaches up to 9200 km^2. Eastern Anatolia Region has the highest number of lakes in Turkey. The largest lake in Turkey is the Van Lake (3713 km^2). Erçek, Çıldır and Hazar lakes are also located in this region. The largest lakes of the Central Anatolia Region are mostly shallow and contain amounts of salts. Akşehir Lake, Eber Lake and the second biggest lake of the country Tuzgölü (Salt Lake) are within the borders of this region.

Marmara and the strait's are the most important water passages connecting the Black Sea to the outer world. The Marmara Sea, which is located totally inside the national borders is connected to the Black Sea by İstanbul Bosphorus and to the Aegean and Mediterranean Sea by the Çanakkale Strait.

2.2 Climate

Although Turkey is situated in a geographical location where climatic conditions are quite temperate, the diverse nature of the landscape, and the existence in particular of the mountains that run parallel to the coasts, results in significant differences in climatic conditions from one region to the other. While the coastal areas enjoy milder climates, the inland Anatolia plateau experiences extremes of hot summers and cold winters with limited rainfall.

The average annual temperature varies between 18-20 ^{0}C on the South coast, falls to 14-15 ^{0}C on the West coast, and finally in the interior areas, (according to the location of the place from the mean sea level) fluctuates between 4-18 ^{0}C. Because of the highly variable terrain and exposure to hot and cold winds, local microclimates can vary widely from the regional averages.

The average rainfall per year is about 650 mm, which varies considerably from region to region. For example in the central and south-eastern plateaus, it is 250 mm and in the north-eastern coastal plains and mountain regions it is 2,500 mm.

Turkey had been separated into seven major geographic regions based on factors like climate, natural plantation an the distribution of agricultural activities. These seven major geographic regions are as follows: Mediterranean Region, Aegean Region, Marmara Region, Black Sea Region, Central Anatolia Region, Eastern Anatolia Region and Southeastern Anatolia Region. The climates of each geographical regions are summarised in table 1:

Mediterranean Region

The Mediterranean climate is predominant along the shoreline in which the summer season is hot and dry and the winter season is warm and precipitant. Burdur and the Isparta provinces behind the Toros (Taurus) Mountains to the west are the transition region between the Mediterranean climate and terrestrial climate.

Aegean Region

The Mediterranean climate is encountered along the shoreline. The climate hardens as one moves towards the inner regions. In these regions, the terrestrial climate starts.

Marmara Region

The winter season is extremely cold. Frost events and snow precipitation are frequent.

Black Sea Region

The Black Sea climate, which is characterised by precipitation all year round, can be divided into three types. Precipitation is highest in the Eastern Black Sea Region (Trabzon, Rize) with temperatures high and warm in summer and winter respectively. The Central Black Sea Region (Ordu) has a Mediterranean climate and experiences less precipitation compared with the Easter Black Sea regions. The Western Black Sea Region (Zonguldak, Sinop) is characterised by low precipitation and moisture especially in the summer season.

Central Anatolia Region

The winter season is cold and the summer season is slightly warmer than in the Mediterranean climate type. The precipitation occurs mainly in spring and autumn.

Eastern Anatolia Region

Severe terrestrial climate characterises Eastern Anatolia where the winter season continues for long periods, with snow and frequent frost events. Summer seasons are chilly in comparison to the Southeastern Anatolia Region.

Southeastern Anatolia Region

The steppe climate type prevails here with very high temperatures and severe drought in the summer season. Evaporation is high and reaches up to 1000-2000 mm or more yearly.

Table 1: Climatic Regions in Turkey (Meteo 2002)

Region	Aver. Temperature	Max Temp. *	Min Temp. *	Frozen Days	Aver. Precipitation	Days With Precipitation	Max. Daily Precipi-tation *	Max. Snow Cover Depth *
Unit	^{0}C	^{0}C	^{0}C	Number	mm/ year	Number	mm/d	cm
Mediterranean	15.6	45.6 24.8.1958 ADANA	-29.0 30.1.1968 GÖKSUN	27.3	807.0	79.0	374.6 20.9.1968 DALAMAN	200 20.3.1953 GÖKSUN
Eastern Anatolia	9.9	43.9 1.8.1966 KULP	-43.2 13.1.1940 KARAKÖSE	122.3	608.2	85.5	159.6 24.6.1957 BAŞKALE	565 13.2.1969 GEÇİTLİ
Aegean	13.9	47.0 25.8.1958 MARMARİS	-28.1 29.12.1948 KÜTAHYA	30.6	676.1	79.3	231.1 25.10.1930 İZMİR	110 2.2.1942 DUMLUPINAR
Southeastern Anatolia	16.9	47.6 19.7.1962 CEYLANPINAR	-24.2 11.1.1933 DİYARBAKIR	32.4	589.6	707.	120.6 7.11.1957 VİRANŞEHİR	115 1.2.1968 BESNİ
Central Anatolia	11.0	41.8 1.8.1954 ÇANKIRI	-34.4 6.2.1950 SİVAS	99.1	417.9	83.2	182.4 15.12.1947 AKŞEHİR	215 29.1.1968 İMRANLI
Black Sea	11.9	44.2 18.7.1962 GÖKHÖYÜK	-34.0 9.2.1929 BOLU	48.4	757.5	105.2	431.5 1.8.1955 ZONGULDAK	296 30.1.1968 BÜYÜKDÜZ
Marmara	13.5	43.7 23.8.1958 BALIKESİR	-29.4 5.1.1942 BURSA	33.6	704.6	92.9	231.7 21.8.1951 ÇORLU	375 13.2.1941 ULUDAĞ ZİR.
TURKEY	13.2	47.6 19.7.1962 CEYLANPINAR	-43.2 13.1.1940 KARAKÖSE	56.2	651.6	85.1	431.5 1.8.1955 ZONGULDAK	565 13.2.1969 GEÇİTLİ

2.3 Seism-tectonics of Turkey

Turkey has frequently suffered from major damaging earthquakes since the year 2000. The Kocaeli-İzmit on the 17th of August 1999 and the Düzce earthquakes on the 12th of November 1999 killed thousands of people and destroyed many structures.

The earthquakes are particularly concentrated on the well known active tectonic lines. The seism tectonic map of Turkey shown in Figure 2 gives a general idea of where the segment boundaries along the North and East Anatolian Faults and the other main tectonic provinces are located.

Figure 2: Main Tectonic Belts in Turkey

The main tectonic belts are the following of which especially the first two are the most active.

- North Anatolian Fault
- East Anatolian Fault
- Aegean Graben System
- East Anatolian Contractional Province
- Cyprus-Hellenic Arc
- Central Anatolian Ova Province

The North Anatolian fault is seismically one of the most active fault in the world. The fault starts near the Karlıova to the east where it meets the East Anatolian fault, making a curvature outward in the central part, and continues to the western end of the Mudurnu Valley segment. At this point it divides into two strands. The northern strand called İzmit-Sapanca fault extends from Sapanca Lake through the northern part of the Armutlu Peninsula toward and into the Marmara Sea. This fault dangerously threatens the İstanbul area. It makes some step forming troughs like a kind of pull-apart basin and appears again on land near Mürefte, continuing along the Saros Bay and then enters the Aegean Sea. The southern branch called İznik-Mekece fault runs from Geyve through Mekece passing south of the İznik Lake to the Gemlik Bay. It goes into the Marmara Sea, appearing near the Bandırma Bay, cutting the Kapıdağ Peninsula and continues through the Biga Peninsula and then enters the Aegean Sea.

The East Anatolian Fault, a conjugate of the North Anatolian fault, is a sinistral fault, 400 km in length with a slip rate of around 5 mm per year. The latest big earthquake related to this fault occured on the 1st of May 2003 in Bingöl.

Since earthquakes affect the structure of water and sewerage system and WWTPs, seism tectonics of the regions should be taken into consideration in design and construction works. According to structural regulations, there are five earthquake zones in Turkey ranked from 1 to 5 with the first and 5th as most and least dangerous:

- 1st earthquake zone (very dangerous)
- 2nd earthquake zone
- 3rd earthquake zone
- 4th earthquake zone
- 5th zone (not dangerous)

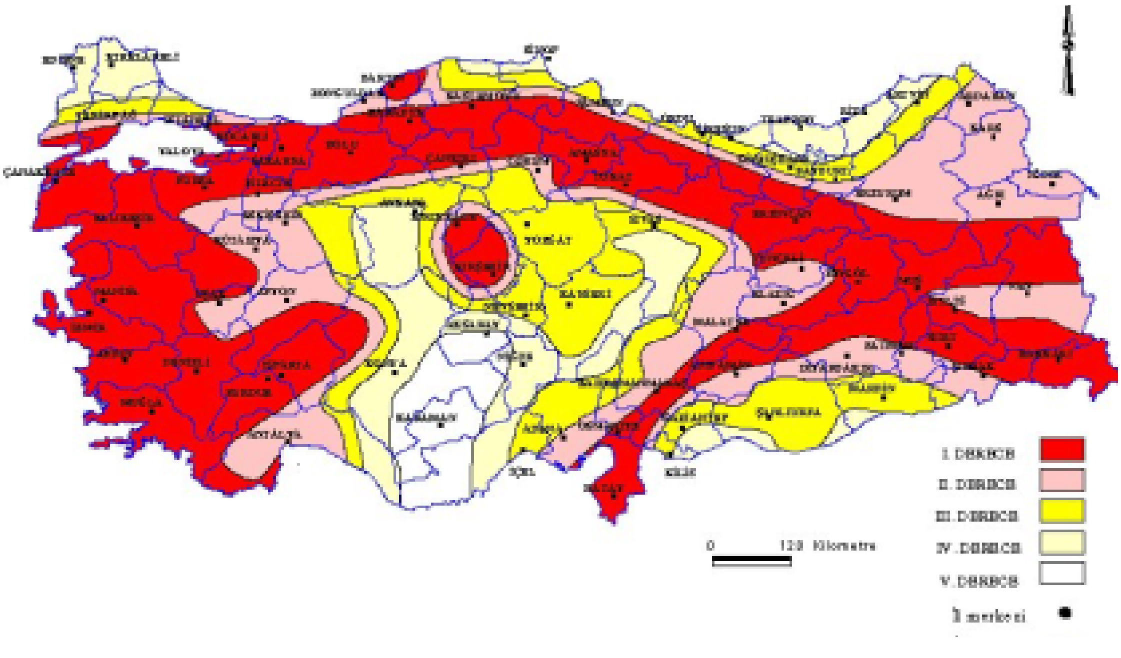


Figure 3: Earthquake Zones in Turkey

2.4 Demography

Turkey's population count has been recorded every five years since 1927. The rural population has continuously decreased at the expense of urban population growth since

1950. At the latest population count in the year 2000, total population was 67.803.927 consisting of 23.797.663 rural and 44.006.274 urban in habitants.

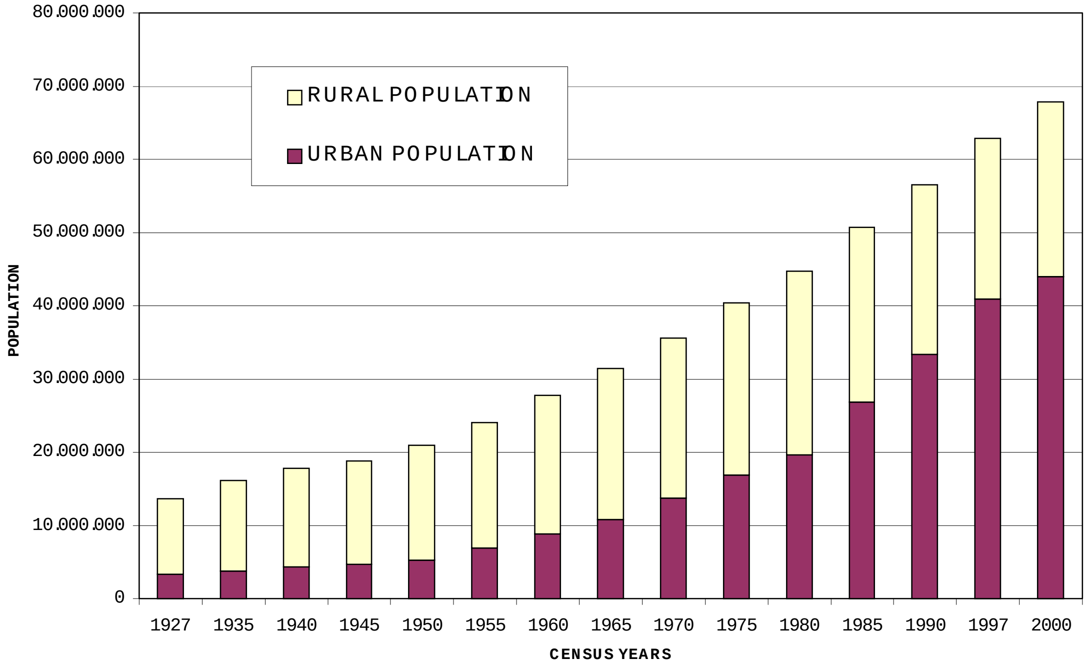


Figure 4: Census Results in Turkey

Turkey has a secular government and people have different religions. About 95% of the people are Muslim. The other 5% are Greek Orthodox, Jewish and Armenian. According to State Statistical Institution and State Planning Organisation, Turkey's population is expected to reach 75.000.000 by the year 2010, 85.000.000 by the year 2020 and 90.000.000 by the year 2025.

Following the acceleration of agricultural mechanization in the 1950's and the rapid growth in industrial investments, migration from villages to the cities speeded up reducing the proportion of population living in rural areas.

Likewise, while 71,8% of economically active manpower worked in the farming sector in 1968, this came down to 66.1% in 1970, 60.9% in 1975, 60.6% in 1983 and 49.3% in 1990. A major portion of the economically active population is still employed in the agricultural sector. The basic reason behind this is that a large part of agricultural production is carried out in small family enterprises in Turkey. According to the 1980 general agricultural census, 0.18% of the enterprises are large scale and 99.82% small scale, 4.8% of the farm land belongs to large enterprises, 95.2% to small ones [FAO 2003].

2.5 Socio–economic Situation

According to World Bank reports, at the end of 2002 Turkey has the 19th biggest economy in the World. According to purchasing power parity, gross national income is 426 billion dollars (6120 dollars per capita).

After the period following 1980, the support of the industrial sector had been concentrated in the level of production and the foreign capital investments were increased. But Turkey suffered by high inflation rates. A new and extensive economic program has been initiated in the beginning of 2000 which firstly resulted in an inflation decrease. Secondly Turkey's economy progressed by the rate of 5%, and it is expected that Turkey will be the 17th biggest economy at the end of 2003.

The primary energy sources as energy consumption in Turkey could be counted as charcoal, lignite, petroleum, natural gas, hydrologic and geothermal energy, and wood and in addition to these primary sources, solar energy is also used.

Turkey is an extremely rich country with respect to the variation of mineral deposits and reserves. Today, production of 53 different mineral deposits and mines are realized in the mining sector in Turkey.

Turkey had 37 billion $ export during the year 2003. It is expected that this amount will be 49 billion $ at the end of 2004. The percentage of agriculture, industry and mining are as follows.

Agriculture	12.50%
Industry	84.00%
Mining	3.50%

Turkey is also a touristic country. There are many charming beach sites along Eagean and Mediterranean costs. In 2003, about 14 million tourists visited Turkey and the touristic income is about 9.4 billion $.

As the surface area of Turkey is wide, three borders are surrounded by seas and as Turkey is a passageway country between Asia and Europe, the transportation sector holds a major importance in the economy of the country. The transportation and the communication sector form approximately 14% of the gross domestic production of Turkey. At the inland freight transportation, highways hold the majority with the proportion of 87.4%. This proportion is 5.5% in railroad transportation, 5.3% in sea transportation and 1.8% in pipeline transportation. 95% of the inland passenger transportation is done by highways.

The communication activities had become one of the basic service sectors of economy in Turkey. The telecommunication, radio, television and information networks provide fast, cheap, qualified and secure services in the free competition medium of the country.

2.6 Agriculture and Forestry

Soils with high production capacity cover 6.5% (5 million ha) of the total land area (77.9 million ha) of Turkey. This proportion is equal to 1/5 of the potential agricultural soils of the country. Pasture land, forest and settlement areas cover about 4.8 million ha. [FAO 2003].

Geographical and climatic conditions make Turkey suitable for vibrant agricultural/food production activities. Turkey is one of the rare countries, which is self sufficient in food production. Growth in this sector accelerated rapidly after the application of the planned period initiated in 1963. The annual growth rate calculated averages about 3.3%. This rate is above the average annual population increase (2.2%) in the same period. The increase in the production is highly dependant on the increase of planting fields and of the number of animals.

The infrastructure supplied by the government in the field of irrigation and soil processing has assisted the growing agriculture in Turkey in the last years. As an example, after the completion of the Southeast Anatolia Project (GAP) in the 21st Century, it would be possible to irrigate 1.7 million hectares of agricultural field of the 3.1 million hectares present in the region. Therefore the variety of agricultural products and agriculture-oriented industry in the region will increase and consequently the competition power of the regional economy both in internal market and foreign markets.

Parallel to the improvements in the industry sector new and modern technologies being used in agriculture sector and new management understandings have developed. The export of agricultural products in 2003 was about five billion dollars and it is expected to be six billion dollars in 2004.

However, soil erosion is a crucial problem affecting soil fertility and sustainability in agriculture. Water and wind erosion has affected the majority of arable land (approximately 68%) causing degradation of soil structure and soil loss. Whilst conventional technique of terracing, strip cropping and appropriate cultivation techniques have been shown to reduce soil loss and increase yield of arable crops, transfer of knowledge to and application by farmers has not been extensive [FAO 2003].

Improper agricultural practices, low quality of irrigation water, water logging and unbalanced fertilization have caused salinity problems in some areas. It has been estimated that 1,5 million ha of the arable land resource suffers from yield limitations because of salt and boron problems and a further 2,8 million hectare from water logging.

26% of Turkey is covered by forest regimes. The area covered by fine quality and productive forests form only a very low ratio of 13%. The productive forest area per person in the country is 0.14 hectares. The average annual wood production in the forestry sector by both public and private sectors is approximately 29 million m^3 . Approximately 68% of this wood production is used as fuel. From 1985, significant amounts of wood is imported every year in order to cover the inner market demands.

2.7 Targeted Area İstanbul

Within the **EMWATER-Project**, the peri-urban areas of İstanbul are the target areas. İstanbul is the biggest city in Turkey and one of the biggest metropolitan cities in the world. İstanbul is also the culture, economy trade and art center of Turkey and many of the industrial organisations are established in İstanbul.

The population of the city is 10.041.477 and it has an area of about 5512 km² with a population density of 1822 persons/km. The socio-economic conditions vary highly. Especially in new developing peri-urban areas the living conditions are not very well.

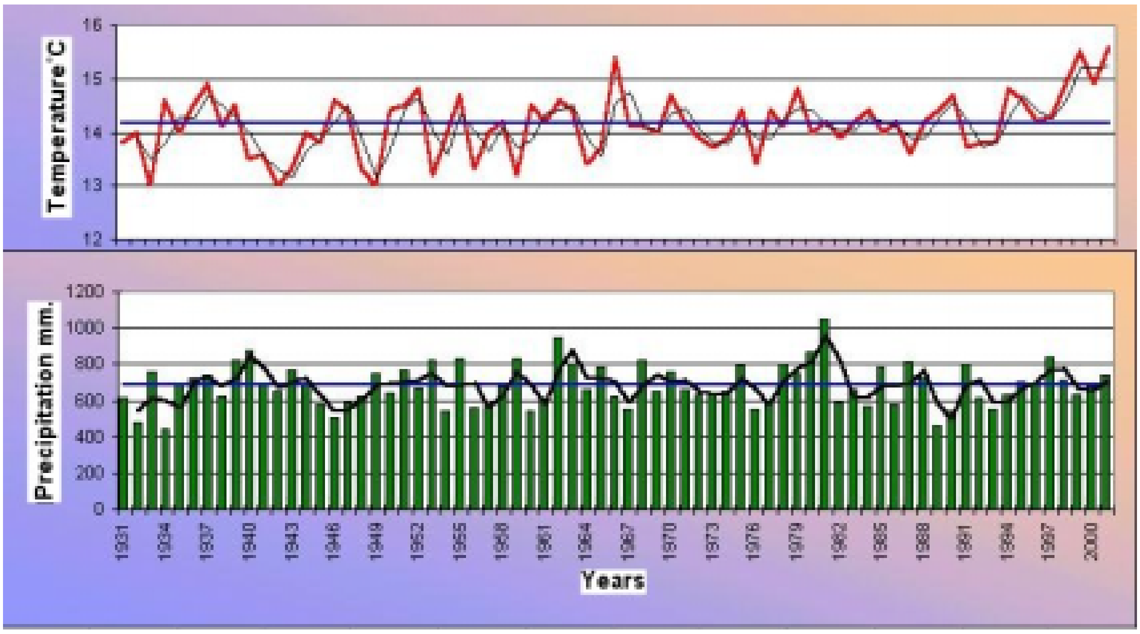


Figure 5: Temperature and Precipitation in İstanbul from 1931 to 2001

The climate of the city is close to that of the Marmara region. The mean climatic factors are summarised in figure 5 and table 2.

Table 2: Meteorologic Data from İstanbul

Month	Sun Shine Durations Hours/day	Average Rainy Days	Average Frozen Days	Average Snow Covered Days
January	2.25	18.2	6.4	3
February	3.15	15.5	6.8	3.2
March	4.21	13.7	4.2	1
April	6.12	10.1	0.3	-
May	8.24	8	-	-
June	10.25	5.2	-	-
July	11.06	3.5	-	-
August	10.23	3.8	-	-
September	8.11	6	-	-
October	5.39	10	-	-
November	3.41	12.9	0.4	0.2
December	2.34	17	2.4	1

İstanbul is situated in the first earthquake zone. One segment of North Anatolia Fault is passing very near to İstanbul.

3. LEGAL AND INSTITUTIONAL FRAMEWORK

3.1 Water Legislation in Turkey

The basic legislation in the water sector is the Turkish Constitution, which states that water resources are natural wealth of the country, under the authority of the state and to be used for the benefit of the public. The Turkish civil code covers water issues in two categories as common waters and private waters. Except some privately owned small springs, the development of water resources, including groundwater, are in general under the responsibility of the State. Nevertheless, utilization of groundwater resources is regulated by a specific law, which licenses the user upon request, within the limits of safe yield of the relevant aquifer. Groundwater use rights can neither be transferred nor sold (DPT 2000, Balman 2000).

The major systematic aspect of water-related activities in Turkey is central planning. On the national level, five-year development plans are the main instrument which aim at ensuring the optimum distribution of all kinds of resources among various sectors of the economy. The link between the relevant sectors is the main concern. In order to guide planning on the national level and facilitate rational decision making in this respect, a special emphasis is to be given to the development of an overall strategy based on the inventory of natural resources including water resources.

Water activities are based on the following laws in Turkey :

Law Number	Name of the Law
167	Ground Water Law
178	The Law About The Water Supply to Military Areas
442	Village Law
743	Turkish Civil Law
831	Water Law
1053	Law of the Domestic Water Supply for Settlements over 100.000 Population
1380	Water Products Law
1580	Municipalities Law
1593	General Sanitary Law
2560	ISKI Establishment Law
2819	EIEI Establishment Law
2872	Environmental Law
3202	Village Affairs General Directorates Establishment Law
3621	Coastal Law
4373	Protection of Storm Water Law
4759	Bank of Province’s Establishment Law

5442	City Administration Law
5516	Drainage Law
6200	DSİ's Establishment Law
7478	The Law of Rural Area Water Supply

3.2 Responsible Bodies in the Water and Wastewater Sector

A number of governmental and non-governmental organizations have direct and indirect responsabilities and interests in the development and conservation of water resources in Turkey.

Institutional framework has three levels; namely, decision making, executive and users level. On the decision making level, the Prime Ministry, The State Planning Organization and different ministries take part. Governmental organizations under the ministries are on the executive level. There are both governmental and non-governmental organizations on the water user's level for the operation and maintenance of the projects.

The four main organizations responsible for the development of water resources are the General Directorate of State Hydraulic Works (DSI), General Directorate of Rural Services (GDRS), General Directorate of Bank of Provinces (Iller Bank) and General Directorate of Electric Power Resources Survey and Development Administration (EIE) which belong to several ministries.

3.2.1 Ministry of Energy and Natural Resources

Within the Ministry of Energy and Natural Resources, there are the two following institutions which are mainly responsable for water resources management:

General Directorate of State Water Works (DSI)

The General Directorate of State Water Works (DSI) was founded in 1954 and is the main Water Authority of the State. Its major tasks are summarized below:

a. Investigation, project and construction, management and services for flood protection, irrigation, drainage, land reclamation, energy production, stream improvement

b. Investigation of groundwater resources, well opening, and protection of groundwater

c. Potable, useable and industrial water supply to cities with population exceeding 100,000 ; carrying out investigations, projects and constructions for such purposes.

Directorate of Electric Works and Investigation (EIEI)

The General Directorate of EIEI was founded in 1935. This institution selects the water resources suitable for the hydroelectric generation of energy, and carries out all investigations and project works for such purposes.

3.2.2 Ministry of Agriculture and Rural Works

The General Directorate of Rural Services is a part of the Ministry of Agriculture and Rural Works.

The General Directorate of Rural Services (GDRS)

The General Directorate of Rural Services is responsible for efficient use of water resources, the supply of potable water, design and construction of treatment plants in **rural areas** (cities and municipalities with less than 100,000 population). Besides it carries out work in of small-scale irrigation projects (water supply below 500 liters per second flow rate, irrigation of smaller land less than 500 hectare-areas).

3.2.3 Ministry of Public Works and Inhabitance

Within the Ministry of Public Works and Inhabitance, the following institution is financially related to water issue:

The General Directorate of the Bank of Provinces (İller Bank)

The General Directorate of the Bank of Provinces (İller Bank) was founded in 1937. This Bank aids all municipalities in the build-up and collection of potable-useable water and wastewater, discharge and treatment affairs. The Bank supports the municipalities in investigation, feasibility studies, project and construction of such works. The municipalities receive financial credits from the Bank. The tasks performed up to date by the Bank of Provinces will be discussed more comprehensively in later sections.

3.2.4 Ministry of Environment and Forestry

The Ministry of Environment was founded in 1991 with the tasks of protection and remediation of the environment, effective management of rural and urban land and the natural resources, protection and improvement of natural resources of Turkey as well as prevention of all kinds of environmental contamination.

The Ministry of Environment was unified with the Ministry of Forestry under a single name (Ministry of Environmental and Forestry) in 2003. it’s major tasks are being continued with the added task of Forestry protection and management.

The General Directorate of Meteorological Works is also a part of the Ministry of Environment and Forestry.

3.2.5 Ministry of Tourism and Culture

The Ministry is involved in the potable water supply, sewage collection and similar infrastructure of all facilities located in tourist regions.

3.2.6 Metropolitan Municipalities of Big Cities

Metropolitan municipalities in Turkey are founded with special law. These organizations provide service to cities exceeding a certain population. Currently there are 15 metropolitan municipalities all over the country.

In big cities, water and sewage works associations are built for providing water supply and sewage collection services. They serve about 22.000.000 people.

The names of the water and sewerage Administrations are :

İstanbul Water and Sewage Administration (ISKI)

Ankara Water and Sewage Administration (ASKI)

İzmir Water and Sewage Administration (IZSU)

Adana Water and Sewage Administration (ASKI)

Bursa Water and Sewage Administration (BUSKI)

Gaziantep Water and Sewage Administration (GASKİ)

Konya Water and Sewage Administration (KOSKİ)

Kayseri Water and Sewage Administration (KAYSU)

Antalya Water and Sewage Administration (ASAT)

Diyarbakır Water and Sewage Administration (DISKI)

Mersin Water and Sewage Administration (MESKI)

Eskişehir Water and Sewage Administration (ESKI)

Samsun Water and Sewage Administration (SASKI)

Erzurum Water and Sewage Administration (ESKI)

Kocaeli Water and Sewage Administration (ISU)

3.2.7 Municipalities

According to the prevailing laws and regulations in Turkey, sufficient amounts of hygienic potable-useable water supply to people living with municipal regions as well as collection and treatment of sewage and effluents without giving any harm to the environment are the responsibility of the municipalities.

Currently (in 2003) there are 3149 municipalities in Turkey which are listed in Table 3. Among these municipalities, 15 of them have metropolitan status.

According to the population count in 2000, municipalities provide service to 54,000,000 inhabitants. The remaining 14 million people obtain water and sewage services from the General Directorate of Rural Works.

Table 3: Municipalities in Turkey

Range of population	Number	Population
0-2000	354	594.624
2001 – 10.000	2213	8.916.943
10.001 – 50.000	449	9.309.686
50.001 –100.000	75	5.217.897
100.001 – 1.000.000	53	12.955.060
> 1.000.000	5	16.564.492
TOTAL	3.149	53.558.702

3.3 Responsible Body in the Targeted Area

The mainly responsible body in the targeted area is İstanbul Water and Sewerage Administration (ISKI). ISKI was established at 1981 by the law number 2560 (Official Gazette, 23.11.1981, No: 17523). ISKI is responsible to perform all the works related to water supply and sewerage works (including WWTP) of Metropolitan İstanbul Area. ISKI has the following structure.

a. **General Meeting**: General Meeting is the Town Council of the Greater İstanbul Municipality. The President of the General Meeting is the Mayor of İstanbul. General Meeting makes decisions about investment programs, water tariffs, foreign credits and other important issues.

b. **Council of Managers**: This has a president and five members and is the decision making body for ISKI.

c. **Controllers** : ISKI has two controllers.

d. **General Director** : He is the active manager of ISKI.

The main functional departments of ISKI are the following:

1. Planning and Design Department
2. Water Construction Department
3. Wastewater Construction Department
4. Water Transmission and Distribution Department
5. Water Treatment Department
6. Wastewater Treatment Department
7. Sewerage Department
8. Distribution Systems Department
9. Sewerage License Department
10. Distribution Systems Operation and Maintenance Department

ISKI also has many other supporting departments.

At present ISKI is a well furnished organization with many well educated and experienced personnel. Its financial structure is also quite satisfactory.

4. WATER SECTOR

4.1. World Water Resources

The total estimated amount of water in the world is 1400 million cubic kilometers. About 97.5% of this water is contained in the seas and oceans as saline water. The annual amount of precipitation reaching the ground is about 100.000 cubic kilometers. Only 9000 cubic kilometers of this water may be used for technical and economic benefits.

Total water consumption in the world in 1990 was 4130 km³. About 2680 km³ (65%) of this water was used for irrigation, 400 km³ (10%) for potable-useable water, 950 km³ (23 %) for industrial use and the remaining 100 km³ (2%) evaporated from reservoirs.

According to widespread criteria, countries with water potential per person less than 10.000 m^3 are considered “water poor”. In accord with this approach, 11 African, 9 Far Eastern and 26 Middle Eastern countries fall into this category-in the year 1990. Since rapid population growth is continuing, this situation may get worse in the coming years (DPT 2001).

In underdeveloped and developing countries, rapid urbanization and growth of demand for potable-useable and industrial water in many regions exist and efforts to meet such demand necessitate big scale and costly projects.

The consumption of water in certain regions gives rise to serious water discharge problems in these regions. This discharge water should be treated. On the other hand, water treatment necessitates serious financing.

When these facts are considered together, efficient water management as well as performing extensive research on this matter, educating and enlightening all consumers is of vital importance.

4.2. Turkey’s Water Resources

The Turkish overall water budget is shown in Figure 6. the mean level of precipitation is 643 mm. This corresponds to about 501 billion cubic meters of water per annum. Turkey’s renewable water potential is about 234 billion cubic meters.

As seen from the flow diagram in Figure 6, the total amount of surface and ground water in Turkey that can be technically and economically consumed is 110 billion m^3. Of this amount, about 95 billion m^3 originates from inter-country born rivers, 3 billion m^3 from streams reaching Turkey from neighboring countries, 12 billion m^3 from ground water.

Turkey’s useable water per person is 1622 m^3, and water potential 3451 m^3 per year. Considering these average values of the water budget, it seems that Turkey is a water-rich country. But the precipitation regime shows wide seasonal and regional variability. Topographical irregularities, uneven distribution of resources and precipitations with respect to the various geographical regions are major sources of problems related to Turkey`s water resources.

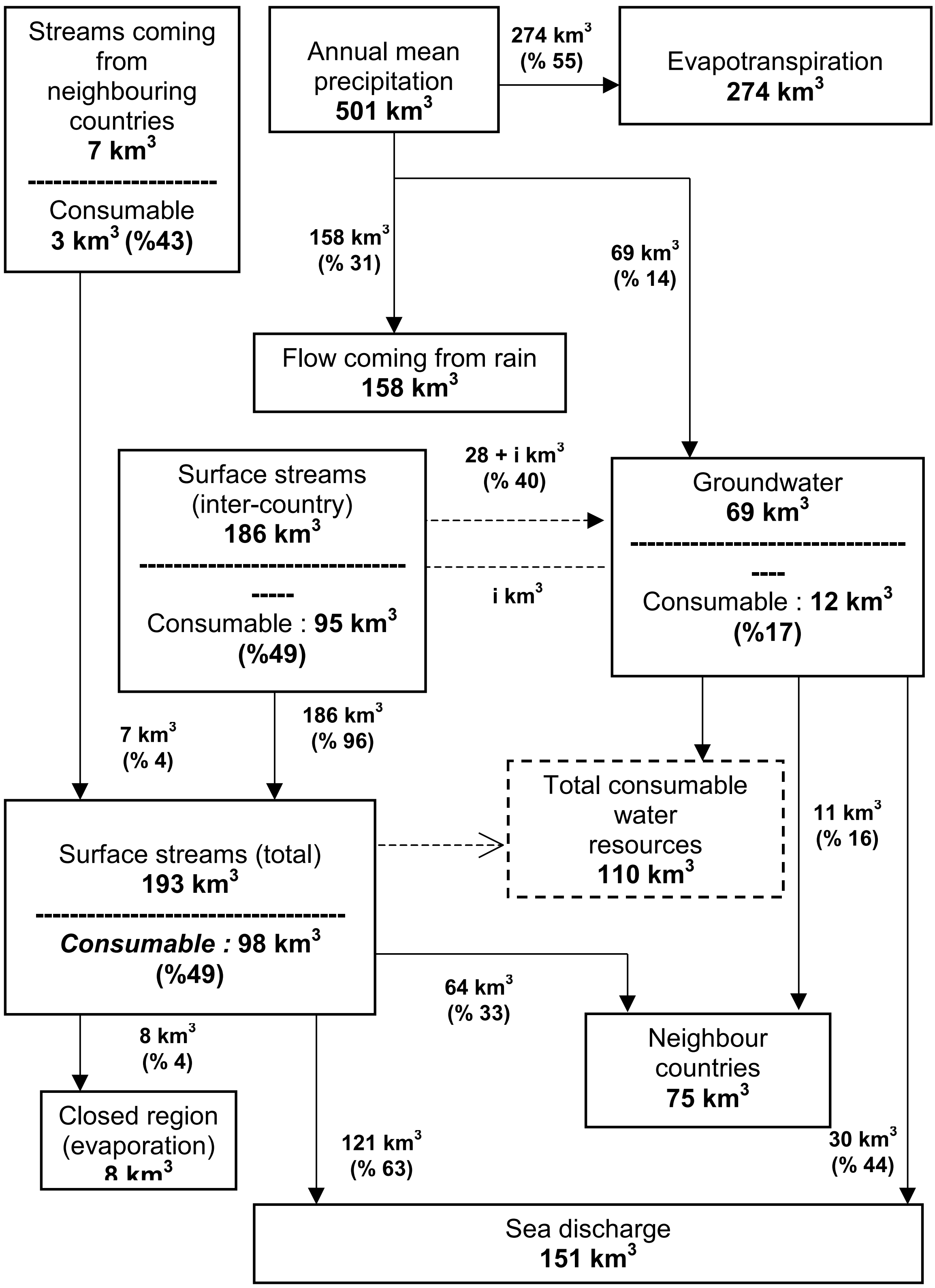


Figure 6: General water budget

On the one hand, Turkey is not a water rich country since the water potential is only 21% of the world´s average. But on the other hand, compared to the other Mediterranean countries involved in this project, the mean Turkish water potential is much bigger especially than in Jordan and Palestine.

Table 4: Usable water potential of some countries and continents

Country or Continent	**Water Potential (m^3) Per annum per Capita**
JORDAN	160**
LEBANON	1300*
TURKEY	1622*
PALESTINE	370**
ASIAN AVERAGE	3000*
WEST EUROPEAN AVERAGE	5000*
AFRICAN AVERAGE	7000*
SOUTH AMERICAN AVERAGE	23000*
WORLD AVERAGE	7600*

* Turkish State Planning Organisation
** World Resources Institute 1990

After 1980, serious work was carried out on potable water, sewage, water treatment plants and solid waste treatment and disposal. In this period, attention was given to the training of technical people working in the sector, and many investigations and projects were realized.

As results of these efforts in the field of water supply,

- potable water is supplied to all urban inhabitants. Improvement and further development of present potable water plants are planned.
- Potable water plants built in rural areas provide service to about 1 million people.

Data on drinking water supply per capita per day in Turkey is given below:

	Drinking water per capita per day (L/d)
Big Cities	200 – 250
Other Cities	150 – 200
Villages	100 – 120

The primary problem in the sector is inadequacy of financing. Moreover, in small municipalities especially, there are problems arising from lack of trained technical staff to handle potable water and sewage systems. Trained staff in such municipalities is limited or non-existent, therefore existing plants are not operated efficiently, for example loss due to water leakage in some plants is very high. Some municipalities deliberately keep the used water tariff low or do not charge the consumers for sewage services. This approach renders financing new plants very difficult.

The population in urban areas benefit from potable water services. On the other hand, especially in small towns, potable water plants are built by the municipalities, therefore the compability of the water quality standards with internationally accepted standards cannot always be guaranteed.

At this time, it is expected that new potable water plants will be built in developing regions of urban areas, and that water quality standards of present plants will be improved.

Since groundwater resources are not sufficient for urban potable water supply, surface water sources have also been utilized for the last 20 years, and potable water reaches the consumers after treatment.

In rural areas, the basic resources utilized for the supply of potable-useable water is groundwater and water from wells and springs. The number of potable water production wells opened up till now is 5201, and the flow rate is about 500.000 liters per second. The number of spring resources is 42948, and the flow rate is 2.9 million liters per second. Since consumers in rural regions are not charged for the potable water they use, there is no recycling of expenditures.

Another important problem in the potable-useable water sector in Turkey is the lack of a high level of coordination in resources management. Water resources budget should be prepared so as to include the quality and amount of water, and the purpose of primary usage of country-wide resources should be determined. Due to uncoordinated actions, some high quality water resources that can be used without treatment are occasionally used inefficiently for irrigation.

4.3 Drinking Water Supply

It is roughly estimated that at present almost 92% of the urban population have public water supply in acceptable quality. Public water supply in the municipalities of Turkey is summarized in Annex C. In rural areas the drinking water is supplied by wells or springs.

4.4 Water Demand

The State Statistical Institute estimates that Turkey's population will reach 90 million by 2025. In that case, the amount of usable water per capita will drop to 1222 cubic meters by 2025.

Turkish State Planning Organisation forecasted the Turkish water consumption as you can see in Table 5. It is assumed that at 2030 domestic water consumption will be 500 l/cap/day. Additionally, the domestic water consumption amount includes 5000 million m³ for touristic demand.

Table 5 Development of Water Consumption in Turkey (DIE 2002)

Year	**Irrigation**		**Domestic**		**Industrial**		**Total**
	Million m³	%	Million m³	%	Million m³	%	Million m³
1990	22.016	72	5.141	17	3.443	11	30.600
1997	26.415	74	5.520	15	3.710	11	35.645
2000	31.500	75	6.400	15	4.100	10	42.000
2030	71.500	65	25.300	23	13.200	12	110.000

The forecast of 500 l/cap/day water consumption seems to be very high,. compared to the drinking water consumption in the EU. E.g. the German water consumption at present is about 130 l/cap/day.

In Turkey, especially in hot summer months water consumption is very high. People use to irrigate their gardens and public parks by drinking water. A lot of people are not aware to use water efficiently.

4.5 Water Sector in the Targeted Area Istanbul

Presently, almost all the people in the city have access to high quality drinking water. At present, ISKI suppies high quality water to everybody living in İstanbul. According to monthly “İSKİ News Bulletin”, 350 – 400 samples from different points of the water network are taken regularly and the results are perfectly according to Turkish, WHO, EC and EPA standards.

The drinking water consumption in Istanbul is forecasted by ISKI and presented in the following table.

Table 6: Water Demand in Istanbul

	Population	**Water consumption**	
Year	Mio	m³/day	Mio m³/year
2000	12,1	2.571.435	939
2010	14,7	3.554.956	1.298
2020	16,5	4.264.151	1.556
2030	17,7	4.811.380	1.756
2040	18,7	5.303.516	1.936

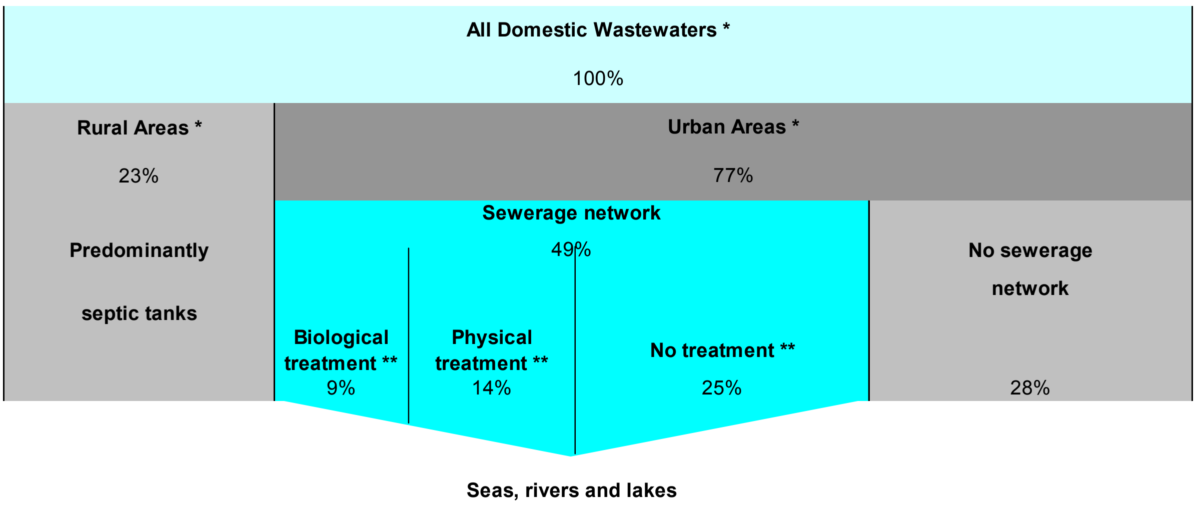
5. WASTEWATER SECTOR

5.1. General

After 1980 a lot of efforts were made in the field of wastewater management:

- Sewage network services were provided to 13.400.000 inhabitants covering the metropolitan municipalities.
- About 3.6 million people obtained wastewater treatment services through the cooperation of the Bank of Provinces.
- Many wastewater treatment plant constructions were completed in big cities like İstanbul, Ankara and İzmir, and some plants are currently under construction. In the next 2-3 years, all major wastewater and sewage treatment plants of metropolitan municipalities will be in operation.
- In rural areas, 2540 villages obtained simple sewage treatment services based on anaerobic sewage degradation in trenches.

An overview on the Turkish sewerage network and WWT is given in the following flow scheme:



* based on pe
** based on wastewater flow

Figure 7: Overview on the Wastewater Treatment and Disposal in Turkey (DIE 2001)

Only half of the whole domestic wastewaters is collected in central sewage networks. In rural areas the wastewater is mainly collected in septic tanks or not collected at all. Less than 10% of the whole wastewater is treated biologically.

This overview is based on data from 1998 and currently there are a lot of efforts done like explained before. Therefore this poor wastewater management situation will be more and more improved. However the primary problem in the wastewater sector is as well as in the water sector the inadequate finance.

The Turkish Minister for Environment Osman Pepe assesses 35 Million Euro in the next 15 to 20 years to adapt the infrastructure for wastewater, solid wastes and wasted air to the EU level, on the occasion of his visit in Berlin, Germany (KA 2004).

5.2 National Policies – Effluent requirements

Water treatment, treated wastewater discharges and the principles of the use of treated wastewater are based on the following law and regulations in Turkey (DPT 2000, Balman 2000).

a. Environmental Law :

Law number : 2872

Published in official gazette : August 8, 1983

No. of official gazette : 18132

b. Water Pollution Control Regulation

Published in official gazette : September 4, 1983

No. of official gazette : 19919

c. Water Pollution Control Regulation Technical Instructions

Published in official gazette : January 7, 1991

No. of official gazette : 20784

According to the Turkish Environmental Law and Water Pollution Control Regulation; minimum effluent standards for municipal wastewater are given in the following table.

Table 7: Minimum Effluent Standards for Municipal Wastewater

N < 1000 person, Influent BOD_5 load < 60 kg/day

Parameter	Unit	Composite Sample (2 hrs)	Composite Sample (24 hrs)
Biochemical oxygen demand (BOD_5)	mg/l	50	45
Chemical oxygen demand (COD)	mg/l	180	120
Suspended Solids (SS)	mg/l	70	45
PH		6-9	6-9

N= 1000 - 10000 people, Influent BOD_5 load < 60-600 kg/day

Parameter	Unit	Composite Sample (2 hrs)	Composite Sample (24 hrs)
Biochemical oxygene demand (BOD_5)	mg/l	50	45
Chemical oxygene demand (COD)	mg/l	160	110
Suspended Solids (SS)	mg/l	60	30
PH		6-9	6-9

N > 10 000 people, Influent BOD_5 load > 600 kg/day

Parameter	Unit	Composite Sample (2 hrs)	Composite Sample (24 hrs)
Biochemical oxygen demand (BOD_5)	mg/l	50	45
Chemical oxygen demand (COD)	mg/l	140	100
Suspended Solids (SS)	mg/l	45	30
PH		6-9	6-9

In practice, in small treatment plants, BOD_5 < 30 mg/l and SS < 20 mg/l principle is acceptable.

Before designing a treatment plant and before deciding the treatment process, an environmental impact assessment study is essential. If the receiving water is important and will be used as public water resource or if it will pass through a settlement area, the standards will be more strict. In that case, the engineer preparing the design work and the control engineer will decide the necessary standard.

Other effluent characteristics (such as N and P and other substances such as toxic materials etc.) are decided according to the environmental impact assessment reports. If these elements will harm the receiving water and the environment, their removal can also be necessary. In sensitive areas, N and P treatment is compulsory.

There are presently a lot of efforts done to prepare the adoption of EU standards and specification in water and wastewater works.

Table 8: Criteria for Deep Sea Discharges in Turkey

Parameter	Values
pH	6 - 9
Temperature	< 35 Cº
Suspended solids	< 350 mg/l
Oil and gress	< 10 mg/l
Swimming materials	none
BOD_5	< 250 mg/l
COD	< 400 mg/l
Total nitrogen	< 40 mg/l
Total phosphorus	< 10 mg/l
Surface active elements	< 10 mg/l

Additionally :

- It is strictly forbidden to discharge material which are biologically non degradable

- The dangerous and harmfull material mentioned in "Dangerous and Harmfull Materials Regulation" are also forbidden.

Parameter	Limits
1. Temperature	In any case the temperature of w.w. to be discharged should not be more than 35 Cº. In first dilution, the discharge of w.w should not increase the sea water temperature : - 1 Cº between May and October - 2 Cº in the other months
2. Most probable total and Fecal coliform number	At the end of overall dilution : - Total coliform < 1000 T.C/100 ml. - Fecal coliform < 200 F.C/100 ml
3. Solid and swimming	Out of the band near to the diffuzor (the with of the band is equal to sea depth at that point). There will be no swinming and solid materials
4. Minimum discharge pipe	Population < 1000 l > 500 m. Population > 1000 l > 1300 m.

At present, about 45% of treated wastewaters are discharged to the seas.

In the “Water Pollution Control Regulation Technical Instructions” there are wastewater quality standards for effluents to be discharged to the sea. Also, there are criteria for deep sea discharges which are given in table 8.

In sensitive areas such as touristic Mediterranean, Aegean and Marmara Sea Costs, in designing deep sea outfall, it is compulsory to obey European Union instructions which are given in the Annex B.

5.3 Wastewater Influent Characteristics In Turkey

The concentration in the wastewater depends on the original concentration in the water supply, and the uses to which the water has been put. The climate and the wealth as well as habits of the people have a marked effect on the wastewater characteristics. Concentrations are also affected by water consumption, ground or surface water infiltration and exfiltration in sewer system.

For more than 25 years, influent analysis have been carried on especially by the Iller Bank. It was observed that wastewater characteristics vary not only from city to city, but also from season to season and even hour to hour within a given city. The range of values are given in Table 9.

Table 9: Typical Domestic Wastewater Characteristics in Turkey

Parameter	Load	Concentration
	g/cap/d	mg/l
BOD_5	45-60	200-360
Chemical oxygen demand	1.6-1.9 x BOD_5	360-570
Total organic carbon	0.6-1.0 x BOD_5	150-220
Total solids	170-220	800-1100
Suspended solids	70-145	350-750
Grit (inorganic, 0.2 mm and above)	5-15	25-75
Grease	10-30	50-150
Alkalinity (as calcium carbonate, $CaCO_3$)	20-30	-
Chlorides	4-8	20-40
Total nitrogen N (*)	6-12	30-60
Organic nitrogen	~ 0.4 x total N	12-24
Free ammonia	~ 0.6 x total N	18-36
Nitrite	-	
Nitrate	0.0-0.5 x total N	0-30
Total phosphorus, P	0.6-4.5	3-22
Organic phosphorus	~ 0.3 x total P	1-7
Inorganic (ortho-and polyphosphates)	~ 0.7 x total P	2-15
Potassium (as potassium oxide K_2O	2.0-6.0	10-30
Microorganisms present in wastewater	(per 100 ml	
Total bacteria	10^9-10^{10}	
Coliforms	10^9-10^{10}	
Faecal streptococci	10^5-10^6	
Salmonella typhosa	10^1-10^4	
Protozoan cysts	up to 10^3	
Helminthic eggs	up to 10^3	
Virus (plaque forming unit's)	10^2 – 10^4	
pH 6.5 – 8.0	-	

Domestic wastewater characteristics in several Turkish cities and municipalities are given additionally in Annex J and K.

5.4 Existing and Planned Wastewater Treatment Plants

Big cities and municipalities such as İstanbul, Ankara, İzmir have modern WWTPs incl. nutrient removal. The WWTP in other metropolitian cities are under construction. As example, some technical data for Ankara and İzmir WWTP are given in the Annexes E and F.

As an example for successfull biological treatment, the effluent characteristics of İzmir WWTP are given in the following table.

Table 10: Effluent Characteristics in İzmir WWTP

Parameter	Values (mg/l)
BOD_5	< 20 mg/l
COD	< 100 mg/l
Total Suspended Solids	< 30 mg/l
Total N	< 12 mg/l
Total P	< 1 mg/l

Another example for influent and effluent characteristics of a WWTP in İstanbul are given in the Annex A (Paşaköy WWTP). General informations about sewerage and WWT in the municipalities of Turkey are given in Annex D.

In Turkey, generally three main types of treatment plant are preferred:

a. For small communities (less than 20 000 pe) ponds are the preferred choice.

The type of ponds depends on the climate of the region, availability and price of land. A big advantage of ponds is the little need of operation and maintenance. The main types of ponds used include :

a1. Stabilization ponds, preferred where land is available and climate is mild

a2. Facultative aerated lagoons

a3. Anaerobic lagoons and facultative aerated lagoons

b. For middle sized WWTPs trickling filters are preferred.

c. For large scale WWTPs either classical activated sludge or extended aerated activated sludge plants are preferred.

One of the important problems in WWT is high electrical energy cost. So, the municipalities don't prefer WWTP having a lot of mechanical and electrical equipments and instruments.

Annexes G, H and I give some ideas about the types of WWTP generally used in Turkey (WWTPs financed by the İller Bank).

5.5 Disposal of Sewage Sludge

In Turkey, sewage sludge from the existing WWTP are utilized either in agriculture or disposed to landfills. If the sludge is produced from industrial WWTP and contains poisonous materials, it is treated as hazardous waste material.

The principle of the sewage sludge disposal are based on the following regulations.

- Soil Pollution Control Regulation

  Published in official gazette : December 10, 2001

  No. of official gazette : 24609

- Solid Wastes Control Regulation

  Published in official gazette : March 14, 1991

  No. of official gazette : 20814

The permission of the Environmental Ministry is necessary for the application of WWTP sludge on fields in agriculture. The WWTP operator are in charge to make the necessary analyzes of the sludge and the soil and apply for approval to the Ministry.

5.6 External Credits In Water And Wastewater Treatment Plants

Water and Sewerage Organisations of Metropolitan Municipalities are funded by external credit. Most of the treatment plants constructed using these credits are working successfully and some are still under construction.

Some of the organisations which use external credit and the credit sources are shown the following table (DPT 2002).

Table 11: Administration and Credit Sources

Administration	Source of Credits
1. Adana - ASKİ	European Investment Bank and KFW
2. Ankara - ASKİ	KFW, Word Bank, Kuveyt Fund, European Investment Bank
3. Antalya - ASAT	World Bank
4. Bursa - BUSKİ	World Bank
5. Diyarbakır - DISKI	KFW, WordBank, Kuveyt Fund,European Investment Bank
6. Erzurum - ESKİ	France
7. Eskişehir - ESKI	France
8. Gaziantep - GASKI	Banque Paribas, France
9. Istanbul - ISKI	World Bank, KFW, Nordic Investment Bank, French Government, Kuveyt Fund, Banque Parisbas (France), European Settlement Fund
10. Izmir - IZSU	World Bank, Banque de Paris et des Pays-Bas SA
11. Izmit -	Chase Manhattan Bank, England, Eximbank-Japan

5.7 Sewerage System in the Targeted Area İstanbul

Most parts of the city have sewerage network. There are many WWTPs and deep sea outfalls into the sea. The sewerage system also covers most of İstanbul area. But especially, in suburban areas the sewerage system should be improved.

The wastewater receiving body in İstanbul is Marmara Sea and Bosphorous. There are a lot of WWTP and deep sea discharges in İstanbul. The names and the capacities of WWTP and deep sea discharges are given in table 12.

Table 12: WWTPs in İstanbul

Name of WWTP	Max.Capacity (m^3/sec)
A. Anatolian Site :	
1. Kadıköy Pretreatment and Sea Outfall	Q = 12.780
2. Kücüksu Pretreatment and Sea Outfal	Q = 7.570
3. Tuzla Treatment Plant	-
4. Paşaköy Treatment Plant	
B. Europe Site :	
1. South Küçükçekmece WWTP and Sea Outfall	Q = 3.000
2. North Küçükçekmece WWTP and Sea Outfall	Q = 6.000
3. Ataköy Küçükçekmece WWTP and Sea Outfall	Q = 9.030
4. Ambarlı Küçükçekmece WWTP and Sea Outfall	Q = 7.520
5. Yenikapı Küçükçekmece WWTP and Sea Outfall	-
6. Baltalımanı Küçükçekmece WWTP and Sea Outfall	Q = 13.000
7. Büyükçekmece	Q = 2.700

One of the major WWTP in İstanbul is Paşaköy. The influent and effluent characteristics determined in this plant are summarized in Annex A.

6. WATER REUSE

The main objective of the EMWater Project is to encourage reuse-oriented wastewater management. Therefore draft policy guidelines for efficient wastewater treatment and reuse will be elaborated which shall support the further elaboration of water laws, standards, legislation and policies in the Mediterranean partner countries. New water resources shall be developed by using treated wastewater as a source for the expanding water demands in the region.

The policy guidelines will suggest different reuse purposes and evaluate different technologies and their costs. Quality standards for different agriculture applications will be developed recognizing health risks and integrating environmental aspects, regional and international experience, as well as institutional aspects.

Treated wastewater shall be reused whenever appropriate. Today, technically proven wastewater treatment and purification processes exist to produce water of almost any quality desired. The contaminants in reclaimed wastewater that are of public health significance consist of biological and chemical agents. In the planning and implementation of wastewater reclamation and reuse, the intended water reuse applications dictate the extent of wastewater treatment required. Possible applications are:

- Irrigation in agriculture (plants not eaten by humans; plants eaten cooked; plants eaten uncooked) or for landscaping (with direct contact; without direct contact)
- Groundwater recharge
- Industrial reuse
- Human reuse (usable water; drinking water)

Advantages of wastewater reuse

The reuse of wastewater reduces the demand on freshwater sources. Additionally the technology may diminish the volume of wastewater discharged, resulting in a beneficial impact on the aquatic environment. Capital costs are low to medium, for most systems, and are recoverable in a short time; this excludes systems designed for direct reuse of sewage water. Operation and maintenance are relatively simple except in direct reuse systems, where more extensive technology and quality control are required. The provision of nutrient-rich wastewaters can increase agricultural production.

Disadvantages of wastewater reuse

Reuse of wastewater may be seasonal in nature, resulting in the overloading of treatment and disposal facilities during the rainy season; if the wet season is of long duration and/or high intensity, the seasonal discharge of raw wastewaters may occur. Health problems, such as water-borne diseases and skin irritations, may occur if people come into direct contact with reused wastewater. In some cases, reuse of wastewater is not economically feasible because of the requirement for an additional distribution system. The reuse of reclaimed wastewater may not be culturally or religiously accepted in some societies. These circumstances have to be analyzed carefully before a reuse orientated system is implemented.

6.1 Types of Reuse

Treated wastewater usage depends on several factors (supply and demand, treatment requirements, storage, distribution system, associated environmental and health risks, cultural acceptance). Treated wastewater can be reused for different applications, e.g. agriculture, industry, households or groundwater recharge. Most common is the reuse in agriculture.

6.1.1 Agricultural Reuse

In the Mediterranean basin, wastewater has been used as a source of irrigation for centuries. In addition to providing a low cost water source, the use of treated wastewater for irrigation in agriculture combines three advantages. First, using the fertilizing properties of the water eliminates part of the demand for synthetic fertilizers and contributes to decrease levels of nutrient in receiving waters (rivers, sea, ocean, lakes). Second, the practice increases the available agricultural water and third, it may eliminate the need for expensive tertiary treatment.

However, wastewater is often associated with environmental and health risks. As a consequence, its acceptability to replace other water resources for irrigation is highly dependent on whether the health risks and environmental impacts entailed are acceptable.

Because crop water requirements vary with climatic conditions, the need for supplemental irrigation will vary from month to month through the year. This seasonal variation is a function of rainfall, temperature, crop type, and stage of plant growth, and other factors depending on the method of irrigation being used. The supplier of reclaimed water must quantify these seasonal demands, as well as any fluctuation in the reclaimed water supply, to assure that the demand for irrigation water is met. To assess the feasibility of reuse, the supplier of reclaimed water must be able to reasonably estimate irrigation demands and reclaimed water supplies.

The constituents of concern in using reclaimed water for agricultural irrigation are salinity, sodium, trace elements, excessive chlorine residual, and nutrients. The most important nutrients to a crop’s needs called macro nutrients are nitrogen, phosphorus, calcium, magnesium and sulphur. The needed trace elements or micronutrients are boron, copper, iron, chloride, manganese, molybdenum and zinc. Reclaimed water usually contains enough of these nutrients to supply a large portion of a crop’s needs since these nutrients are present in human urine and feaces.

The types and concentrations of constituents in reclaimed wastewater depend upon the municipal water supply, the influent waste streams (i.e. industrial contributions), amount and composition of infiltration in the wastewater collection system, the wastewater treatment processes, and the type of storage facilities.

Industrial influence can be a big problem for water reuse because e.g. metal working industry produces wastewater that is highly polluted by metal concentrations and should be pretreated in an adequate manner at source. When mixing it with domestic wastewater, the metals are almost impossible to be removed from the whole wastewater stream.

6.1.2 Water Reuse in Parks and Green Areas

Due to rising tourism in the coastal regions, there is also an increasing water demand in parks and green areas. The demand is highly varying during the seasons, often the tourist season is coherent to the season of water shortage. The conditions for irrigation of parks and green areas are similar to those of irrigation in agriculture. Although there are usually no fodder crops located in parks, bad smell can be a problem raising with irrigation with treated wastewater. Consequently, there should be required a good quality of treated wastewater as well as for agricultural reuse.

6.1.3 Groundwater Recharge

The purposes of groundwater recharge using reclaimed water include the establishment of saltwater intrusion barriers in coastal aquifers, the augmentation of potable or non-potable aquifers, the storage of reclaimed water for future reuse, and the control or prevention of ground subsidence.

Infiltration and percolation of reclaimed water take advantage of the subsoil's' natural ability for biodegradation and filtration, thus providing additional in situ treatment of the wastewater and additional treatment reliability to the overall wastewater management system. The treatment achieved in the subsurface environment may eliminate the need for costly advanced wastewater treatment processes, depending on the method of recharge, hydro geological conditions, requirements of the downstream users, and other factors. Additionally groundwater recharge helps provide a loss of identity between reclaimed water and groundwater. This loss of identity has a positive psychological impact where reuse is contemplated and is an important factor in making reclaimed water acceptable for a wide variety of uses, including potable water supply augmentation.

Methods of Groundwater Recharge are riverbank or dune filtration, surface spreading, or direct injection. Recharge via riverbank or sand dune filtration is practiced in Europe as a means of indirect potable reuse. Surface spreading is a direct method of recharge whereby the water moves from the land surface to the aquifer by infiltration and percolation through the soil matrix. Direct injection involves the pumping of reclaimed water directly into the groundwater zone, which is usually a well-confined aquifer. Direct injection is used where groundwater is deep or where hydro geological conditions are not conducive to surface spreading. Direct injection is also an effective method for creating barriers against saltwater intrusion in coastal areas. Direct injection requires water of higher quality than surface spreading because of the absence of soil matrix treatment used by surface spreading.

The risk of groundwater recharge, that has to be considered, is the possibility of aquifer contamination. Aquifer remediation is difficult, expensive, and may take years to accomplish. Many criteria specify the quality of the reclaimed water, the groundwater, and the aquifer material that have to be taken into consideration prior to construction and operation recharge systems. These include possible chemical reactions between the reclaimed water and the groundwater, iron precipitation, ionic reactions, biochemical changes, temperature differences, and viscosity changes.

6.1.4 Industrial Reuse

Industrial reuse represents a significant potential market for reclaimed water. Reclaimed water is ideal for many industries where processes do not require water of potable quality. Also, industries are often located near populated areas where centralized wastewater treatment facilities already generate an available source of reclaimed water. Reclaimed water for industrial reuse may be derived from in-plant recycling of industrial wastewaters and/or municipal water reclamation facilities. Recycling within an industrial plant is usually an integral part of the industrial process and must be developed on a case-by-case basis. Industries, such as steel mills, breweries, electronics, and many others, treat and recycle their own wastewater either to conserve water or to meet or avoid stringent regulatory standards for effluent discharges.

Cooling water is currently the predominant industrial reuse application. In most industries, cooling creates the single largest demand for water within a plant. Worldwide, the majority of industrial plants using reclaimed water for cooling are utility power stations. Other reuse applications are the recycling of boiler-feed water or process water, and the use of reclaimed water for irrigation and maintenance of plant ground.

6.2 Regional Experiences

Water reuse in agriculture is common throughout the Middle East and North Africa. Water reuse can be planned through specifically designed projects to treat, store, convey and distribute treated wastewater for irrigation. Examples of planned reuse can be found in Egypt and Tunisia. Reuse can also be unplanned, usually after discharge into open watercourses. This is the case in Jordan, where wastewater is treated to some extent, and in Morocco, where most of the wastewater is untreated, as well as in Algeria, West Bank and Gaza, Syria, and Yemen. In most countries of the region, wastewater treatment plants are not operated and maintained adequately, making wastewater unsuitable for unrestricted irrigation even where it has passed through a treatment plant. Wherever available, farmers prefer to rely on freshwater, which is usually very cheap. But if no other source of water is available, farmers throughout the region use wastewater for irrigation.

The benefits of promoting wastewater reuse as a means of supplementing water resources have been recognized by many countries. In some of them such as Egypt, Tunisia, Jordan, Malta, Cyprus and Spain, several projects are already in operation or under planning. Other countries, such as Greece, France and Italy are seriously considering wastewater reuse and reclamation.

6.3 Status Quo of Water Reuse in Turkey

Reuse of wastewater in agriculture is officially not a recent practice in Turkey. However, indirect (unplanned) irrigational reuse has been applied for many years.

Traditionally, water reuse is not considered in planning and design of treatment plants in Turkey. It has been reported that some of the wastewater treatment plants in rural areas do not receive raw wastewater since the untreated wastewater is intercepted from the manholes of the sewerage network by the farmer who are in desperate need of irrigation water for their crops. As a result, while wastewater plants remain idle, a potential risk of public health is created due to the reuse of untreated wastewater (Sarikaya & Eroglu 1993).

The main water demand is in the field of agriculture as seen in chapter 4.4.

Due to the rapidly developing tourism especially along the Aegean and Mediterranean Coast, water reuse for other purposes is gaining more importance. Tourist villages are being built as single units for their wastewater management since they are usually far away from municipal service boundaries. Protection of the coastal water quality is of primary importance in these locations. Therefore wastewater is treated to secondary level before being discharged into the sea. Shortage of fresh water sources and increased water demand in summer months forced these tourist complexes to reuse the treated wastewater. The main application is irrigation in parks and recreational areas (Sarikaya & Eroglu 1993).

Water reuse is also gaining importance in large cities like Istanbul. Newly developed satellite towns within the Istanbul metropolitan area are planned in order to meet a part of the water requirement by use of reclaimed water. An example of this type of development is the Anatepe Satellite town project funded by Emlak Bank of Turkey. The reclaimed wastewater is designed to be used to irrigate parks, for washing cars and fire fighting. The design capacity of the plant is 1036 m^3/day (Sarikaya & Eroglu 1993).

However, there are currently still a lot of hindrances why treated wastewater is not reused in large scale in Turkey:

a. The irrigation water is rather cheap for farmers as DSİ or Village Affairs Organisation offers cheap and suitable quality irrigation water to the farmers.

b. There are a lot of bureaucratic formalities in using the treated wastewater in irrigation.

c. It is rather difficult for any organisation to recharge groundwater sources with treated wastewater due to problems of social acceptance as well as bureaucratic and legal difficulties.

d. The decision makers in this field are not well aware of appropriate reuse technologies.

6.4 International Guidelines

Existing wastewater reuse regulations for irrigation purposes are based mainly on biological quality considerations, crops to be irrigated and risk groups.

Historically, California was the first country that set regulations in 1918, Israel followed then in 1952 (Salgot & Angelakis 2001).

In 1985, FAO published guidelines with additional standard values for chemical parameters (see table 14).

In 1989, WHO set numerical standards for microbiological parameters, as seen in table 13, which have become widely accepted and were adopted in many countries afterwards.

This standard approach, the setting of numerical standards based on technical decisions, is not based on real circumstances which makes it highly objectionable. In recent years, the epidemiological approach is discussed more intensively and recommendations for revising the WHO guidelines were developed (Blumenthal et al 2000). It is recommended to decrease the guideline limit for nematode eggs in conditions that favour the survival of nematode eggs and where children are exposed. A typical situation that often occurs is, when raw wastewater is allowed to bypass conventional treatment plants especially during periods of overflow after storms which allows untreated wastewater containing nematode eggs (in areas where nematode infections are endemic) into the effluent that is reused for agriculture. For these situations the limit is recommended to be reduced to 0.1 egg/l.

Table 13: Guidelines of the WHO (World Health Organisation) for the use of treated wastewater for irrigation purposes (WHO 1989)

Cate-gory	Reuse conditions	Exposed group	Intestinal nematodes[b] (arithmetic mean no. of eggs per litre[c])	Faecal coliforms (geometric mean no. per 100 ml[c])	Wastewater treatment expected to achieve the required microbiological guideline
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[d]	Workers, consumers, public	$\leq$ 1	$\leq$ 1000	A series of stabilization ponds designed to achieve the microbio-logical quality indicated, or equivalent treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[e]	Workers	$\leq$ 1	No standard re-commended	Retention in stabilization ponds for 8-10 days or equivalent helminth and faecal coliform removal
C	Localized irrigation of crops in category B if exposure to workers and the public does not occur	None	Not applicable	Not applicable	Pretreatment as required by irrigation technology but not less than primary sedimentation

[a] In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.
[b] *Ascaris* and *Trichuris* species and hookworms.
[c] During the irrigation period.
[d] A more stringent guideline limit ($\leq$ 200 faecal coliforms/100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.
[f] In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

Table 14: Recommendations of the FAO (Food and Agriculture Organization of the United Nations) for the quality of water used for irrigation purposes (FAO 1985)

Potential irrigation problem	Unit	Degree of restriction on reuse		
		None	Slight to moderate	Severe
Salinity				
EC	dS/m			
TDS	mg/l			
Infiltration				
SAR EC	SAR (-) dS/m	0 - 3 > 0.7	0 - 3 0.2 - 0.7	0 - 3 < 0.2
SAR EC	SAR (-) dS/m	3 - 6 > 1.2	3 - 6 0.7 - 1.2	3 - 6 < 0.7
SAR EC	SAR (-) dS/m	6 - 12 > 1.9	6 - 12 1.2 - 1.9	6 - 12 < 1.2
SAR EC	SAR (-) dS/m	12 - 20 > 2.9	12 - 20 1.9 - 2.9	12 - 20 < 1.9
SAR EC	SAR (-) dS/m	20 - 40 > 5.0	20 - 40 2.9 - 5.0	20 - 40 < 2.9
Specific ion toxicity				
Sodium (Na)				
Surface irrigation Na	SAR (-)	< 3	3 - 9	> 9
Sprinkler irrigation Na	me/l	< 3	> 3	
Chloride (Cl)				
Surface irrigation Cl	me/l	< 4	4 - 10	> 10
Sprinkler irrigation Cl	me/l	< 3	> 3	
Boron	mg/l	< 0.7	0.7 – 3.0	> 3.0
Trace elements				
Al	µg/l	5.000	Recommended maximum concentrations	
As	µg/l	100		
Be	µg/l	100		
Cd	µg/l	10		
Co	µg/l	50		
Cr	µg/l	100		
Cu	µg/l	200		
F	µg/l	1.000		
Fe	µg/l	5.000		
Li	µg/l	2.500		
Mn	µg/l	200		
Mo	µg/l	10		
Ni	µg/l	200		
Pd	µg/l	5.000		
Se	µg/l	20		
V	µg/l	100		
Zn	µg/l	2.000		
Miscellaneous effects				
Nitrogen (NO_3-N)	mg/l	< 5	5 - 30	> 30
Bicarbonate (HCO_3^-)	me/l	< 1.5	1.5 - 8.5	> 8.5
pH	-	Normal range: 6.5 - 8.4		

6.5 National Guidelines

Water reuse was not officially legitimised, until the regulation for irrigational wastewater reuse was issued in 1991 by the Ministry of Environment. According to the “Water Pollution Control Regulations” treated wastewater can be used in irrigation, the consumer must obtain a written permission from concerned government organisations. The commission organized by the State Water Organisation, İller Bank and Agriculture Ministry and Environmental and Forest Ministry will decide whether the effluent can be used in irrigation or not.

According to Turkish Water Pollution Control Regulations, the effluent quality criteria for irrigation are given in the following tables. The WHO guidelines are generally adopted except the limits for the intestinal nematodes and the residual chlorine. Concerning the microbiological standards, the Turkish regulation seems unsufficient and needs to be revised according to the actual discussions (as mentioned before).

Boron concentrations are particularly important for Turkish conditions because Turkish is rich in terms of boron sources. Therefore water for irrigation is separately classified with respect to their boron concentrations (Sarikaya & Eroglu 1993) which is not named expressively here.

Table 15: Maximum Concentrations of Toxic Elements in Effluents for Irrigation

Elements	Max. Concentration (mg/l)
Aluminium (Al)	5.0
Arsenic (As)	0.1
Beryllium (Be)	0.1
Cadmium (Cd)	0.01
Chromium (Cr)	0.1
Cobalt (Co)	0.05
Copper (Cu)	0.2
Fluorine (F)	1.0
Iron (Fe)	5.0
Lead (Pb)	5.0
Lithium (Li)	2.5
Manganese (Mn)	0.2
Molybdenum (Mo)	0.01
Nickel (Ni)	0.2
Selenium (Se)	0.02
Vanadium (V)	0.1
Zinc (Zn)	2.0

Table 16: Effluent Quality Criteria for Irrigation

Effluent quality criteria	First class effluent (very good)	Second class effluent (good)	Third class effluent (usable)	Fourth class effluent (usable by care)	Fifth class effluent (can not be used)
EC25 * 10^6 (umhos/cm)	0.250	250-750	750-2000	2000-3000	>3000
Sodium percent (Na%)	<20	20-40	40-60	60-80	>80
Sodium absorption range	<10	10-18	18-26	<26	
Sodium carbonate residual					
meq/l	<1.25	1.25-2.5	>2.5	12-20	
mg/l	<66	66-133	>133	625-710	
Chloride (Cl)					
meq/l	0-4	4-7	7-12	12-20	>20
mg/l	0-142	142-249	249-426	626-710	>710
Sulfide (SO_4)					
meq/l	0-4	4-7	7-12	12-20	>20
mg/l	0-192	192-336	336-575	576-960	>960
Total salts mg/l	0-175	175-525	525-1400	1400-2100	>2100
Boron[1] concentration mg/l	0-0.5	0.5-1.12	1.12-2.0	2.0	-
NO_3 or NH^+_4	0-5	5-10	10-30	30-50	>50
Fecal coliforms (in 100 ml)	0-2	2-20	20-102	102-103	>103
BOD_5 (mg/l)	0-25	25-50	50-100	100-200	>200
Suspended solids mg/l	20	30	45	60	>100
pH	6.5-8.5	6.5-8.5	6.5-8.5	6-9	<6 or >9
Temperature ºC	30	30	35	40	>40

[1] With respect to Boron concentration there is even a more detailed classification of irrigation waters

7. PUBLIC AWARENESS

7.1 Assessment of Institutional, Political and Social Framework.

Without public and political awareness, efficient wastewater management and its reuse are impossible to realize. It is recognized that in the future Turkey may face serious water shortage but the consequence taken by the decision makers is focussing large water projects like embankment dams. These kind of projects are not only very cost intensive but also can cause a lot of secondary problems like salinization.

The threatening water shortage is supported by a relatively high water consumption that will increase further like forecasted. No incentive for the consumer is offered to save water by increasing the water tariff on a cost-covering level.

However, people as well as decision makers and NGO's are not aware of water saving and the merits of water reuse. Such most of them are against reuse, especially reuse of treated water in irrigation, there is therefore a need to educate about water reuse and its benefits. They should be convinced that if carried out properly reuse is not a hazard to public health.

7.2 Status of Ongoing NGO Activities Dealing With Wastewater

There are a lot of NGOs dealing with general environment and wastewater. The name of some environmental NGOs are given in table 13. Their activities range from organizing conferences and education programs to preparing documents, and monthly or quarterly journals and bulletins, even books.

Table 17: NGOs dealing with Environmental and Wastewater Issues

1. Turkey's Environmental Foundation
2. Association of the Protection of Turkey's Nature
3. Environmental Protection and Investigation Center
4. Turkish Environmental Education Foundation
5. Turkish Environmental Protection and Forestry Association
6. The Association of Application of Environmental Technologies
7. Turkish Nature Protection Foundation
8. Ankara Environmental Protection Foundation
9. İzmir Environmental Platform
10. Environmental Volunteers Association

7.3 How to Approach Public Education and Outreach

In Turkey, it is necessary to reach the public and decision makers about the reuse of treated wastewater.

The essential element to be used in educational program should include :

- Media (press releases)
- Television and radio
- Video and slide presentation
- Written materials (brochures, fact sheets, internet sites)
- Community outreach (school programs, presentation for affected communities)
- Educational meetings (conferences, seminars, symposiums.)

The media plays the major role in promoting awareness. In Turkey there are a lot of daily newspapers. Millions of people follow these newspapers every day. The most important newspapers are : Hürriyet, Milliyet, Sabah, Cumhuriyet, Akşam, Radikal, Yeni Şafak, Zaman and Takvim.

Turkish Environmental Engineering Chamber which is an active NGO is publishing a monthly magazine and a monthly bulletin about the environmental problems and important environmental topics.

The water and sewerage organisations of metropolitan municipalities (such as ISKI) prepare monthly bulletins about their activities. Also, some of them have very impressive web sites.

In addition to the written press, televisions are prepaying many environmental programs. In Turkey, the most followed TV channels are TRT 1, ATV, Canal D, CNN, Türk, Show T.V, Star T.V and TGRT.

There are hundreds of radio stations. (except big ones, there are at least 2-3 local radios in every provinces). They have environmental programs and host regular talk shows on various environmental issues.

8. PILOT PLANT PRELIMINARY STUDY

8.1 Site Selection

The pilot plant and reuse facilities will be established at the Yıldız University´s Davutpaşa Campus which has an area of 112 ha. The campus is not fully completed some parts are still under construction.

In this area, there are many places suitable for installing a pilot plant. The precise location will be determined in spring 2004 in consultation with the Turkish authorities.

8.2 Wastewater Source

The pilot plant will be used in the treatment of domestic wastewater produced within University Campus. At present, the wastewater from the chemical laboratories is discharged to the sewerage system, but separating the chemical wastewater is planned for the near future.

The wastewater within the campus is produced only between 7.00 a.m. and 8.00 p.m. and its characteristics and flow will be determined by analyses carried out in the University laboratories.

Yıldız University will need a lot of water to irrigate the huge campus area, as such in the near future, a full scale treatment plant can be established and treated water can be used in the irrigation of grasses and trees in the campus area.

8.3 Technology Selection

The technology of the pilot plant should meet the following requirements:

- New and applicable for Turkey
- Simple and reliable technology
- Low energy demand
- Resistent to earthquakes events
- Mediterranean climate in Istanbul (see also chapter 2)
- Odor control considering the location on the campus
- Can be used for educational purposes
- Appropriate for domestic wastewater treatment (like produced in the campus area)
- Hygienically safer effluent with the purpose of water reuse in agriculture

In the decision making process, four different concepts were evaluated for this purpose (Wendland et al, 2003).

1st concept: Separate collection of grey water and black water, grey water treatment is constructed wetlands or slow sand filtration (SSF), black water treatment either in a discontinuously fed biogas plant and recycling of the nutrients in agriculture or in a UASB reactor with further tertiary treatment for water reuse.

2nd concept: Separate collection of grey water and black water, gray water treatment in SSF, black water treatment in rotating disc contactor followed by a tertiary treatment for disinfection

3rd concept: treatment of combined domestic wastewater in a UASB plant with further treatment in a SSF or natural lagoon, water reuse in agriculture.

4th concept: Treatment of combined domestic wastewater in a membrane bioreactor and water reuse.

During the first EMWATER Regional Meeting in Amman in December 2003, the four concepts were intensively discussed.

The first two concepts require a source separation inside the buildings. They can not be applied in the pilot plant study because only mixed domestic wastewater is available on the campus.

Either the 3rd or 4th concept may be applied in our case. The 3rd concept was preselected because it met the technology selection requirements given earlier. The UASB reactor as anaerobic pretreatment has on the one hand a lot of advantages but is on the other hand very sensitive to low temperature and diluted wastewater.

Therefore, the results of the wastewater analyzes (carried out in February and March 2004) should be taken into consideration in making the final decision on the technology of the pilot plant.

8.4 Preliminary Design of the Pilot Plant

The capacity of the pilot plant mainly affects the construction cost. In this first preliminary design, the capacity of 50 equivalent population is chosen and will be revised after a detailed cost calculation.

The amount of wastewater to be treated in the pilot plant:

$$Q = 50 \text{ person x } 200 \text{ l/cap/day} = 10\,000 \text{ l/day} = 10 \text{ m}^3\text{/day} = 0.12 \text{ l/s}$$

Since there will be no wastewater production at night, $V = 5 \text{ m}^3$ storage reservoir minimum must be planned to supply the pilot plants continuously. The other units will be designed after analyses of the wastewater to be treated.

The preliminary design of the pilot plant is shown in figure 8.

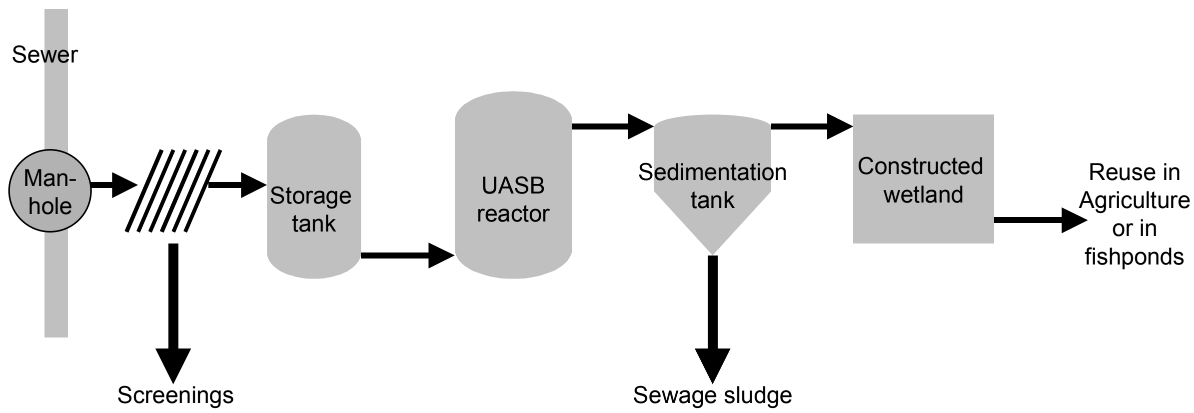


Figure 8: Draft Flow Scheme of the Preselected Pilot Plant

The concept of the pilot plant is summarized in the table below.

Table 18: Units of the Preselected Pilot Plant

	Unit	Task
1	Screen	To protect the following pumps from clogging
2	Storage tank	To equalize the wastewater flow
3	UASB	To remove up to 80% of the organic compounds in the wastewater in a cost effective and simple way
4	Sedimentation tank	To separate the sewage sludge from the treated water flow
5	Constructed wetland	To remove the residual organic compounds and nitrogen and to make the effluent hygienically safer

9. CONCLUSIONS

- Country profile

  Many parts of Turkey are lying in seism-tectonic active areas. Any construction is affected by the permanent earth-quake danger which must be taken into consideration when designing a WWTP. Generally, decentralized WWT concepts can cope much better with earth-quakes than centralized ones.

- Legal and institutional framework

  In Turkey exists a substantial package of environmental laws and regulations that are gradually adapted to EU standards. A large number of ministries and institutions are responsible for water issues which easily leads to interface problems with decision making. There is a lack of clear responsibilities concerning e.g. licensing procedure for water reuse.

- Water sector

  Turkey may face severe water shortage in the future because of the fast growing demand in agriculture, industry and in the private sector. Action in respect of water saving and water reuse must be taken in order to decelerate the increase of water demand.

- Wastewater management

  In recent years, many WWTP (e.g. in Istanbul, Ankara and Izmir) have been erected and this development is continuing. However, less than 10% of the whole wastewater quantity is treated in an adequate way respectively according to EU regulations. There is a lack of data regarding the quantity and quality of domestic and industrial wastewater (influents and effluents) and regarding the generation and disposal of sewage sludge.

- Water reuse

  In Turkey, no water reuse is practiced on a large scale. There are regulations that allow water reuse but the implementation is difficult to realize (see legal and institutional framework). The regulations seem unsufficient with respect to the microbiological standards from WHO. Reuse of treated wastewater is not accepted by the public. The successful demonstration of treating and reuse technology is necessary for convincing people about the benefits of water reuse.

- Public awareness

  In general, there is a growing awareness about environmental problems. However, there is only little awareness concerning water issues like water saving and reuse. Missing popularity, cultural reasons and little acceptance hinder authorities from charging people cost covering tariffs for water and wastewater which would offer an incentive for saving water. Training courses and e-learning programs focussing on various groups from school children to decision makers are reasonable means to raise public awareness in Turkey.

- Pilot plant preliminary study

  In the field of wastewater treatment, there are already divers technologies available and in operation in Turkey. Therefore, the preliminary pilot plant study aimed at finding a new appropriate technology for peri urban and rural areas in Turkey. The result was a combination of a UASB reactor as primary treatment and constructed wetlands as secondary treatment. If the wastewater analyzes meet the requirements for the UASB technology, a pilot plant with this concept will be realized on the campus Davutpaşa in Istanbul.

Within the **EMWATER-Project**, the overall objective in Turkey must be consequently to raise public awareness on water issues. With the aid of an appropriate pilot plant technology, the successful treatment and proper reuse of water will be demonstrated.

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ANNEX A

INFLUENT AND EFFLUENT CHARACTERISTICS IN İSTANBUL PAŞAKÖY W. W. T. P.

Date	Discharg	BOD 5 (MG/L)		S.S. (mg/l)		Total N (mg/l)		Total P (mg/l)	
Months	m³/day	influent	effluent	influent	effluent	influent	effluent	influent	effluent
January 2003	64.822	166	6	247	7	37,7	13,9	2,8	2,1
February 2003	39.912	65	5	148	9	19,2	12,0	1,9	1,4
March 2003	66.626	119	13	199	18	25,7	15,1	3,0	1,9
April 2003	71.042	159	19	211	24	27,8	13,9	3,0	2,0
May 2003	60.193	238	31	305	24	44,5	22,0	4,3	3,2
June 2003	46.661	274	27	384	18	78,0	25,0	5,8	4,3
July 2003	44.338	234	6	348	5	58,9	8,0	4,1	2,7
August 2003	41.914	264	5	413	5	56,8	9,4	3,3	2,4
September 2003	41.890	258	9	420	6	60,5	12,2	5,2	3,0
October 2003	50.906	274	8	400	5	61,1	13,0	4,0	3,0
November 2003	61.880	213	29	294	63	39,9	9,9	3,2	2,6
December 2003	60.634	150	23	212	65	28,9	13,7	2,9	2,1
Average	62.467	201	16	298	21	44,9	14,0	3,6	2,6

Annex B

DISCHARGE STANDARDS OF DOMESTIC W.W.FOR SENSITIVE AREAS (EU 1991)

Parameter	Max. Concentration mg/l	Minimum Treatment Efficiency (%)
BOD5	25	70-90
COD	125	75
T.S.S.		
N > 10 000	35	70
2000 < N < 10 000	60	90
Total Nitrogen		
P > 100 000	10	70-80
10 000 < P < 100 000	15	70-80
Total Phosphorous		
P > 100 000	1	80
10 000 < P < 100 000	2	80

P : Design Population of the project area.

ANNEX C

PUBLIC WATER SUPPLY IN THE MUNICIPALITIES OF TURKEY

Provinces	No.of Total Municipalities	Population of Municipalities	Municipalities having Public Water System: No.of Municipalities	Municipalities having Public Water System: Percentage in Total Municipality Population	Municipalities Having Water Treatment Plants: No.of Municipalities	Municipalities Having Water Treatment Plants: Percentage in Total Municipality Population
TURKEY	**3 215**	**53 377 431**	**1 879**	**75,3**	**170**	**16,8**
Adana	53	1 567 944	48	91,5	2	70,7
Adýyaman	28	409 832	25	92,7	-	-
Afyon	108	644 053	104	95,2	-	-
Aðrý	12	265 494	11	89,6	-	-
Amasya	29	248 195	27	76,6	-	-
Ankara	67	3 712 005	64	97,7	10	87,6
Antalya	103	1 413 280	99	96,4	3	40,5
Artvin	12	95 581	11	92,5	-	-
Aydýn	54	663 127	53	96,7	1	21,6
Balýkesir	52	691 665	45	74,9	5	8,6
Bilecik	15	141 041	15	99,2	2	3,3
Bingöl	13	141 510	12	45,5	-	-
Bitlis	15	254 642	12	93,1	-	-
Bolu	13	153 389	13	96,7	-	-
Burdur	29	175 616	26	92,6	-	-
Bursa	55	1 800 896	49	83,2	10	73,5
Çanakkale	34	276 966	33	96,1	3	38,3
Çankýrý	28	182 168	26	94,5	-	-
Çorum	38	362 467	33	89,2	1	44,5
Denizli	100	668 806	84	83,5	-	-
Diyarbakýr	32	954 496	29	88,9	3	56,6
Edirne	26	269 882	26	96,9	2	60,0
Elazýð	26	432 086	20	84,3	1	1,4
Erzincan	29	247 235	27	86,0	-	-
Erzurum	39	613 806	39	95,7	4	56,5
Eskiþehir	32	606 393	30	98,1	3	79,6
Gaziantep	28	1 074 178	28	99,9	4	86,1
Giresun	31	329 820	19	82,4	-	-
Gümüþhane	18	115 729	18	93,4	-	-
Hakkari	8	159 264	6	68,9	-	-
Hatay	76	954 148	73	96,0	-	-
Isparta	50	421 763	46	97,1	1	35,2
Ýçel	70	1 404 078	68	96,3	10	59,3
Ýstanbul	74	9 838 860	71	91,5	45	92,1
Ýzmir	89	3 015 330	72	91,9	13	22,5
Kars	10	147 092	10	96,2	-	-
Kastamonu	21	176 609	21	98,0	2	38,8
Kayseri	65	895 194	58	95,4	2	59,9
Kýrklareli	26	240 129	23	63,7	2	23,3
Kýrþehir	30	196 220	29	93,7	-	-
Kocaeli	45	1 089 256	39	93,8	7	49,9
Konya	206	1 920 108	205	98,6	7	43,0
Kütahya	77	481 539	73	94,5	2	11,0
Malatya	54	686 355	49	93,9	-	-
Manisa	84	919 718	75	95,0	3	0,7
Kahramanm	64	741 617	52	87,8	1	0,4
Mardin	31	501 829	24	78,7	-	-
Muðla	61	445 940	56	91,5	1	7,2
Muþ	27	252 721	21	84,8	-	-
Nevþehir	45	236 901	43	96,4	1	6,1
Niðde	52	271 410	36	75,5	-	-
Ordu	72	651 672	54	68,2	16	18,3
Rize	21	239 997	20	69,6	-	-
Sakarya	40	517 550	42	99,2	14	59,7
Samsun	51	739 758	39	88,7	12	53,3
Siirt	13	178 416	13	98,8	1	-
Sinop	11	107 103	11	97,2	-	-
Sivas	46	513 092	45	92,8	-	-
Tekirdað	33	500 123	28	83,5	2	1,4
Tokat	77	598 165	75	84,9	2	0,8
Trabzon	77	727 320	56	77,7	6	32,8

ANNEX D

SEWERAGE AND WWTP IN THE MUNICIPALITIES OF TURKEY

Provinces	No.of Total Municipalities	Population of Municipalities	Municipalities Having Sewarage System: No. Of Municipalities	Municipalities Having Sewarage System: Percentage in Total municipality Population	Municipalities Having WWTP: No. Of Municipalities	Municipalities Having WWTP: Percentage in Total Municipality Population
TURKEY	**3 215**	**53 377 431**	**1 879**	**75,3**	**170**	**16,8**
Adana	53	1 567 944	27	83,9	2	4,9
Adıyaman	28	409 832	12	77,1	2	45,2
Afyon	108	644 053	88	79,5	1	19,2
Ağrı	12	265 494	9	46,4	-	-
Amasya	29	248 195	24	86,2	-	-
Ankara	67	3 712 005	55	96,1	12	87,1
Antalya	103	1 413 280	24	30,9	16	27,5
Artvin	12	95 581	9	67,8	-	-
Aydın	54	663 127	18	58,4	5	42,1
Balıkesir	52	691 665	42	87,5	5	14,0
Bilecik	15	141 041	13	89,1	-	-
Bingöl	13	141 510	8	77,4	-	-
Bitlis	15	254 642	6	55,6	-	-
Bolu	13	153 389	13	95,2	2	19,7
Burdur	29	175 616	18	75,2	1	9,9
Bursa	55	1 800 896	50	97,3	9	74,7
Çanakkale	34	276 966	27	78,9	1	0,6
Çankırı	28	182 168	18	76,2	-	-
Çorum	38	362 467	25	87,6	1	44,1
Denizli	100	668 806	57	71,7	-	-
Diyarbakır	32	954 496	22	65,3	-	-
Edirne	26	269 882	17	75,8	-	-
Elazığ	26	432 086	11	78,4	1	60,4
Erzincan	29	247 235	13	62,7	1	43,3
Erzurum	39	613 806	32	92,6	-	-
Eskişehir	32	606 393	16	79,3	3	71,7
Gaziantep	28	1 074 178	23	95,9	3	79,5
Giresun	31	329 820	21	66,2	-	-
Gümüşhane	18	115 729	13	73,4	-	-
Hakkari	8	159 264	2	27,4	-	-
Hatay	76	954 148	16	33,7	1	13,3
Isparta	50	421 763	42	85,1	2	39,2
İçel	70	1 404 078	18	60,8	7	47,9
İstanbul	74	9 838 860	62	83,9	41	80,7
İzmir	89	3 015 330	67	84,8	5	68,3
Kars	10	147 092	4	56,3	-	-
Kastamonu	21	176 609	18	50,9	-	-
Kayseri	65	895 194	30	74,0	-	-
Kırklareli	26	240 129	22	87,2	-	-
Kırşehir	30	196 220	9	53,0	-	-
Kocaeli	45	1 089 256	30	80,5	4	19,1
Konya	206	1 920 108	93	65,6	4	5,0
Kütahya	77	481 539	68	87,0	2	35,1
Malatya	54	686 355	37	80,8	-	-
Manisa	84	919 718	64	83,3	4	33,7
Kahramanmaraş	64	741 617	15	68,9	2	9,2
Mardin	31	501 829	18	46,3	-	-
Muğla	61	445 940	16	39,8	5	11,8
Muş	27	252 721	8	29,7	-	-
Nevşehir	45	236 901	29	71,9	3	11,1
Niğde	52	271 410	16	51,5	2	37,5
Ordu	72	651 672	47	51,0	3	32,9
Rize	21	239 997	15	51,5	-	-
Sakarya	40	517 550	18	74,7	-	-
Samsun	51	739 758	22	79,1	3	14,5
Siirt	13	178 416	13	85,5	-	-
Sinop	11	107 103	11	91,7	-	-
Sivas	46	513 092	36	87,3	-	-
Tekirdağ	33	500 123	20	73,3	1	18,2
Tokat	77	598 165	66	87,4	1	0,4
Trabzon	77	727 320	41	55,0	1	1,9
Tunceli	10	56 932	9	83,5	-	-
Şanlıurfa	26	914 185	12	71,5	1	38,0
Uşak	24	222 924	19	81,5	-	-

ANNEX E
TECHNICAL DATA FOR ANKARA WWTP

BASIC DESIGN DATA	
Total Plant Area	182 Ha
Main Interceptor	3,45 x 4,60 m box culvert-gravity flow
Equivalent Population to be Served	3,9 Million (2002)-6,3 Million (2025)
Wastewater Inflow-	765.000 m³/d (2002)
Dry Weather Flow	-1.377.000 m³/d (2025)
Peak Storm Weather Flow	1.530.000 m³/d (2002)-2.754.000 m³/d (2025)
Sludge Cake Production	700 m³/d (2002)-1.130 m³/d (2025)
Biogas Production	60.000 m³/d (2002)-96.000 m³/d (2025)
Power Supply	10 MW
PRELIMINARY TREATMENT STATION	
Total Use Area	11.000 m²
Coarse Screen Openness	40 mm
Fine Screen Openness	15 mm
10 Aerated Grit/Scum Chambers	
Volume (each of Double Chambers)	584 m³
Surface	209 m²
Detention Time	11 min
PRIMARY SEDIMENTATION TANKS	
10 Circular Sedimentation Tanks	
Volume, per unit	7600 m³
Surface Area	1.963 m²
Diameter	50 m
Depth	5 m
Detention Time	1.5 hr
AERATION TANKS	
10 Rectangular Tanks with Surface Aerators	
Volume, per unit	13.000 m³
Surface Area (153 x 17 m)	2.600 m²
Depth	5 m
Detention Time	4 hr
FINAL SEDIMENTATION TANKS	
20 Circular Sedimentation Tanks	
Volume, per unit	9200 m³
Surface Area	2.376 m²
Diameter	55 m
Depth	5 m
Detention Time	3 hr
RETURN SLUDGE PUMPING STATION	
3 Tubular Casing Pumps	
Maximum Capacity (for each)	1,84 m³/sec
RAW SLUDGE THICKENERS	
7 Circular Sedimentation Tanks	
Volume, per unit	1.964 m³
Surface Area	491 m²
Diameter	25 m
Depth	4 m
Detention Time	2 day
DIGESTERS	
8 Cylindrical Prestressed Concrete Tanks	
Volume, per unit	11.250 m³
Diameter	25 m
Height	35 m
Detention Time	14 day
GAS STORAGE TANK	
2 Cylindrical Storage Tanks	
Volume, per unit	4.000 m³
Diameter	22 m
Height	17 m
DIGESTED SLUDGE THICKENERS	
5 Cylindrical Sedimentation Tanks	
Volume, per unit	1.964 m³
Surface Area	491 m²
Diameter	25 m

ANNEX F

TECHNICAL VALUES OF IZMIR WWTP

DISCHARGE	
Average dry weather flow	7 m³/sec
Maximum dry weather flow	9 m³/sec
Maximum wet weather flow	9 m³/sec
WASTEWATER COMPOSITION	
BOD5	400 mg/l
COD	600 mg/l
T.S.S	500 mg/l
Total-N	60 mg/l
Total-P	6 mg/l
DISCHARGE CRITERIA (24 Hr. Composit)	
BOD5	20 mg/l
COD	100 mg/l
T.S.S	30 mg/l
NH4-N	10 mg/l
Total-N	12 mg/l
PO4-P	1 mg/l
SCREENS :	
Number of screen	3 (2-11)
Distance between screen bars	20 mm
GRIT CHAMBERS	
- No of grit chambers	4
- Aeration for each unit	6.3 m³/minute
- No. Of blowers	2 + 1
PRIMARY SETTLEMENT TANKS	
Numbers	12
Tank diameters	40.9 m
Active Volume	5200 m³
Hydraulic Detention Time	2.13 hours
BIOPHOSPHOR TANKS	
Numbers	6
The length of tanks	90 m
The width of tanks	15.5 m.
Volume of each tank	8200 m³
Hydraulic detention time	1.1 hours
AERATION TANKS	
Numbers	12
The length of each tank	154 m
The width of each tank	28 m
The volume of one tank	24 790 m³
MLSS	3800 mg/lt
No. Of total blowers	12-13
The capacity of one blower	355 kwh
The number of total diffusors	21600
FINAL SETTEMENT TANKS	
- Numbers	12
- Tank diameters	60 m
- Active volume of each tank	9800 m³
- Hydraulic Detention Time	2.7 hours
- Recirculation rate	76%
SLUDGE DEWATERING UNITS	
- No. Of Dewatering Tables	10
- Capacity of each dewatering tables	99 m³/hr
- No. Of belt presses	10
- The capacity of each belt filters	24 m³/hr
- No. Of polyelectrolite unit	2+1
- Capacity of polyeelectrolite unit	2880 kg/day

ANNEX G

THE WASTEWATER TREATMENT PLANTS IN OPERATION
(Designed and Constructed By İller Bank)

Municipality	City	Type of Treatment	Operated Since	2000 Population	2003 Population	Present Amount of Treated WW (lt/sec)
ADIYAMAN II	ADIYAMAN	Pond	2000	58538	62.121	179,75
AFYON	AFYON	Trickling Filter	1995	128.516	136.382	394,62
AKÇAKOCA	DÜZCE	Activated Sludge	2003	25.560	27.124	62,79
AKHİSAR	MANİSA	Trickling Filter	1988	81.510	86.499	250,29
AKSARAY	AKSARAY	Pond	1993	129.949	137.903	399,02
AKŞEHİR	KONYA	Pond	1988	60.226	63.912	184,93
ALAŞEHİR	MANİSA	Trickling Filter	1995	39.590	42.013	97,25
ALTINOVA Gr.	YALOVA	Extendet Aerated Activated Sludge	2003	13.555	14.385	24,97
ANTAKYA	HATAY	Trickling Filter	1998	144.910	153.780	444,96
AYDIN	AYDIN	Pond	1991	143.267	152.036	439,92
BOR	NİĞDE	Pond	2000	29.804	31.628	73,21
BUCAK	BURDUR	Pond	1990	28.833	30.598	70,83
BURHANİYE	BALIKESİR	Activated Sludge	2002	31.227	33.138	76,71
ÇUBUK	ANKARA	Activated Sludge	1999	46.605	49.458	114,49
ÇORUM	ÇORUM	Activated Sludge	2001	161.321	171.195	495,36
DEVREK	ZONGULDAK	Pond	1996	21.360	22.667	52,47
DÜZCE	DÜZCE	Absistem Dam.Filt	1993	56.649	60.116	173,95
EĞRİDİR	ISPARTA	Pond	1994	16.905	17.940	31,15
ELAZIĞ (Merkez)-AKÇAKİRAZ-YURTBAŞI	ELAZIĞ	Activated Sludge	1994	282.508	299.800	867,48
ERCİS	VAN	Pond	2002	70.881	75.219	217,65
GEREDE	BOLU	Pond	1998	25.188	26.730	61,87
GÖLÇÜK Gr.	KOCAELİ	Extendet Aerated Activated Sludge	2003	113.088	120.010	347,25
HEKİMHAN	MALATYA	Pond	1993	13.206	14.014	24,33
IĞDIR	IĞDIR	Pond	1992	59.880	63.545	183,87
ILGIN	KONYA	Pond	1984	26.698	28.332	65,58
İZMİT	KOCAELİ	Extendet Aerated Activated Sludge	1994	373.000	395.831	1.145,34
KADINHANI	KONYA	Pond	2000	14.816	15.723	27,30
KARABÜK	KARABÜK	Activated Sludge	2003	100.749	106.916	309,36
KARACABEY	BURSA	Pond	1988	40.624	43.111	99,79
KARAMAN	KARAMAN	Pond	1999	105.384	111.834	323,59
KARAMÜRSEL Gr.	KOCAELİ	Extendet Aerated Activated Sludge	2003	38.869	41.248	95,48
KOZAN	ADANA	Pond	1993	75.833	80.475	232,85
KÖRFEZ Gr.	KOCAELİ	Extendet Aerated Activated Sludge	2003	175.935	186.704	540,23
KÜTAHYA	KÜTAHYA	Activated Sludge	1992	166.665	176.866	511,77
MANAVGAT	ANTALYA	Pond	1988	71.679	76.066	220,10
MANİSA	MANİSA	Trickling Filter	1993	214.345	227.465	658,17
MURADİYE	VAN	Pond	2002	19.702	20.908	48,40
NAZILLI	AYDIN	Activated Sludge	1988	105.665	112.133	324,46
NİĞDE	NİĞDE	Activated Sludge	1988	70.088	74.378	215,21
NİZİP	GAZİANTEP	Activated Sludge	2000	71.629	76.013	219,95
OSMANİYE	OSMANİYE	Trickling Filter	2003	173.977	184.626	534,22
S.KOCHİSAR	ANKARA	Pond	1987	42.083	44.659	103,38
Ş.URFA	ŞANLIURFA	Pond	1995	385.588	409.189	1.184,00
SAMSAT	ADIYAMAN	Pond	1989	6.917	7.340	8,50
SELÇUK	İZMİR	Pond	1990	25.414	26.970	62,43
SÖKE	AYDIN	Pond	2000	62.384	66.202	191,56
SURUÇ	ŞANLIURFA	Pond	1985	44.421	47.140	109,12
TERME	SAMSUN	Pond	1990	25.052	26.585	61,54
VAN	VAN	Activated Sludge	1995	284.464	301.875	873,48
Y.GEDİZ	KÜTAHYA	Pond	1992	20.441	21.692	50,21
YENİÇAĞA	BOLU	Pond	1990	6.364	6.754	7,82

ANNEX H

THE WASTEWATER TREATMENT PLANTS UNDER CONSTRUCTION BY İLLER BANK

Municipality	City	Type of Treatment	2000 Poyulation	2003 Population	Treatment Capacity
AKÇAKOCA	DÜZCE	Activated Sludge	25.560	27.124	62,79
BALIKESİR	BALIKESİR	Trickling Filter	215.436	228.622	661,52
BEYŞEHİR	KONYA	Activated Sludge	41.312	43.841	101,48
BURDUR	BURDUR	Pond	63.363	67.241	194,56
DATÇA	MUĞLA	Activated Sludge	8.108	8.604	9,96
DENİZLİ	DENİZLİ	Activated Sludge	275.480	292.342	845,90
DEVELİ	KAYSERİ	Trickling Filter	35.084	37.231	86,18
DİNAR	AFYON	Activated Sludge	35.424	37.592	87,02
İZMİT DOĞU Gr.	KOCAELİ	Extendet Aerated Activated Sludge	100.000	106.121	307,06
SİLİFKE	İÇEL	Activated Sludge	64.827	68.795	199,06
VAN İlave	VAN	Activated Sludge	284.464	301.875	873,48
YOZGAT	YOZGAT	Activated Sludge	73.930	78.455	227,01

ANNEX I

THE WASTEWATER TREATMENT PLANTS DESİ GNED BY İ LLER BANK

Municipality	City	Type of Treatment	2000 Population	Expected 2020 Population	Treatment Capacity
ADIYAMAN I	ADIYAMAN	Trickling Filter	120.000	127.345	368,48
AFŞİ N	KAHRAMANMARAŞ	Trickling Filter	35.834	38.027	88,03
AKYAZI	SAKARYA	Activated Sludge	23.192	24.612	56,97
ALAÇATI	İZMİR	Activated Sludge	8.401	8.915	10,32
ANAMUR	İÇEL	Activated Sludge	49.948	53.005	153,37
ARABAN	GAZİ ANTEP	Pond	10.666	11.319	19,65
ARMUTLU	YALOVA	Activated Sludge	4.221	4.479	5,18
BAYRAMİ Ç	ÇANAKKALE	Extendet Aerated Activated Sludge	11.988	12.722	22,09
BESNİ	ADIYAMAN	Extendet Aerated Activated Sludge	36.123	38.334	88,74
BEŞİ Rİ	BATMAN	Pond	8.554	9.078	10,51
BOLU	BOLU	Activated Sludge	84.565	89.741	259,67
BOZOVA	ŞANLIURFA	Pond	19.848	21.063	48,76
Cİ ZRE	ŞIRNAK	Pond	69.591	73.851	213,69
ÇELİ KHAN	ADIYAMAN	Pond	11.306	11.998	20,83
ÇERMİ K	Dİ YARBAKI R	Pond	15.843	16.813	29,19
ÇEŞME	İZMİR	Activated Sludge	25.257	26.803	62,04
Çİ Lİ MLİ	DÜZCE	Pond	7.147	7.584	8,78
ÇINARCIK-TEŞVİ Kİ YE-KOCADERE	YALOVA	Extendet Aerated Activated Sludge	13.242	14.053	24,40
DERİ K	MARDİ N	Pond	19.806	21.018	48,65
EDREMİ K- ZE YTİNLİ	BALİ KESİ R	Extendet Aerated Activated Sludge	10.893	11.560	20,07
ELBİ STAN	KAHRAMANMARAŞ	Trickling Filter	71.500	75.876	219,55
EREĞLİ 1 1	KONYA	Pond	82.633	87.691	253,73
ERGANİ	Dİ YARBAKI R	Extendet Aerated Activated Sludge	47.333	50.230	145,34
ESENKÖY	YALOVA	Activated Sludge	3.318	3.521	4,08
GÖLKENT	SAKARYA	Pond	2.167	2.300	2,66
GÖZPINAR	Sİ İRT	Pond	3.574	3.793	4,39
GÜZELYURT	MALATYA	Pond	5.810	6.166	7,14
HANİ	Dİ YARBAKI R	Pond	10.918	11.586	13,41
HANKENDİ	ELAZIĞ	Pond	2.737	2.905	3,36
HENDEK	SAKARYA	Activated Sludge	28.537	30.284	70,10
K.MARAŞ	KAHRAMANMARAŞ	Activated Sludge	326.198	346.164	1.001,63
KARGIPINARI	İÇEL	Extendet Aerated Activated Sludge	12.714	13.492	23,42
KIRŞEHİ R	KIRŞEHİ R	Activated Sludge	88.105	93.498	270,54
KOZLUK	BATMAN	Pond	27.109	28.768	66,59
KULP	Dİ YARBAKI R	Pond	15.825	16.794	29,16
KURTALAN	Sİ İRT	Pond	24.865	26.387	61,08
LULEBURGAZ	KIRKLARELİ	Trickling Filter	79.002	83.838	242,59
MALATYA	MALATYA	Activated Sludge	381.081	404.406	1.170,16
MEZİ TLİ	İÇEL	Chemical Treatment	49.328	52.347	151,47
Mİ DYAT	MARDİ N	Pond	56.669	60.138	174,01
NEVŞEHİ R(Merkez)-NAR-GÖRE	NEVŞEHİ R	Activated Sludge	67.864	72.018	208,38
NUSAYBİ N	MARDİ N	Pond	74.110	78.646	227,56
ORDU	ORDU	Activated Sludge	112.525	119.412	345,52
REYHANLI	HATAY	Pond	52.135	55.326	160,09
SAPANCA-ARİ Fİ YE	SAKARYA	Activated Sludge	18.580	19.717	34,23
SASON	BATMAN	Pond	9.705	10.299	17,88
SEYDİ ŞEHİR	KONYA	Pond	48.372	51.333	148,53
Sİ İRT	Sİ İRT	Activated Sludge	98.281	104.297	301,78
Sİ LVAN	Dİ YARBAKI R	Pond	64.136	68.062	196,94
Sİ VEREK	ŞANLIURFA	Pond	126.820	134.582	389,42
Sİ VRİ CE	ELAZIĞ	Activated Sludge	5.432	5.764	6,67
SÖĞÜTLÜ	SAKARYA	Pond	7.858	8.339	9,65
TOKAT	MERKEZ	Activated Sludge	113.100	120.023	347,29
TURGUTREİ S	MUĞLA	Activated Sludge	8.540	9.063	10,49
URLA	İZMİR	Activated Sludge	36.579	38.818	89,86

ANNEX J

DOMESTIC WASTEWATER CHARACTERISTICS IN DIFFERENT SETTLEMENTS

Provinces	Q (m³/day)	BOD5 (mg/l)	COD (mg/l)	SS (mg/l)	Total-N (mg/l)	Total-P (mg/l)
Izmir	605.000	400	600	500	80	6
Tarsus	49.983	350	700	350	70	18
Isparta	15.193	565	-	730	-	-
Ankara	765.000	300	-	450	60	10
Dalaman	9.290	382	-	435	68	15
Adapazarı	271.940	225	-	350	60	10
Kütahya	53.136	209	-	-	-	-
Manisa	65.136	237	-	-	-	-
İzmit	15.472	220	-	-	-	-
Düzce	552	331	-	-	-	-
Niğde	30.408	221	-	-	-	-
Altınoluk	4.000	300	550	300	40	-
Edremit	23.760	270	-	-	45	-
Adana	227.346	243	-	-	-	-
Kayseri	110.000	382	-	464	83	17
Antalya	37.500	400	700	500	60	12
Balıkesir	67.120	333	-	478	52	15

* These values were taken from the project documents.

ANNEX K

ANALYZES OF DOMESTIC WASTEWATERS IN SOME SETTLEMENTS

Provinces	BOD5 (mg/l)	COD (mg/l)	SS (mg/l)	Total-N (mg/l)	Total-P (mg/l)
Izmir	-	465	235	25	8
Ankara	155	300	-	-	-
Istanbul					
Kadıköy	222	450	310	49	8.1
K.Çekmece	185	400	200	42	7.4
Baltalimanı	150	340	140	35	6.8
Sefaköy	880	3750	630	21	220
Yenikapı	300	680	480	68	7
Ömerli	460	1000	460	98	18.5

Annex L

According to the Soil pollution Control Regulation, it is obligatory to obey the following rules :

a. It is forbidden to use raw sewage sludge for vegetable and fruit agriculture. It is forbidden to discharge it also to agricultural fields, forests, pastures and grasslands.

b. It is forbidden to use stabilized sewage sludge for the production of vegetables and fruits which are eaten without cooking.

c. The maximum values of heavy metals in sludge designed for agricultural utilization are the following.

Heavy Metals	Limit Values (mg/kg dry sludge)
Lead (Pb)	1200
Cadmium (Cd)	40
Chromium (Cr)	1200
Copper (Cu)	1750
Nickel (Ni)	400
Zinc (Zn)	4000
Mercury (Hg)	25

d. The maximum heavy metal contents of the soil on which the stabilized sewage sludge are the following:

Heavy Metals	In mg/kg dry soil	
	pH<6	pH>6
Lead (Pb)	50	300
Cadmium (Cd)	1	3
Chromium (Cr)	100	100
Copper (Cu)	50	140
Nickel (Ni)	30	75
Zinc (Zn)	150	300
Mercury (Hg)	1	1.5

e. If the stabilized sewage sludge is utilized in agriculture every year for 10 years period, the maximum heavy metal values are the following:

Heavy Metals	Limit Loading Values (gr/acre/year)
Lead (Pb)	1500
Cadmium (Cd)	15
Chromium (Cr)	1500
Copper (Cu)	1200
Nickel (Ni)	300
Zinc (Zn)	3000
Mercury (Hg)	10

f. It is forbidden to apply stabilized sewage sludge on areas closer than 10 meters to surface waters and wetlands.

g. It is forbidden to apply stabilized sewage sludge on frozen and snow covered areas.

As seen from the above values, it is rather difficult to obey the mentioned regulations. The regulations should be revised and applicable values should be accepted.