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Republic of Turkey:
Sustainable Urban Water Supply and Sanitation

Reaching Compliance with the European Union's Water Framework Directive in a Sustainable Way – Challenges and Opportunities for Turkey's Water Supply and Sanitation Sector

Updated Report

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BOT	Build, Operate and Transfer (a type of PPP arrangement)
CAPEX	Capital Expenditures
DBO	Design, Build, Operate (a type of PPP arrangement)
DSI	See GDSHW
DWD	EU Drinking Water Directive
EIA	Environmental Impacts Assessment
EU	European Union
GDSHW	General Directorate of State Hydraulic Works
GDWM	General Directorate for Water Management of the MoFWA
GoT	Government of Turkey
IUWM	Integrated Urban Water Management
IWRM	Integrated Water Resources Management
LCC	Life Cycle Cost
MM	Metropolitan Municipality
MoEU	Ministry of Environment and Urbanization
MoFWA	Ministry of Forestry and Water Affairs
NRW	Non-Revenue Water
O&M	Operation and Maintenance
PPP	Public-Private Partnership
RBPAP	River Basin Protection Action Plans
SKI	General Directorates for Water and Wastewater Administration
SPA	Special Provincial Administration
SUEN	Turkish Water Institute
TL	New Turkish Lira (TRY)
TurkStat /TUIK	Turkish Statistical Institute
UWWD	EU Urban Wastewater Directive
WFD	EU Water Framework Directive
WPP	Water Partnership Program of the World Bank
WSS	Water Supply and Sanitation
WUD	Water Utility Departments of municipalities (not MMs)
WWTP	Wastewater Treatment Plant

Executive Summary

Objective. The main objective of this report is to identify and analyze key issues faced by the Water Supply and Sanitation (WSS) services in Turkey, as Turkey works to reach compliance with the European Union (EU) Drinking Water Directive (DWD) and Urban Wastewater Directive (UWWD), the WSS-related aspects of the EU Water Framework Directive (WFD), and to initiate a dialog with authorities on opportunities to enhance the sustainability (technical and financial) and affordability of service provision, consistent with these Directives. This objective is consistent with Turkey's focus on reaching the Sustainable Development Goals. The report identifies questions which were discussed at a high level workshop on the subject and hopes to generate interest for further analysis and support from the World Bank.

Turkey's Rich Experience in WSS Services Management. The Turkish Republic has a long and rich experience in the water sector. The 1926 Water Law places the overall responsibility for water resources management at the state level. This was confirmed in the Constitution of 1982 that provided that the state owns the right to explore and operate these natural resources, but can transfer this right to private institutions for a defined period. Municipalities are responsible for WSS services in their respective areas. In 1981, as a pragmatic response to water shortages and sewage problems in İstanbul, the government of Turkey introduced a new service provision model in Istanbul's municipality. It established a dedicated Water and Sewage Administration (SKI), called "ISKI" in Istanbul, as a public utility owned by the municipality but with an independent budget. ISKI was entrusted to finance large WSS investments through international loans under the Treasury Guarantee Scheme. Turkey thereafter created 16 "metropolitan municipalities" (MM) by consolidating the municipalities in the main urban areas and by equipping each with an SKI. The March 31, 2014, law created 14 new metropolitan municipalities and SKIs and extended the service area of all metropolitan municipalities to cover the entire province. As a result, there are 30 SKIs responsible for providing WSS services to 77 percent of the population (62 million in 2014). Other municipalities provide WSS services through a municipal department. Special provincial administrations (SPA) provide services in non-municipal areas.

Turkey Has Made Significant Progress Towards Compliance with EU Directives. The accession process of the Turkish Republic to the EU led to a major effort to harmonize its legislation with the EU's overarching WFD and with WSS-related DWD and UWWD. Consistent with the WFD principles of "good ecological status," integrated water resources management and holistic approaches to protect and control water resources (in both quantity and quality), Turkey defined 25 river basins and prepared River Basin Protection Action Plans for each of them. It entrusted the Ministry of Forestry and Water Affairs (MoFWA) to coordinate WFD compliance and coordination of the preparation of river basin management plans, both centrally through the Water Management Coordination Board, and locally through basin management committees. Turkey also made great progress towards compliance with the DWD and the UWWD, which is the focus of this report. It entrusted institutions, established service providers and developed regulations, standards, programs, and action plans for sector investments and management of WSS. Reshuffling in the government in 2011 resulted in modifications of Turkey's institutional arrangements that conferred most of the WSS mandates on MoFWA and on the Ministry of Environment and Urbanization (MoEU). Funding responsibilities rely on the General Directorate of State Hydraulic Works (GDSHW or DSI) and on İlBank. The latter, which is Turkey's development Bank, also assesses municipalities' creditworthiness and funds and channels international funding to the WSS sector.

MoFWA, through its General Directorate for Water Management (GDWM), is in charge of preparing river basins management plans. GDWM is attempting, through a draft by-law, to redefine the "sensitive water bodies and the drainage areas of these water bodies as urban sensitive areas and/or nitrate sensitive areas." It also determines the environmental quality standards which are to be used for improvement of surface and groundwater protection and associated threshold values.

MoEU assesses environmental impacts, determines wastewater treatment standards, issues discharge permits, and monitors the performance of wastewater treatment plants. It also prepares the EU compliance operational program, creates financial agreement frameworks and sets priority levels for projects.

Turkey' WSS Sector Status Shows Good Coverage and Service Levels. In 2014, Turkey's efforts in WSS resulted in reaching 97 percent access rates to piped water supply and 90 percent connection rates to the sewage network for populations living in municipalities, and respectively 91 percent and 84 percent nationally. The Turkish Statistical Institute, TurkStat, reported access levels to treated water at 58 percent in municipalities and 54 percent nationally. Considering that the customer satisfaction rate with the water supply service was 79 percent in 2012 and above 76 percent since 2009, it is assumed that the rest of the supplied water is mostly in a good enough condition that it does not require complex treatment methods and can be distributed after a simple disinfection. In 2014, despite increasing population, access, and per capita consumption levels, Turkey decreased the ratio of wastewater discharged without treatment from 36 percent (1,226 million m^3) in 2006 to 19 percent (813 million m^3) in 2014 and lowered the level of non-revenue water (NRW) from 54 percent to 35 percent in the same period. These levels match those of EU member states in the Danube River Basin.

WSS Debt-Funded Investments Efforts Limit SKIs' Creditworthiness. 2014 and 2015 data on payables shows that the total debt levels of most SKIs exceed budget revenues. The majority of SKIs, most of which were established in 2014, operate at a loss, despite reasonable tariff levels, and have low creditworthiness. This shows that better financing and efficiency improvements are needed to improve SKI operational and investment capacity.

There are issues hindering implementation of EU Directives: Excessive standards. If Turkey's drinking water standards are mostly consistent with those set by the DWD, its two wastewater standards[1]are more stringent than those of the UWWD, and are applied in an even stricter fashion. Areas labeled as "sensitive" appear to differ from the EU's recommended linkage of sensitivity to eutrophication or to an actual and worsening environmental threat. A new draft by-law may harmonize standards to align them with those of the EU, but may augment the list of areas set as "sensitive areas".

Incremental costs of compliance. The report includes an analysis of the estimated costs of reaching compliance in three scenarios: (i) under UWWD standards; (ii) under Turkish standards for nutrient removal in sensitive areas; and (iii) under Turkish standards of scenario (ii) plus additional nitrogen removal for all cities above 50,000 people. For each scenario two options for "sensitive areas" are considered: (i) as currently defined; and (ii) as set in the draft new by-law. Resulting estimated costs of compliance range between 5.2 and 6.3 billion Euros for additional investments (4 billion Euros more if funded through debt) and 844 million to 1.4 billion Euros per year for related operation and maintenance (O&M), which represent between 116 and 186 billion Euros considering O&M and amortization over the lifetime of the investment. The least-cost scenario on investments and O&M is to apply EU standards and current sensitive areas. These costs are only partial costs, focused only on wastewater. As publicly available data

1 Regulation on Urban Wastewater Treatment and Regulation on Water Pollution Protection

and benchmarks did not allow including the cost of pumping stations, deep sea outfalls and sludge treatment, transport and disposal, assumptions were made that estimated some of these costs. Nevertheless, considering Turkish versus EU standards with the current "sensitive areas" is estimated to cost 17 percent more in investments and 59 percent more in yearly O&M costs. Applying EU standards with new "sensitive areas" would add costs of 15 percent more in investments and 52 percent more in yearly O&M. Few SKIs can afford such additional costs.

Scattered responsibilities. The multiplicity of institutions with shared responsibilities for the water sector, whether on resources management or WSS, and the overlapping of numerous action plans and investment programs, limits Turkey's efficiency in compliance and complicates monitoring. It also hinders Turkey's capacity to have a real vision of the "big picture" of sector and progress.

Need for utilities to improve their operational and financial performance. Increasing demographic and economic demand for water combined with resources reduction due to the impact of climate change make NRW reduction a top priority. Better energy efficiency and capacity building are also critical to operating wastewater treatment plants (WWTP) and managing sludge to meet discharge targets in a sustainable manner.

Insufficient publicly-available data on WSS utilities. There is currently no benchmarking system for the provision of WSS services in Turkey. MoFWA/GDWM created one on NRW, but the guideline document has proven insufficient to obtain reliable and comparable data, and it is not in electronic form. This affects the capacity to effectively monitor utilities' performance, to make informed strategic decisions, and to improve the incentive framework to encourage efficiency and financial sustainability. MoFWA/GDWM is providing training in order to improve reporting on NRW.

These Issues can be Turned into Opportunities.

It is well known in the EU that, of all environmental directives, the UWWD is one of the most expensive to comply with. As a basic measure (Annex VI part B) of the WFD, the implementation of the UWWD has not yet generated the expected improvements of the "good ecological status" in EU Member States. This represents an opportunity for Turkey to focus on the core principles of the WFD, improve and apply water-related regulations accordingly, and then retrofit to the EU.

Other countries have obtained compliance, and their experience could benefit Turkey. Key aspects to reach sustainability include (i) ensuring the efficiency of new investment, taking into account the total cost for optimized O&M costs over the lifetime of the investments; (ii) improving the efficiency and performance of existing infrastructure; and (iii) providing adapted support to improve SKI creditworthiness.

Setting treatment standards based on expected environmental impacts rather than only on effluents? Consistent with the WFD, a first question worth asking is whether investment decisions and standards-setting should be determined on the basis of the expected impacts of the treated wastewater discharges on the ecological status, taking into consideration its actual water quality, its documented evolution, and its planned uses in the discharge area and downstream in the river basin.

Setting "sensitive" and "less-sensitive" areas for impact? The designation limits and geographical extent of "sensitive areas" determine wastewater treatment standards and costs, but will they have the expected impacts? Is the assessment of "sensitivity" of receiving bodies adequately based on reliable water quality monitoring and related to the actual economic impact of the discharge?

The WFD links the sensitivity of the receiving environment mostly to its level of eutrophication. Does it make sense to require stringent and expensive nutrient removal technology in small cities in Turkey's river basins when the pollution they generate is only minimal and presumably negligible in comparison to larger untreated point or non-point pollution sources?

Implementing incrementally-phased approaches? There is strong evidence in support of phased approaches, with increasingly stringent requirements implemented over time, based on the extent to which prior actions actually contributed to the "good ecological status" of the receiving environment. Such phased approaches optimize environmental and sustainability objectives. Implemented both in space and time, they entail a holistic approach at the scale of the water body and river basin to respond to river basin objectives rather than applying fixed effluent standards at the scale of each urban area. They also allow for adapting the approach over time if the monitoring of the ecological status demonstrates that objectives are not being met. If EU members adopted this approach, why not Turkey?

Utilizing Integrated Urban Water Management (IUWM)? IUWM is widely recognized as a way to make decisions on water and wastewater management and reuse to optimize resources and funding through a holistic approach at the city level. IUWM utilizes a holistic, integrated, and sustainable management of increasingly scarce water resources at the scale of urban areas.[2] It links infrastructure options to urban planning and considers the whole "water cycle" in the solution-seeking process. Questions worth analyzing in Turkey include: To what extent are utilities' plans for infrastructure development integrated into urban plans? Is their implementation coordinated? Which incentives and mechanisms would make sense to facilitate IUWM approaches as urban centers develop plans to comply with EU Directives and ensure water security?

2 Chapter 5.6 presents a more detailed definition of IUWM and a description of aspects of what it can encompass in the Turkish context.

Introduction

Background and Objectives

Background. The Government of Turkey (GoT) and the World Bank have a long history of collaboration through project financing in the water supply and sanitation (WSS) sector. As part of this collaboration, and in order to inform a broader sector dialogue, the World Bank secured a grant from the Water Partnership Program (WPP) to conduct an analytical work entitled "Sustainable Urban Water and Wastewater Services in Turkey," which is the basis for this report.

Study and Report Objectives. The main objective of this report is to identify and analyze the main issues faced by the WSS services in Turkey and to initiate a dialog with authorities on opportunities to enhance the quality, sustainability (technical and financial), and affordability of service provision as Turkey works to reach compliance with the European Union (EU) Drinking Water Directive (DWD) and the Urban Wastewater Directive (UWWD) and with WSS related aspects of the EU Water Framework Directive (WFD). This objective is also very consistent with Turkey's focus on reaching the recently established Sustainable Development Goals. The report identifies questions which were discussed at a high level workshop and related inputs subsequently received.

Data limitations. Collecting and organizing the data necessary to perform in-depth analysis has proven a challenge that could not be overcome in the timeframe of this study. The report therefore relies solely on publicly available data and studies and on information collected through meetings with Turkish counterparts and EU colleagues and disseminated or validated at the workshop.

Structure of the Report

This report is designed and written for high-level officials and authorities in central and local governments. Chapter 1, which presents the sector's main objectives, institutional arrangements, and regulatory framework, is kept short, as these are well-known to the target audience of this report.

Chapter 2 presents an overview of the technical and financial status of the WSS.

Chapter 3 compares the requirements of the EU Drinking Water and Urban Wastewater Directives with Turkish regulations and presents a short overview of the current compliance levels.

Chapter 4 estimates the cost of reaching compliance with regulations related to wastewater collection and treatment and service provisions in three scenarios: (i) under EU Urban Wastewater Directive requirements; (ii) under Turkish standards for nutrient removal in sensitive areas; and (iii) under Turkish standards of scenario 2, plus compulsory nitrogen removal treatment for cities of more than 50,000 people. It estimates the costs and operation and maintenance (O&M) requirements of existing infrastructure (per available data), incremental costs needed to comply with the regulations in each scenario, and where data is available, the related impact on O&M and tariffs for utilities.

Chapter 5 proposes questions worthy of further analysis which were discussed at a high-level workshop.

Project team and Acknowledgements

This analytical work was led by Xavier Chauvot de Beauchêne (Senior WSS Specialist and Task Team Leader), with support from Manuel Mariño (Lead Technical Consultant), Emre Tokcaer (Technical Consultant), Isik Kocaman (Financial Consultant) and the World Bank Country Office in Turkey. The team acknowledges and thanks the General Directorate for Water Management (GDWM) of the Ministry of Forestry and Water Affairs (MoFWA), and the institutions which participated in the October 18, 2016 high-level workshop held in Ankara, with special thanks to presenters and panelists.

Chapter 1 - Turkey's Experience in Water and Wastewater Services Managenment

1.1. A Long and Rich Experience

The Turkish Republic has a long and rich experience in the water sector, starting from the 1926 Water Law (No 831), which set the overall responsibility for water resources management at the state level. The Constitution of 1982 confirmed that all natural resources, including water, are under the state's trusteeship. The state owns the rights for exploring and operating these natural resources. However, the state can transfer this right to private institutions for a defined period. The state has supported water resources development while adopting liberalization policies as part of the economic transformation program.

In the 1980s, population increases in cities, especially in İstanbul and Ankara, resulted in depletion of available water sources followed by water shortages and serious sewage problems. In response to these crises, in 1981 Turkey introduced a new model for water service provision, piloted in İstanbul, by establishing a Water and Sewage Administration, called ISKI, that was subordinated to the municipality as a public body but with an independent budget. The so-called "ISKI Law" did not only result in autonomy of WSS services but also encouraged ISKI to finance large-scale WSS investments through international loans under the Treasury Guarantee Scheme.

As it became clear that the sensible scale for the provision of WSS and other services in large urban areas is the metropolitan area and not individual municipalities, in 1984 Turkey consolidated the municipalities forming Ankara, Istanbul, and Izmir into "Metropolitan Municipalities" (MM). In 1986, a decision was made to implement the ISKI Law in all MMs. Between 1986 and 1993, the thirteen largest cities in the country were restructured in the same way[3] and a General Directorate for Water and Sewage Administration (SKI) was established in each of them to provide WSS services within their provincial borders. In other municipalities, WSS services are provided by different departments of the municipality. Special Provincial Administrations provide WSS services in non-municipal areas.

In 2014, Turkey consolidated the municipalities forming the main metropolitan areas into MMs and expanded ISKI Law to all 30 MMs, covering 77 percent of the population, or about 62 million people. "SKIs" are responsible for WSS services within MM borders, which correspond to provincial borders. In smaller municipalities, different departments of each municipality provide WSS services. Appendix A, "Maps and Population Breakdown," shows a map of the 30 metropolitan municipalities in Turkey.

The accession process of the Turkish Republic to the EU became a major influence on the development of the WSS regulatory framework as Turkey began to harmonize its legislation in accordance with EU legislation, particularly the Water Framework Directive (WFD), which aims at protecting and improving all types of European waters. The directive introduced an ecological and integrated (holistic) approach in a number of areas, including: river basin planning; programs of measures; strategies for elimination of pollution by dangerous substances (in a related directive on priority substances); public information and consultation; and application of economic incentives (cost recovery and adequate pricing). To be consistent with the WFD principles of protection and control of water resources, both in quantitative and qualitative terms, and in order to achieve "integrated water resources management," Turkey identified 25

3 Adana (1986), Bursa, Gaziantep, Konya (1987), Kayseri (1988), Antalya, Mersin, Diyarbakır, Erzurum, Eskişehir, Izmit (changed into "Kocaeli" in 2014), Sakarya and Samsun (1993).

hydrologic basins, defined "sensitive water bodies, urban sensitive areas and nitrate sensitive areas", and completed twenty-five river basin protection action plans. (See Appendix A, "Maps and Population Breakdown", for a map of river basins).

1.2. Overview of Institutional Arrangements

The roles and responsibilities of different ministries related to the water sector were reshuffled in 2011. As a result the Ministry of Forestry and Water Affairs (MoFWA) and the Ministry of Environment and Urbanization (MoEU) were established. At the central level, MoFWA and MoEU share most of the water sector mandates.

The primary mandates of MoFWA in relation to water issues are to develop policies on protection of water resources and their sustainable use and to coordinate national water management. The General Directorate for Water Management (GDWM) is in charge of delivering on these mandates, particularly: (i) preparing River Basins Management Plans; (ii) identifying and monitoring urban sensitive areas and nitrate sensitive areas; and (iii) together with related agencies and ministries, identifying targets, principles and receiving body standards for surface and groundwater protection, and monitoring water quality or having it monitored.

MoEU also has responsibilities regarding water governance, especially related to environmental protection and rehabilitation, and is charged with assessing and monitoring environmental impacts of projects and activities. As such, it determines treatment standards for wastewater treatment plants, issues discharge permits, and is in charge of monitoring performance of wastewater facilities. MoEU is also in charge, through its EU Investments Department, of preparing and implementing the operational program in accordance with the legislation, EU directives, and international agreements, in particular the financial agreement frameworks with the EU. As such, it sets projects' priority levels.

IlBank is the development and investment Bank of Turkey. It has a major influence on municipal investments, a large share of which is in WSS. It establishes the creditworthiness and therefore the acceptable debt level of all local governments in Turkey, provides loans (grants for small municipalities and local governments) and guarantees, channels funding from international finance institutions (IFI), and carries out all aspects of related due diligence.

The General Directorate of State Hydraulic Works (GDSHW) also known as DSİ, is mandated to develop all water and land resources in Turkey. It also undertakes investments in the supply of potable and industrial water, and if required, invests in wastewater treatment plants for municipal settlements (Article 10 of the law No 1053 as revised in 2007).

Because a number of ministries and institutions are involved in different aspects of water sector management, a Water Management Coordination Board was created in 2012. Its primary objective is to foster cooperation and coordination among all ministries, institutions, and organizations in accordance with a common strategy framework in order to increase potable water quality and quantity and to ensure the sustainability of water protection and usage balance. Water sector management and monitoring at the decentralized level is carried out by a Local Environment Board at the provincial level, and by the recently created Basin Management Committees.

A General Directorate of Water and Wastewater Administration "SKI" is established in every metropolitan municipality to carry out the WSS in accordance with the provisions of Law No 2560. SKIs are public entities that are affiliated with the metropolitan municipality and have an autonomous budget. According to Law No 2560, SKIs are also responsible for drainage and for ensuring protection of the water basins, even those located outside the boundaries of their service area. The governance structures of SKIs include a General Board, a Management Board, and auditors. The Metropolitan Municipality Council serves as the General Board of an SKI. Key responsibilities of the General Board include: (i) to decide on the five year investment plan; and (ii) to review and decide on annual investment programs.

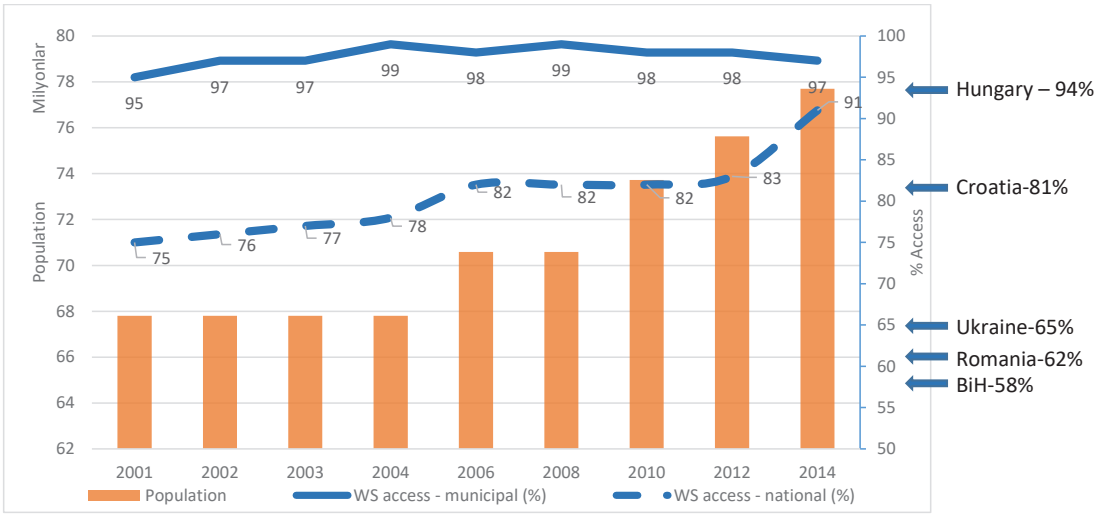
Chapter 2 - Water Sector Status in Turkey Shows Good Coverage and Service Levels

2.1. A Quick Overview of WSS Services in Turkey

2.1.1. Water Supply almost Universal, with Uneven Performance

Access to water supply: According to TurkStat data - "Main Sector Indicators from 2006 to 2014" (see Appendix B), for 2014, out of the 84 percent of the population living in municipalities, 97 percent had access to piped water supply, but only 58 percent were served by a drinking water treatment plant. These ratios drop to 91 percent and 54 percent respectively when considering the whole population, including rural non-municipal areas. Considering that the rate of customer satisfaction with the water supply service was 79 percent in 2012 and above 76 percent since 2009, it is assumed that the rest of the supplied water is mostly in good enough condition, and therefore does not require complex treatment methods and can be distributed after a simple disinfection. Turkey's rate is slightly higher than the 90 percent access rate to piped water supply in EU member states in the Danube river basin.[4] As illustrated by Figure 2.1, from 2001 to 2014, when the population increased by 10 million people, WSS utilities provided access to water to 20 million people.

Figure 2.1: Water Supply Access Rates and Demographic Growth in Turkey from 2001 to 2014 and Comparison with Selected EU Member States and Countries in the Danube River Basin.



4 For comparison purposes, all data from EU-member countries mentioned in this chapter refer to countries belonging to the Danube river basin, as these are currently considered more relevant to Turkey. (ref: http://documents.worldbank.org/curated/en/327761467999140967/pdf/96396-REVISED-WP-P146139-PUBLIC-Box391472B-SoS-Report-150610.pdf)

Quality and reliability of service provision. There is no centralized data collection system capturing information on continuity, reliability, or quality of water service provision in Turkey. However, TurkStat conducts surveys on population well-being, which determine, inter alia, the level of satisfaction of the people with the network water services they receive, and these can be used as a proxy. The results of the latest population well-being surveys carried out between 2004 and 2012 show that 79 percent of the customers expressed satisfaction with the water supply service in 2012. This is consistent with surveys in EU-member states from the Danube basin, where only Romania and Bulgaria, with roughly 70 percent and 60 percent respectively, show levels of satisfaction lower than this figure, and where only Slovenia and Austria with levels of satisfaction close to 95 percent, show higher levels. This is understood as anecdotal evidence of safety and reliability of the service provided, because no information on water quality was published (see Appendix B, Main Sector Indicators from 2006-2014.).

Service performance including Non-Revenue Water (NRW). Service performance that includes NRW is not measured in the TurkStat survey. NRW is also not measured by most municipalities. In the "Main Sector Indicators table" presented in Appendix B, the term "water distribution" corresponds to the amount of water consumed by customers, or water sold. This is measured by water meters, which are believed to equip 95 percent of households. However, some municipalities also have some bulk consumers or supply the military for a lump sum without using metering. District metering and metering at reservoirs and water sources generally does not exist, except in the case of pumping.

Assuming that all of the water distribution by municipal water supply networks is the total billed water and that the rest of water abstraction for the municipal water supply network is not billed, the NRW values can be calculated as the rate of "difference between water abstracted and distributed" to "water abstracted". Calculating in this fashion results in an NRW decrease from 60 percent in 2004 to 35 percent in 2014, which corresponds to almost halving the yearly water losses per capita, from 43.7 m^3 in 2004 (3 billion m^3) to 23.7 m^3 in 2014. This, combined with the sharp increase of the population, demonstrates a significant effort to decrease physical losses, to disconnect illegal connections and unbilled authorized water, and to replace customer meters. This remains higher than the average in EU member states. Data from EU-member states in the Danube river basin show NRW levels consistently lower, in the order of 30 percent or less. Only Croatia, Romania (both with about 45 percent), and Bulgaria (with over 60 percent) have higher NRW levels. (See Figure 2.2).

Nevertheless, water losses in Turkey represent about 1.84 billion m^3 per year, which corresponds to the volume needed to supply the average water consumption of 133 l/day to 38 million people. As demand for water increases due to demographic and economic growth while available resources are decreasing due to the impacts of climate change, efficiency improvements such as NRW reduction appear to be of critical importance to guarantee adequate water resources and to improve the financial sustainability of WSS service provision. However, the optimal target level for NRW reduction depends on the specific case of each service provider, both in terms of availability of water resources and the costs of improving and maintaining water network efficiency. Yet, investing in performance improvement is a "no-regret" solution in most places in Turkey, and it is increasingly understood that the optimum is evolving to lower NRW as demands get closer to the water resources available.

A MoFWA climate change models' worst-case scenario estimated that water availability in Turkey could drop from the current yearly 112 billion m^3 to around 50 billion m^3 by 2100 [5] or even below

5 -Presentation of Prof Dr, İzzet Öztürk on the Hydrological Modelling and Assessment within the scope of Climate Changes Impact on Water Resources Project, General Directorate of Water Management, Ministry of Forestry and Water Affairs. The presentation was downloaded from the below link on November 1st, 2016:
http://iklim.ormansu.gov.tr/ckfinder/userfiles/files/2_Hidrolojik%20Modelleme%20ve%20De%C4%9Ferlendirme.pdf

40 billion m^3 depending on the models. In the meantime, the cumulative water demand for domestic, industrial, and irrigation uses is expected to increase from 43 billion m^3 in 2015 to 54 billion m^3 by 2020 and to 62 billion m^3 by 2100. This means that the overall demand is expected to exceed the water available before the end of the century. Models predict that the water availability decrease is expected to be more severe in central provinces and provinces located on the southern and western shores of Turkey. Obviously, the effort to improve water efficiency should include irrigation and industrial water as well as domestic water supply.

Figure 2.2: Non-Revenue Water Level and Yearly Loss Per Capita Relative to Demographic Growth in Turkey from 2004 to 2014 and Comparison with Selected Countries in the Danube River Basin.

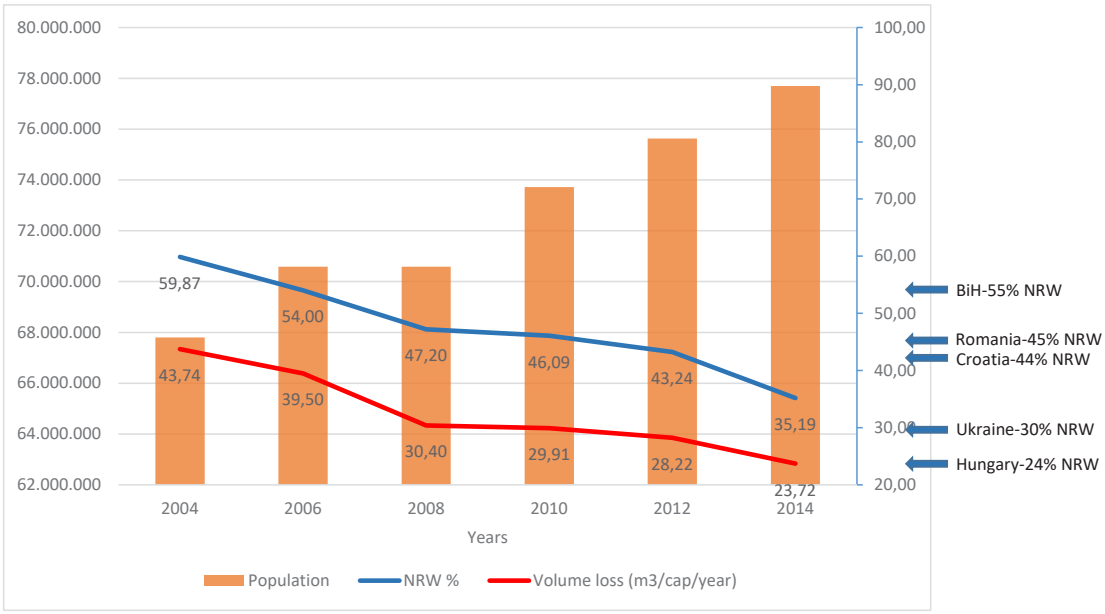


Table 2.1: Water and Wastewater Indicators in Turkey and Danube Basin Countries (EU Members and All).

Item	Unit	In Turkey					In Danube basin countries (2012)	
		2006	2008	2010	2012	2014	EU Member States	All States
Rate of population served by a water supply network in total pop	%	82	82	82	83	91	90	83
Water abstraction per capita in municipalities	l/cap/day	245	215	216	216	203	n/a	n/a
Water consumption per capita	l/cap/day	113	113	116	123	133	100 - 150	122
Non-Revenue Water (NRW)	%	54	47	46	43	35	< 30	35
Rate of population served by a sewerage system in total pop.	%	72	73	73	78	84	90	66
Rate of population served by a WWTP in total population	%	42	46	52	58	64	67	45
Amount of wastewater discharged without treatment	(1000 m^3)	1,226.4	1,009.9	863.0	815.6	813.1	n/a	n/a

Source: Calculations of authors based on TurkStat data for Turkey's indicators; "Water and wastewater services in the Danube Region – A state of the Sector, WB and Danube Partnership, May 2015" for Danube Basin countries.

Per Capita water consumption. Although the water abstracted per capita has decreased from 2006 to 2014, during the same period there was an eight percent increase in water consumption per capita[6] from the distribution network, from 113 l/cap/day in 2006 to 133 l/cap/day in 2014 (Table 2.1). This has been consistently increasing since 2006 and may therefore continue to increase in the future, putting additional pressure on the water resources and delivery systems. These levels are comparable to international standards. By means of comparison, consumption in EU member states from the Danube basin have been declining in recent years and are currently in the 100-150 l/cap/day range, with consumption in Slovakia, the Czech Republic, and Hungary already below 100 l/cap/day.

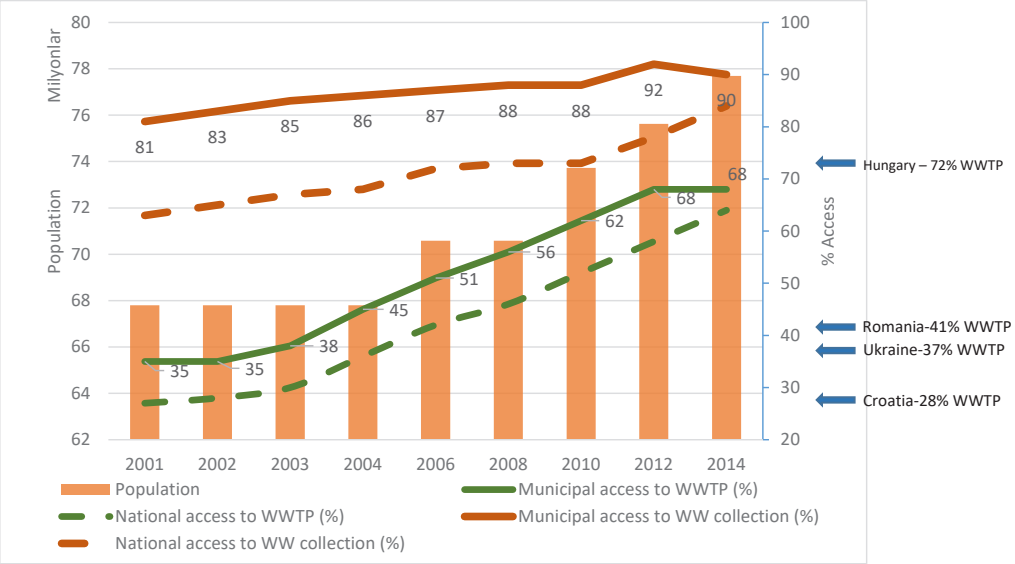
2.1.2. Sanitation and Wastewater Treatment: An Ongoing Effort

Turkey has made significant efforts to increase wastewater collection and treatment in municipalities, which has resulted in making strong progress in wastewater indicators.

Connection rates to **wastewater services increased.** In the "Main Wastewater Indicators for Municipalities" table (Table B.3) in Appendix B ("Main Sector Indicators for 2006-20014"), the "population served" indicates the connection rate. The analysis of this data shows a remarkable effort to increase wastewater collection and treatment in Turkey. Indeed, while municipal areas recorded a 14 million increase in population between 2006 and 2014, the connection rate in these service areas remained the same for water supply, connection rate to sewage networks increased from 87 percent in 2006 to 90 percent in 2014, and the municipal population served with wastewater treatment plants increased from 51 percent in 2006 to 68 percent in 2014 (Figure 2.3). This means that between 2006 and 2014, while the Turkish population increased by 7 million people, WSS municipal service extended sewer access to 14 million people and access to wastewater treatment to 20 million people. In other words, on a daily basis for the past eight years, Turkish water utilities connected an average of 4,800 people to a sewer and provided wastewater treatment to an additional 6,850 people.

6 Water consumption per capita figures are calculated by dividing the amount of water distributed through the municipal water supply network by the municipal population served by the water supply network.

Figure 2.3: Access to Wastewater Collection and Treatment Relative to Demographic Growth in Turkey from 2001 to 2014 and Comparison with Selected Countries in the Danube Basin.



These rates are comparable to that of EU-member countries in the Danube river basin, both for connection and treatment rates. Connection rates in urban areas reach over 90 percent in most countries, with only Bulgaria and Romania in the 80-90 percent range. Regarding treatment, the rates range from a low of 28 percent in the case of Croatia to close to 95 percent in Austria, with an average of 67 percent.

The latest life satisfaction survey results, used as a proxy for service performance, shows that 71.5 percent of customers were satisfied with their sanitation services in 2012.

Biogas digestion, sludge composting or reuse, and treated wastewater reuse remain anecdotal. Few municipalities in Turkey have piloted biogas digestion, composting, and reuse, as was done in Ankara, or treated wastewater reuse, as was done in Konya. The most common practice seems to be to dispose of sludge in solid waste landfills or to incinerate them, but both are very expensive solutions. Although possible, the use of sludge in agriculture is not a common practice in Turkey, as it is in most EU countries. The impacts of climate changes on resources and energy costs should encourage policies in favor of treated wastewater reuse and biodigestion wherever it makes economic sense, because it serves both economic and environmental agendas. The EU is working on a new directive aiming at encouraging treated wastewater reuse, Turkey could benefit from increasing such practices.

2.1.3. Some Data on Tariffs and Sector Investments

Tariffs. There is no WSS sector regulator in Turkey. Water and wastewater tariffs set and charged by municipalities in Turkey are not available as a whole, and they need to be checked separately for each municipality or service provider. Each SKI applies different water and wastewater tariffs depending on customer groups. Household rates can differ as well depending on the service area and/or level of consumption. A discounted household tariff of up to 50 percent is applied under the law to customers with disabilities and to customers having a martyr or veteran household member. Customers located in a new service area of an SKI or a former rural area are charged 25 percent of the regular WSS household tariff. The household tariff rates applied by SKIs as of the end of October 2016 are presented in Table 2.2 below showing the highest and lowest household tariff rates per cubic meter. The highest total WSS tariff is shown in Denizli for the

highest block above 251 m3 of consumption monthly, whereas the Mardin SKI provides this service to household customers at the lowest reduced tariff among listed SKIs. The relative tariff charged for water and for wastewater compared to the total tariff also varies from one SKI to another. Wastewater service represents 15 percent to 30 percent of the total tariff applied, with the highest being in Mardin at 50 percent.

Noteworthy: In comparison, the EU reports an evolution of tariffs that breakdown in EU member states from a balanced (50/50 percent) status towards a 30 percent/70 percent breakdown in favor of wastewater. This means that complying with the UWWD should result in wastewater representing a higher share of the overall water tariff. This calls for a policy review of how tariffs are used as an incentive to achieve more water efficiency, consistent with the provisions of WFD's article 9.

Table 2.2: Applied Household Tariff Rates by SKIs for Water and Wastewater Services in 2016.

Municipality	SKİ	Household Tariff in TL/m3		Household Tariff in EUR/m3	
		Highest	Lowest	Highest	Lowest
Adana	ASKİ	3,18	0,95	0,98	0,29
Ankara	ASKİ	5,10	1,28	1,56	0,39
Antalya	ASAT	3,17	0,35	0,97	0,11
Aydın	ASKİ	4,20	0,88	1,29	0,27
Balıkesir	BASKİ	4,28	1,07	1,31	0,33
Bursa	BUSKİ	5,95	1,32	1,83	0,40
Denizli	DESKİ	13,25	0,39	4,06	0,12
Diyarbakır	DİSKİ	2,56	0,18	0,79	0,05
Erzurum	ESKİ	1,87	0,75	0,57	0,23
Eskişehir	ESKİ	2,76	0,69	0,85	0,21
Gaziantep	GASKİ	11,55	0,41	3,54	0,13
Hatay	HATSU	4,75	0,50	1,46	0,15
İstanbul	İSKİ	8,69	1,02	2,67	0,31
İzmir	İZSU	8,44	0,90	2,59	0,28
Kahramanmaraş	KASKİ	1,83	0,51	0,56	0,16
Kayseri	KASKİ	4,38	0,34	1,34	0,10
Kocaeli	İSU	5,19	0,72	1,59	0,22
Konya	KOSKİ	3,11	1,24	0,95	0,38
Malatya	MASKİ	3,09	0,58	0,95	0,18
Manisa*	MASKİ	-	-	-	-
Mardin	MARSU	2,00	0,02	0,61	0,01
Mersin	MESKİ	7,65	0,54	2,35	0,17
Muğla	MUSKİ	4,04	1,01	1,24	0,31
Ordu	OSKİ	4,09	0,41	1,25	0,13
Sakarya	SASKİ	3,25	0,95	1,00	0,29
Samsun	SASKİ	3,13	0,78	0,96	0,24
Şanlıurfa	ŞUSKİ	4,00	0,88	1,23	0,27
Tekirdağ	TESKİ	3,00	0,75	0,92	0,23
Trabzon	TİSKİ	2,65	0,27	0,81	0,08
Van	VASKİ	2,20	0,55	0,67	0,17

Source: Web-pages of each SKI,

* WSS tariff for Manisa SKI was not available.

As observed in Appendix C, "Water and Wastewater Expenditures 2007 – 2013," Table C.1 shows that from 2007-2013 the total amount of public sector operational and capital investments was 35 billion Turkish Lira (TL). Of this amount, 79 percent (27.8 billion TL[7]) was invested in water and wastewater services, with operational and capital municipal investments representing equal shares, each being 14 billion TL. This demonstrates the high priority given to the sector, which led to the improvements presented above. There is little information and data on investments in water and wastewater financed by commercial loans or bilateral aid without a state guarantee. While large SKIs may have mobilized such financing, they are expected to be very limited. To what extent this situation could be related to a lack of interest from the banking sector, presumed low creditworthiness levels of most utilities, or the terms and conditions proposed to them is unknown.

2.1.4. The Financial Situation of most SKIs[8] is Challenging

The final assessment of the financial health of a municipal utility or, in this case, SKIs, is based on the indicators of total debt/total budget revenues, debt service/total budget revenues, and operating budget surplus/deficit. In general practice – though this is not defined in Turkish law – a municipal utility may be considered financially sound if its total debts do not exceed 60 percent of its total budget revenues, if its total debt service (interest payments and debt repayments in a given year) does not exceed 15 percent of total budget revenues, and if the municipality has an operating surplus (its operating revenues exceed its operating costs).

Thus, the purpose of assessing SKIs' finances and creditworthiness is to get a general impression of their financial situation, to check whether they appear to be well managed and are reasonably sound financially, and to determine whether SKIs have room to take on further investments.

2.1.4.1. Revenues and Expenditures of SKIs are Uneven

As Table 2.3 illustrates, ten SKIs had budget deficits in 2015, while twenty had budget surpluses, some up to 89 percent. A closer look at the SKIs with a budget deficit reveals that most of them are newly established SKIs which in 2014 took over all liabilities of the sub-province municipal utilities into their balance sheet, and in 2015 continued with investments for rehabilitation of existing infrastructure (mostly network) in the new service area. Also, some may not have been very successful in billing and collecting revenues in their first year of operation as an SKI. Two of the SKIs established in 2014, Kahramanmaraş and Malatya, have not made their 2015 annual activity reports publicly available.

The structure of the budget expenditures shows that operational expenditures, such as salaries, social security premiums, and purchases of goods and services, range in 2015 from 36 percent to 89 percent in SKIs established before 2014 and from 31 percent to 80 percent in SKIs established in 2014. However, the financial data available for SKIs is not detailed enough to be able to determine whether the SKIs are running operating deficits. Some de facto capital expenditures (CAPEX) may have been categorized under purchases of goods and services (operating expenditures). The share of capital expenditures in the budgets of newly established SKIs is low (29 percent on average), whereas it is 40 percent in other SKIs.

It should be also noted that the data available aggregates all lines of businesses in SKIs. It therefore does not allow for distinguishing whether the accounts also include some expenditures and revenues which are not directly linked to provision of urban water and wastewater services. Some of the MM are active in the production and sale of bottled water and it is not clear in these cases whether this financial information is also included in SKI's account.

7 Table C.1 did not provide data for 2011, so this figure represents capital investments for years 2007 to 2010, 2012 and 2013.
8 The following sections deals more specifically with SKIs as they are the largest utilities and publish data allowing the analysis.

Table 2.3: Main Financial Indicators of SKIs in 2015.

Municipality	SKİ	Annual Result (MTL)	Cost Coverage Ratio	Short term liabilities/ Revenues	Long-term liabilities/ Revenues	Total Debt/ Revenues	Non-Revenue Water (%)	CAPEX/ Total Costs
Adana	ASKİ	-30,14	92%	33%	52%	85%	47%	25%
Ankara *	ASKİ	463,59	145%	32%	21%	53%	42%	54%
Antalya	ASAT	193,63	143%	17%	132%	148%	33%	34%
Aydın	ASKİ	1,17	101%	276%	122%	398%	66%	21%
Balıkesir	BASKİ	-6,90	71%	34%	223%	256%	60%	31%
Bursa	BUSKİ	10,44	120%	61%	93%	154%	23%	47%
Denizli	DESKİ	-103,42	63%	29%	121%	150%	39%	64%
Diyarbakır	DİSKİ	55,05	129%	35%	76%	111%	51%	31%
Erzurum *	ESKİ	-16,52	87%	343%	271%	614%	50%	35%
Eskişehir	ESKİ	13,06	110%	33%	53%	86%	35%	51%
Gaziantep	GASKİ	45,31	113%	72%	135%	206%	47%	38%
Hatay	HATSU	-41,04	84%	81%	94%	176%	58%	41%
İstanbul	İSKİ	80,42	102%	9%	36%	45%	24%	69%
İzmir	İZSU	74,41	108%	35%	33%	68%	34%	38%
Kahramanmaraş	KASKİ						40%	
Kayseri	KASKİ	1,54	101%	34%	70%	104%	34%	41%
Kocaeli	İSU	127,15	131%	30%	84%	114%	38%	20%
Konya	KOSKİ	46,10	116%	27%	101%	128%	28%	33%
Malatya **	MASKİ						38%	
Manisa	MASKİ	20,09	111%	25%	61%	87%	41%	26%
Mardin	MARSU	-9,93	89%	38%	86%	124%	63%	11%
Mersin	MESKİ	42,81	113%	23%	117%	130%	39%	32%
Muğla	MUSKİ	24,30	113%	40%	489%	529%	29%	15%
Ordu	OSKİ	56,28	189%	42%	33%	75%	69%	17%
Sakarya	SASKİ	6,24	103%	24%	391%	415%	39%	41%
Samsun	SASKİ	-39,51	85%	33%	184%	217%	40%	51%
Şanlıurfa	ŞUSKİ	-327,88	33%	60%	229%	289%	57%	17%
Tekirdağ	TESKİ	-36,59	83%	44%	27%	71%	17%	52%
Trabzon *	TİSKİ	10,52	122%	65%	152%	218%	45%	23%
Van	VASKİ	-26,25	75%	93%	144%	238%	47%	27%

Source: Data: Published Annual financial reports for fiscal year 2015; Calculations: Authors.

* 2014 data as 2015 reports were not available. ** No data available for Kahramanmaraş and Malatya

The data presented in Table 2.3 enables the categorizing of the SKI in four main groups, based on the analysis of their financial health (working ratio and debt coverage ratio) and using NRW as a proxy to determine the operational performance of the SKI and its capacity to improve cost recovery. Table 2.4 presents the indicators and respective thresholds used for defining the groups.

Table 2.4: Indicators and Thresholds Used to Organize the SKIs into Groups.

Indicator	Green (3 points)	Yellow (2 points)	Red (1 point)	Dark Red (0 point)
Non-revenue water	≤ 40%	40% - 50%	51% - 60%	> 60%
Revenues/Expenditures	≥ 100%	75% - 100%	55% - 75%	< 55%
Total Debt/Revenues	≤ 100%	100% - 150%	150% - 200%	> 200%
Result	2,5 – 3 points Group 1	2 – 2,5 points Group 2	1,5 – 2 points Group 3	0 – 1,5 points Group 4

Note: In activity reports of some of the SKIs, non-revenue water (NRW) assessment was only given for the service area before 2014, although financial accounts cover the entire service area, as the process of compiling the technical records for the new service area is ongoing. NRW was nevertheless used as a proxy for the efficiency of service provision, since it represents the standing point of the SKI to improve and/or to apply similar efficiency to the entire service area.

Accordingly, 28 SKIs could be grouped as follows:

- Group 1 – Healthy SKIs (11): Ankara, Antalya, Eskişehir, İstanbul, İzmir, Kayseri, Kocaeli, Konya, Manisa, Mersin, and Tekirdağ. Among these SKIs Eskişehir, İstanbul and İzmir got full points for all indicators. It is also noteworthy that except for Manisa and Tekirdağ, all SKIs in this group were established before 2014.
- Group 2 – Moderately healthy SKIs (7): Adana, Bursa, Denizli, Diyarbakır, Muğla, Ordu, and Sakarya. Among these SKIs Denizli and Ordu SKIs are newly established SKIs.
- Group 3 – SKIs in difficult situations (3): Gaziantep, Samsun, and Trabzon. Among these SKIs, Trabzon is a new SKI, but Gaziantep and Samsun were established before 2014.
- Group 4 – SKIs in a critical situation (7): Aydın, Balıkesir, Erzurum, Hatay, Mardin, Şanlıurfa, and Van. Except for Erzurum, all these SKIs were established in 2014.

The publicly available data was not sufficient to classify the Kahramanmaraş and Malatya SKIs.

Noteworthy: Two-thirds of the SKIs (Groups 1 and 2) appear healthy enough to sustain themselves. Although their creditworthiness levels would need to be carefully evaluated, they may be able to support some of the additional investments and O&M costs expected of them. The remaining ten (Groups 3 and 4) – eight of which are newly established SKIs - are in difficult or critical situations. These SKIs require dedicated support to help improve their situation and work towards cost recovery before they can support additional investments.

2.1.4.2. Liabilities of SKIs are High for Most

The payables of the SKIs can be divided into two groups: long-term liabilities (investment credits - primarily from IlBank and/or other financial institutions) and short-term liabilities (taxes, social security premiums, power bills, and so forth). As was presented earlier in Table 2.3, the data on payables illustrates that the total debts of the majority of the SKIs exceed 100 percent of budget revenues in 2015. These SKIs will not be able to support any major investment program solely based on internally generated funds because it would add a new financial burden to the repayment of their substantial existing debt.

In conclusion, the creditworthiness of more than half of the SKIs, mostly those established in 2014, is low: budget deficits are common, capital expenditures are low, and total debt as a percentage of total revenues is in excess of commonly accepted limits. Thus, the SKI investments are likely to be limited to minor replacement investments of existing assets and to some additional operational expenditures, unless they improve their financial management.

2.1.4.3. Cost Recovery Tariffs and Affordability

The principle of cost recovery holds that the users of municipal services should pay the full cost of service provision. Thus, a full cost recovery tariff should allow the utility to generate sufficient revenues through sales to cover all costs associated with service delivery, including operation and maintenance, debt repayment, and amortization of capital investments. In theory, the

capital investments of utility services are supposed to be financed from the depreciation of its fixed assets and from profit which represents a return on invested capital. In practice, however, the funds generated from depreciation and profits are often insufficient to finance the large investment needs of a municipality or municipal utility, and external sources of finance are often needed to undertake large investment programs. When a municipality or municipal utility uses a loan to finance its capital investments, the full cost recovery tariff should include a provision for debt service, including both payment of principal and interest. Additionally, to ensure capacity to pay, the tariff level should be set taking into consideration the affordability of the customers. In Turkey, the threshold used for calculation of the affordable tariff per cubic meter is 2.5 percent of the household income of the lowest quintile in the SKI service area (See Table 2.5). While social considerations motivating the affordable tariff are commendable, they introduce a pervasive incentive when such tariff represents the tariff charged to all domestic customers irrespective of their consumption and income levels. There are numerous international experiences of tariffs and mechanisms being set to guarantee affordability to the lowest quintiles, while at the same time maintaining proper demand management incentives and cost recovery capacity. Most international organizations, including the World Bank, recommend a threshold of 4 or 5 percent of household's revenue.

Table 2.5: Affordable Household Tariff Rates versus Applied Tariff Rates by SKIs for Water and Wastewater Services in 2016

Municipality	SKİ	Affordable Household Tariff (TL/m3)	Household Tariff Applied by SKİ in city center (TL/m3)	Affordable Household Tariff (EUR/m3)	Household Tariff Applied by SKİ in city center (EUR/m3)
Adana	ASKİ	2,35	3,18	0,72	0,98
Ankara	ASKİ	3,88	5,10	1,19	1,56
Antalya	ASAT	2,95	3,17	0,91	0,97
Aydın	ASKİ	3,37	2,45	1,03	0,75
Balıkesir	BASKİ	2,48	4,28	0,76	1,31
Bursa	BUSKİ	3,49	5,95	1,07	1,83
Denizli	DESKİ	3,37	5,55	1,03	1,70
Diyarbakır	DİSKİ	1,28	2,56	0,39	0,79
Erzurum	ESKİ	2,47	1,87	0,76	0,57
Eskişehir	ESKİ	3,49	2,76	1,07	0,85
Gaziantep	GASKİ	2,28	6,58	0,70	2,02
Hatay	HATSU	2,01	2,75	0,62	0,84
İstanbul	İSKİ	3,72	5,96	1,14	1,83
İzmir	İZSU	3,30	3,60	1,01	1,10
Kahramanmaraş	KASKİ	2,01	1,83	0,62	0,56
Kayseri	KASKİ	2,76	4,38	0,85	1,34
Kocaeli	İSU	3,71	5,19	1,14	1,59
Konya	KOSKİ	2,91	3,11	0,89	0,95
Malatya	MASKİ	2,26	2,65	0,69	0,81
Manisa	MASKİ	3,15	NA	0,97	NA
Mardin	MARSU	1,60	2,00	0,49	0,61
Mersin	MESKİ	2,35	4,08	0,72	1,25
Muğla	MUSKİ	3,37	4,04	1,03	1,24
Ordu	OSKİ	2,95	4,09	0,90	1,25
Sakarya	SASKİ	3,71	3,25	1,14	1,00
Samsun	SASKİ	2,52	3,13	0,77	0,96
Şanlıurfa	ŞUSKİ	1,28	1,63	0,39	0,50
Tekirdağ	TESKİ	3,58	3,00	1,10	0,92
Trabzon	TİSKİ	2,95	2,65	0,90	0,81
Van	VASKİ	1,75	2,20	0,54	0,67

Source: Web-pages of each SKI and TurkStat data: Income and Living Conditions Survey, Distribution of annual equalized household disposable income by quintiles ordered by equalized household disposable income, - Turkey, SR, Level 2, 2014-2015; Calculations: Authors

* WSS tariff for Manisa SKI was not available;

** For affordable tariff calculation, the household size is taken as 4 and the daily water consumption per capita is 133 l/day;

*** The tariff applied by SKI is the block tariff charged to customers located in the city center of relevant SKI.

Table 2.5 shows that only seven SKIs apply a tariff below the affordable WSS tariff and would have a margin for a tariff increase to finance the new investment requirements, whereas the rest of the SKIs would have to improve the efficiency of their operations to be able to finance further investments and apply an improved tariff scheme to support the households of poorest quintile.

Noteworthy: Article 9 of the EU WFD recommends that the tariff be set to allow having a transparent vision of the cost recovery level (preferably as high as possible, but giving some room to the subsidiarity of Member States to integrate social considerations) and providing adequate incentives. In this context, Member States have the flexibility to determine if they wish to finance a portion of the costs (typically debt repayment and or amortization) through other sources. Nevertheless, minimal financial sustainability of the utility requires revenues from tariffs to cover at least the operating costs.

2.2. Some Issues Hinder the Implementation of EU Directives:

This section focuses on the primary sector issues which affect the implementation of the DWD and UWWD. Additional analysis on all of these issues would need to be carried out in order to propose actionable solutions, but this was not possible in the framework of this assignment. Chapter 5 proposes areas for further analysis to consider in this regard. Key issues relating to EU Directive implementation include:

2.2.1. Overlap and Conflicts in regulations, planning and institutions

2.2.1.1. Regulations: Two regulations in force, other standards applied in practice, all more stringent than EU requirements

Wastewater treatment standards in Turkey are regulated by two by-laws, both of which are in force: the By-law on Water Pollution Control; and the By-law on Urban Wastewater Treatment. These by-laws set inconsistent treatment target requirements, which creates confusion. The common practice has been to pick from each by-law the most stringent treatment target for each parameter and to request municipalities to comply with the resulting and de facto new treatment standard, which does not correspond to either of the regulations in force in Turkey. (These regulations are compared in Chapter 3).

As a result, the wastewater treatment levels are planned according to standards higher than those of both published regulations and much higher than those of the UWWD. This appears to be linked to the designation in the regulation of many of the inland and coastal areas as “sensitive areas” and the introduction of a notion of “potentially sensitive area”, which in practice is considered as if it requires applying the treatment standards for “sensitive areas”. The EU regulation makes a direct link between sensitivity of the receiving environment, and either eutrophication or a rigorous analysis demonstrating the actual and specific sensitivity. With these criteria, it would appear that very few, and only geographically selected areas, would qualify as sensitive in Turkey, with the exception of the Black and Marmara Seas (see more on this in Chapter 5), which have eutrophication issues and a few hotspots.

Although these conservative approaches can be perceived as putting Turkey on the safe side, they have direct implications which may represent a much greater risk than is thought to be achieved through perceived additional safety measures:

- Higher treatment requirements increase investment costs, have lasting consequences on O&M costs, and usually involve more complex treatment systems which require highly specialized capacities.
- If the capacity is not in place from the beginning and does not operate in the long run, the probability that the treatment system performs correctly becomes low, challenging the environmental objective.

- Critical costs are often omitted in the plans. Adding a nutrient removal treatment can drive the operating costs up by more than 40 percent, mostly related to the cost of electricity and chemicals. It also generates about 30 percent more sludge, which can become a big and costly problem to handle. Long-term costs of sludge transportation and disposal (for instance, landfills) are rarely quantified.

These have been identified as key aspects worth addressing in the River Basins Management Plans, as it sets the basis for significant wastewater collection and treatment investments.

Noteworthy: Experience from EU Member States shows that the UWWD is by far the costliest part of reaching compliance with the WFD. It is also the one for which actual environmental benefits and related contributions to the "good ecological status" principle of the WFD have been lower than anticipated and are, in places, insufficiently monitored. Consistent with the spirit of the Directives and the holistic approach they promote, treating first major sources, and taking into consideration the pollution dilution and absorption capacity of the sea for coastal cities, seems reasonable.

2.2.1.2. Institutions: many deal with aspects of the sector, which has the big picture?

Responsibilities for the water sector, whether in resources management or WSS, are shared among multiple ministries, departments, and agencies. Following the June 2011 government reshuffling, responsibility sharing between the main sectors ministries - MoFWA and MoEU - has often been either unclear or redundant. This was noted during the stages of design review, standards setting, investment financing, and investment approval. This leads to confusion, inefficiencies and delays. A few examples are presented below.

With respect to water supply, GDSHW under MoFWA is responsible for supplying water from the source to the city, GDWM is responsible for determining the type of drinking water treatment plant needed, while IlBank under MoEU is responsible for making investments regarding the reservoirs and water distribution within the city. Meanwhile, the Ministry of Health is responsible for analyzing and monitoring water quality at the tap, and the Ministry of Interior regulates the subscription of customers to access water and sewerage services. The service provider is left to struggle to get projects moving.

A wastewater collection and treatment project requires the approval of the General Directorate for Environmental Management in MoEU and of MoFWA for the treatment plant. The level of treatment should be decided by MoEU, based on the sensitivity of the receiving body, and the sensitivity is determined by MoFWA. If funded through debt, IlBank would need to review and approve the design. The MoEU reviews and approves the Environmental Impacts Assessment (EIA) and issues the discharge permit for the treated wastewater, because it is responsible for the protection of environment; but it also is under the responsibility of MoFWA regarding the protection of surface and groundwater. Discharges are the responsibility of MoEU to monitor, while discharges into bathing waters also involve the responsibility of the Ministry of Health. In addition it should be also mentioned that:

- The General Directorate of EIA, which handles permitting and licensing under MoEU is also responsible for the operation of treatment facilities;
- The Ministry of Food, Agriculture and Livestock is responsible for water resources protection, wastewater discharges at fisheries locations, and implementing the Nitrate Directive;
- The Ministry of Culture and Tourism is responsible for all public tourism investments including environmental infrastructure in touristic cities;
- The General Directorate of Natural Resource Protection of the MoEU is also authorized to carry out and/or support local authorities for required projects and investments regarding the protection of these areas and for avoiding their pollution; and

- The General Directorate of Local Administration of the Ministry of Interior has responsibilities regarding the functioning of WSS service providers.

Having to deal with so many institutions in decision making on wastewater collection and/or treatment investments makes it very challenging for utilities to get projects approved. It also requires utilities to manage situations of contradicting conclusions or requirements among institutions. This is likely to encourage overdesign in order to avoid having to go through the process multiple times. This results in potentially detrimental consequences on the technical and financial capacity to maintain the facilities in the long run, and can defeat the environmental protection objective which motivated it in the first place.

Despite so many institutions involved, there is still a lack of an institution which has responsibility for the "big picture" and can ensure that Turkey's overall vision for the water sector is actually being delivered for water management aspects, whether at the national level or at the level of each river basin. There is neither a centralized benchmarking system collecting data on WSS providers' technical and financial performance, nor a clear economic regulation for quality and sustainability of WSS service provision (technical and financial).

Establishing a clear institutional framework with clear roles and responsibilities is important to ensure integrated planning and accountability in implementation. These are also key steps for setting Integrated Water Resources Management (IWRM) and Integrated Urban Water Management (IUWM) approaches.

2.2.1.3. Planning: Numerous action plans and investment programs overlap

As a logical consequence of the multiplicity of institutions and the absence of an overall vision for the sector, many of these institutions and agencies involved in the sector have developed their own strategy, program, or plan to support WSS development. Documents, such as the 10th Development Plan, the National Basin Management Strategy, Basin Protection Action Plans, the National Climate Change Strategy, and the National Climate Change Action Plan, largely overlap. Most of these propose funding for infrastructure development. Although they all promote integrated approaches and share the broader sector objectives, each developed its own set of criteria to allocate funding. Harmonization of approaches is warranted to avoid defeating the stated purposes of the activities. The abundance of top-down plans contrasts with the relative absence of planning at the local levels, both municipal and service provider, for WSS development and management. There is a strong need to support the harmonization of such planning with the priorities set through the river basin planning, and to ensure that their implementation is integrated with other relevant local plans, to ensure integrated approaches at the local level as well.

Through the Sustainable Cities Project, the World Bank and the EU (with Instrument for Pre-Accession Assistance (IPA) II grant funding) are jointly providing support to Turkey in order to assist selected metropolitan municipalities in developing critical local planning and integrated approaches for infrastructure development and management. This is achieved through the combination of technical assistance and investment funding for infrastructure development. The project includes a sizeable technical assistance component that provides MMs and SKIs with grant funding to prepare or update city or utility planning, to develop tariff and cost recovery studies, and to provide training and capacity building, all critical elements for achieving long-term technical and financial sustainability in the provision of services. The project also encourages establishing mechanisms for improved coordination of project implementation and for the integration of project-funded investments with urban development plans and other infrastructure development projects. These are fundamental elements of efficient and integrated project implementation, which are the core principles of IUWM approaches. Moreover, the project is structured as a "series of project" model, which allows using the first project to inform the preparation of others, and makes possible adding other MMs and SKIs as needs and priorities evolve.

2.2.2. Completing investments is a beginning, not an end

Finishing the investment (that is, construction works) does not mean that desired objectives are achieved. In order to meet their objectives, the SKIs and/or Municipal Water Utility Departments (WUDs) must ensure that the facilities constructed are operated successfully. Normal practice requires careful and integrated project design, close supervision to ensure quality of construction works and monitoring equipment, embedding in construction contracts the training of staff who will use the facilities and equipment, and working during the construction phase to establish an inventory of assets and accordingly prepare its maintenance plan. Supply of equipment for water-leak detection, monitoring systems, computer-based supervisory control and data acquisition systems (SCADA systems), and preventive maintenance systems are often considered by WUDs as extra and luxury costs, and thus managers do not invest in them. As a result, new investments may not fulfill their objectives when problems of overdesign and lack of proper maintenance result in high operational costs. Close supervision during construction is also essential to ensure quality of works and to limit problems and breakdowns during operation. The SCADA systems and monitoring equipment allow better management of facilities and more effective operation.

Many WUDs and some SKIs do not have proper as-built drawings for their water and wastewater network, and those who have them often only have hard copies. Lack of information about pipe material, diameter, depth, and so forth creates operational difficulties for WUD staff and hinders preventive maintenance and purchase of materials. When there is a problem, for example a pipe breakdown, WUD staff determines the pipe material, diameter, and depth only after excavating, which delays procurement until this technical information becomes known. This is likely to result in higher prices. WUDs would benefit by recording information gained during breakdowns or replacements of new pipelines in a digital database and by also recording technical knowledge from its staff, so that the information is not lost when experienced staff retire or leave. Such a digital database should be linked to digital maps, preferably through Geographic Information System (GIS) software, and should be continuously updated, and information made accessible.

2.2.3. Monitoring & benchmarking invaluable regulation tools

There is currently no benchmarking system for the provision of WSS services in Turkey that allows monitoring of the actual performance of the WSS facilities and of the services provided. Performance improvements can only be achieved when managers can rely on monitored, compiled, and available data obtained over time. Without proper information, planners and authorities cannot credibly assess whether objectives are adequate, investment plans are efficiently implemented, and expected results are actually achieved. These are critical to be able to evaluate sector policies and programs, and to keep people aware of the results achieved through additional tariffs and public funding investments. Without benchmarking, the comprehensive sector programs Turkey is implementing cannot be assessed and deviations cannot be corrected in time, which could translate into increased costs, lower sustainability, and missed opportunities.

The GDWM of MoFWA initiated a benchmarking system, but it is not in digital form, and guideline documents proved insufficient for getting reliable and comparable data without workers having first received prior training. The by-law that requests municipalities' WUDs and SKIs to report to MoFWA on a yearly basis on water losses, and to publish these reports on the Internet for one year, is a step in the right direction. However, designing a system requiring service providers to monitor and regularly report on key indicators of technical performance (for example, NRW and coverage) and financial performance (for example collection and cost recovery), and which makes the information available to the public (for example online), would create a friendly competition for good service and increase accountability of mayors and service providers to their constituents.

In addition, as indicated before, in Turkey there is no institution in charge of regulating, monitoring, and reviewing the economic aspects of WSS service provision, such as structure and tariff levels, standards and quality of services, and the performance of WSS service. A regulator could manage a national benchmark system and issue best practices, guidelines, and procedures to improve WSS services. This would contribute to improve the sector performance and increase the homogeneity of service quality across the country.

2.3. Main Issues Affecting the Sustainability of Service

This section lists sector issues that have been identified as critical to the efficiency and long term technical and financial sustainability of service provision. Although not directly related to implementation of EU directives, these issues have an impact on the capacity of service providers to reach and maintain the WFD's key principles of GES, sustainability, and cost recovery.

2.3.1. Training and capacity building deserve immediate attention

While the importance of training and capacity building is well understood and acknowledged, the establishment of a comprehensive program to build capacity of staff and institutions in the long term management of WSS service provision is yet to be delivered. Some of the sixteen "old" MMs and SKIs have developed their own training and capacity building activities. It could form the basis for the preparation of a national program.

With the enforcement of Law No 6360, the "old" SKIs (Istanbul and Kocaeli excluded) and the newly established ones have seen their service areas expand to reach the provincial administrative boundaries. As a result, the utility of the major provincial municipality "absorbed" all the other service providers which existed in the province. This means that the personnel, assets, investments, liabilities, and receivables related to the provision of water, wastewater, and solid waste disposal services carried out by the sub-provincial municipalities, the Special Provincial Administration (SPA) and other service providers within the provincial boundaries, were transferred to the metropolitan municipalities or its SKI (Transitory Article 1/8 of Law No 6360). Such a profound change requires adjustments to build the capacity of the SKI institutions themselves. Specifically, it needs to consolidate technical information, customer databases, and billing and collection systems, and then carry out the analysis necessary to understand the realities of their situation as a service provider and to plan the reforms they need to implement to improve technical and financial performance. These are prerequisites for developing a service development plan and engaging in a tariff discussion with its shareholders.

2.3.2. Non-revenue water reduction is often an untapped resource

NRW levels in Turkey are estimated at 35 percent on average in 2014. Although technical information gathered for all SKIs shows that NRW levels for SKIs in 2014 are close to the national average, with 38 percent on average, it varies greatly, from 12 percent in Malatya to 60 percent in Balikesir and 80 percent in Hatay. There are very few quantified and recent good practice examples of NRW improvements in Turkey. Although the reduction of NRW from 54 percent in 2006 to 35 percent in 2014 illustrate that a lot has been done, much more could be accomplished, not only to further reduce NRW, but also to document good practices and to facilitate knowledge- and experience-sharing among services providers for faster and more efficient NRW reduction.

The GDWM recently published the Regulation on Control of Water Losses in Drinking Water Supply and Distribution Networks. This regulation imposes various responsibilities on utilities such as digitizing the existing water systems and forming a GIS database, establishing monitoring systems, establishing teams for determining physical losses, and requiring continuous measurement of water input to the system at the sources and at certain points. It also sets targets for NRW in metropolitan municipalities and province municipalities that have less than 30 percent losses within 5 years and

less than 25 percent losses within the following 4 years. Other municipalities need to reach the same target values within 9 years and the following 5 years, respectively.

Consistent with the regulation on NRW reduction, the benefits of NRW reduction would certainly be an economic option for increasing water supply production in many places. A NRW reduction program, eventually considering performance-based contracts where it makes economic sense, is likely to compare favorably to the cost of expansion of water supply production in many places. Moreover, the impacts of climate change, which are increasingly affecting the availability and reliability of water resources, also are a reason to push for NRW reduction and an optimal use of water resources.

Chapter 3 - Comparison of EU and Turkish Regulations

3.1. Turkey Drinking Water Standards Slightly Lower than EU standards

EU standards for drinking water are set within EU Directive 98/83/EC on the quality of water intended for human consumption, and these standards were incorporated into Turkish legislation under Turkish law "Water intended for Human Consumption Regulation: Official gazette 25730, published 17 February 2005". The standards published in the Turkish Law are the same as that of the EU directive except for three parameters ('Bromates', 'Lead', and 'Trihalomethanes'), which are included with more relaxed target values (see tables in Appendix F – "EU and Turkish Drinking Water Standards").

As a result, the drinking water standards in Turkey are very consistent with the standards of the DWD. Although the difference in the three parameters for which treatment values differ would have an impact in the treatment level and costs, it is not believed to be very significant relative to the overall cost of investments or operation of facilities ensuring full compliance with the EU Directive.

3.2. Turkey wastewater standards more stringent than EU's

EU standards for urban wastewaters are defined in Directive 91/271/CEE on collection and treatment of urban wastewaters. Turkey addressees urban wastewater treatment requirements in two by-laws: the 2006 Urban Wastewater Treatment Regulation No. 26047, amended by the 2009 Urban Wastewater Treatment Regulation – Sensitive and Less Sensitive Areas Notification No. 27271; and the 2008 Water Pollution Control Regulation No. 26786. Appendix F summarizes and compares these standards with those of the EU UWWD.

Unlike in the case of drinking water, there are significant differences between the Turkish and EU wastewater standards. The Turkish regulation is more stringent that the EU standards in terms of:

- Higher treatment standards for most parameters
- Applicability of strict treatment standards to small settlements (less than 2,000)
- Sensitive areas defined in places without environmental degradation or eutrophication
- Application of discharge standards for fresh waters also to discharges into coastal waters

Moreover, discrepancies between the two regulations with regard to defining treatment standards lead to a practice of applying both standards simultaneously and picking, for each parameter, the most stringent requirement of each regulation. This results in applying a third standard combining the most stringent parameters of both regulations, thereby de facto creating a new regulation.

Furthermore, it is common practice in Turkey that the MoEU conditions the issuance of its discharge permit to the addition of a Nitrogen removal treatment and the acquisition of the land necessary for the construction of Phosphorus removal (should it be required at a later stage). These requirement, albeit stricter than the published Turkish regulations, have therefore become common practice in the design of wastewater treatment plants, even when discharging in the Sea.

The combination of these with various standards applying to settlements based on its size makes the resulting combination quite complex, as is illustrated in details in Tables F-1 through F-3 of Appendix F – "EU and Turkish Drinking Water Standards".

In general, the Turkish standards are higher than that of the EU on all parameters (except for BOD5 limits in non-sensitive areas), and they are applied in an even more stringent fashion. This results in much higher investments needed to meet these national standards than it would be for Turkey to just meet the UWWD standards.

In a Technical Review Note dated 2009, the EU recommended that Turkey "harmonize its standards to UWWD standards in order to reduce the cost of investments and avoid investments in urban wastewaters that would generate little to no social or environmental benefit. If Turkey harmonized its standards to UWWD standards it would avoid the diversion of valuable funds away from other priority investments that would yield higher social and/or environmental benefits."

A new draft water law, under preparation since 2011, and new draft by-law may harmonize the Turkish standards and make them more compliant with UWWD standards. It would however also increase the list of areas determined as environmentally sensitive by Turkey.

The UWWD distinguishes treated wastewater discharges into coastal waters, with more relaxed treatment standards, a distinction which Turkish regulation does not make.

For discharges in coastal waters in less sensitive areas, the EU sets much lower treatment standards than for freshwater discharges because it takes into consideration the dilution and absorption capacity of the sea. It also applies relaxed standards to up to 150,000 population equivalent (PE), as opposed to 100,000 PE for discharges in fresh waters. These differences are significant for Turkey because the majority of the population is located in coastal areas, which makes a big difference in the cost of treatment.

Chapter 4 - Cost of compliance with EU wastewater collection and treatment standards

This chapter presents the results of a cost-modeling exercise relying on data available to the team. It presents the methodologies, scenarios and key assumptions made, and the criteria and hypotheses used to estimate the costs. These results aim at providing information on their magnitude of the costs of compliance with the EU requirements in Turkey and of the incremental costs related to the current practices of application of treatment standards in Turkey. It also analyzes the impacts of the estimated costs related to the 30 SKIs with respect to their respective financial situations. The objective is to trigger a discussion on standard setting, the related costs of investments and operations costs, and their impacts on the financial and technical situations of the 30 SKIs.

4.1. Methodology and assumptions

The purpose of the modeling exercise was to estimate the investment and O&M costs of bringing wastewater collection and treatment in Turkey into compliance with standards under different scenarios. This section presents the methodology used to build the model and carry out the cost-estimate calculations. Appendix E – "Detailed Methodology for Cost Calculations" - presents more detailed and documented information about this methodology.

- The 2014 population data was used to ensure consistency with use of financial information from published 2014 annual reports for the SKIs of metropolitan municipalities.
- Wastewater networks and coverage data were taken from the River Basin Protection Action Plans (RBPAP). If plans do not include coverage data, it was assumed that no wastewater collection network exists.
- Data on the existence and treatment level of wastewater treatment plants by municipality was derived from the draft By-law on Sensitive Water Bodies. If that data was not available, RBPAP data was used. If RBPAP had no data, it was assumed that the municipality did not have a wastewater treatment plant.
- Data from the Communiqué on Sensitive and Less Sensitive Water Areas related to the By-law on Urban Wastewater Treatment informed option A for Sensitive areas in the model.
- "Urban sensitive areas" defined in the draft by-law on Sensitive Water Bodies proposed by GDWM in May 2016 (pending approval) informed option B for Sensitive areas in the model.
- A Google map was used to identify likely treated wastewater discharge sites for each municipality. This determined treatment levels required in option A Sensitive areas, using Appendix E tables.
- A specific analysis was carried out for municipalities with populations of both less than 10,000 and less than 2,000 to determine which municipalities of less than 2,000 people are likely to discharge into estuaries and which municipalities with a population of less than 10,000 are likely to discharge into coastal waters. These are critical drivers to define level and costs of treatment.
- Google maps was used to identify municipalities discharging into "sensitive areas", in accordance with option A. For option B, the detailed list provided by the draft By-law was used, see Appendix E).

- Acknowledging that wastewater treatment levels are defined based on the size of urban areas and not on municipal administrative boundaries, the team analyzed which municipalities belong to a larger urban settlement and assigned them the name of a Metropolitan Area (MA). This concerned only municipalities consolidated into MMs as part of the March 2014 reform.
- Population data for municipalities now belonging to MMs was adjusted by multiplying the urban population percentage from 2012 with the population figures in 2014. The treatment level required was determined according to the adjusted population estimate. See Appendix D – "Provincial Population Figures for Metropolitan Municipalities."
- For municipalities outside MM borders, the population is concentrated in urban areas. Thus, the entire municipal population was used to determine the treatment levels in each scenario.
- The calculation was made on the basis of three main scenarios and two options for "sensitive area" (A or B), resulting in cost calculations in six different scenarios, described in Table 4.1.

Table 4.1: Description of Scenarios Used in the Assessment

Scenario	Scenario Name	Scenario Description
S1A	EU-UWWD Requirements (sensitive areas as in Communique)	Treatment level determined in accordance with the requirements of the EU- Urban Wastewater Directive.
S2A	Turkish regulation-1 (sensitive areas as in Communique)	Both the By-law on Urban Wastewater Treatment and By-law on Water Pollution Control are considered, and treatment level is determined considering whichever is more stringent for each parameter. No additional Nitrogen removal assumed, if the discharge location is not in a sensitive area.
S3A	Turkish regulation-2 (sensitive areas as in Communique)	As for S2, both the By-law on Urban Wastewater Treatment and the By-law on Water Pollution Control are considered, and the treatment level is determined considering whichever is more stringent for each parameter. In this scenario, Nitrogen removal imposed in addition to secondary treatment for any discharge, even outside sensitive areas, for settlements having a population above 50,000.
S1B	EU-UWWD Requirements (urban sensitive areas: draft By-law)	Same treatment levels as above for each scenario. The urban sensitive areas are as defined in the draft by-law prepared by GDWM MoFWA and pending approval.
S2B	Turkish regulation -1 (urban sensitive areas: draft By-law)	
S3B	Turkish regulation -2 (urban sensitive areas: draft By-law)	

- The treatment level required for each scenario was decided based on the population of the metropolitan areas or municipalities, as relevant, and the sensitivity of the discharge location. In metropolitan municipalities, a correcting factor was introduced to account for the share of the population living in rural areas, so that only the population located in an urban area was considered in the determination of the treatment level and the collection and treatment costs.
- To estimate the costs, the team compared three sets of benchmarks of unit costs. It decided to use the cost functions provided by the FEASIBLE[9] model because they provide differentiated costs per treatment levels and costs for sewerage. See Appendix E for cost functions and assumptions details.
- Tests performed on the benchmarks of unit costs concluded that the FEASIBLE cost functions resulted in higher costs than the costs experienced in Turkey. This is most likely due to their establishment on the basis of unit cost databases of early EU member states. The team therefore developed an adjustments coefficient based on a sample of contract data and recent feasibility studies for wastewater collection and treatment investments in Turkey.
- Investment and O&M costs for urban centers were estimated after assessing the existing infrastructure to determine whether it met treatment level requirements for each scenario.
- Sunken costs related to existing infrastructure were deducted to present only the incremental costs of reaching compliance with treatment or collection requirements in each scenario.
- The estimated lifetime of the collection and treatment infrastructure was estimated at 30 years.
- The costs of treated wastewater discharge (submarine outfall or discharge pipe) and of sludge management, transport, and disposal were estimated based on anecdotal evidence and the author's calculation.

What was not assessed? The costs of pumping stations, decentralized or on-site sanitation in rural areas, were not estimated. The cost of wastewater collection was not corrected based on lower density of population in medium- and small-size cities. The costs and benefits related to biogas digestion, where it makes sense, were also not estimated. The estimates did not include the cost of debt and therefore worked under the assumption that the investments are self-funded by SKIs. The scenarios did not take into consideration the population increase or phased approaches in developing compliance and related timeframe at the scale of urban areas or per river basins (holistic approach of the WFD). As a result the estimates represent only a portion of the costs.

4.2. Results and Analysis

The existing wastewater collection and treatment infrastructure is estimated to have cost about EUR8.7 billion to build, and the associated yearly O&M costs amounts to about EUR762 million. Table 4.2 below presents incremental investments and O&M costs of wastewater infrastructure needed to comply with the six scenarios described above. It provides the total investment cost of additional infrastructure and the O&M costs of running the upgraded systems, considering both wastewater collection networks and treatment plants. Scenario S1A standards (compliance with UWWD) is used as the reference to compare incremental costs of reaching higher standards.

9 http://www.oecd.org/env/outreach/methodologyandfeasiblecomputermodel.htm

Table 4.2: Additional Investment and O&M costs for All Scenarios at the National Level.

Sensitivity	Scenario	Item	Total Value (million EUR)	Variation to S1A
A	S1A	Additional Investment Required (EUR)	5,229	-
		O&M required (EUR/year)	844	-
	S2A	Additional Investment Required (EUR)	5,432	4%
		O&M required (EUR/year)	875	4%
	S3A	Additional Investment Required (EUR)	6,111	17%
		O&M required (EUR/year)	1,341	59%
B	S1B	Additional Investment Required (EUR)	6,006	15%
		O&M required (EUR/year)	1,283	52%
	S2B	Additional Investment Required (EUR)	6,139	17%
		O&M required (EUR/year)	1,303	54%
	S3B	Additional Investment Required (EUR)	6,323	21%
		O&M required (EUR/year)	1,415	68%

As can be seen in Table 4.2, the scenario with the lowest incremental cost is S1A (compliance with UWWD with current sensitive areas), while the one with the highest cost is S3B. The difference of additional investments required between S1A and S2A is low (4 percent). This means that the impact of applying EU or TR legislation is limited if the regulation is applied as published with the current sensitive areas. It is however much higher (17 percent) for S3A, which goes beyond EU requirements and treats all cities above 50,000 PE at a level close to that of a sensitive area. The impact is significantly higher on O&M costs, which are 59 percent higher under S3A compared to S1A. The treatment standard is therefore a major driver of increased costs, with relative impacts on construction costs, but with a much greater and lasting impact due to increased O&M costs.

Similarly, the impacts related to the proposed change of sensitive areas on additional investment costs are moderate, with increases of 15 percent for scenario S1, 13 percent for S2, and 4 percent for S3. They are significantly larger for incremental O&M, namely 52 percent for S1B compared to S1A, 50 percent for S2B compared to S2A, and 11 percent for S3B compared to S3A. The smaller difference for scenario 3 means that requesting nitrogen removal for settlements with a population of more than 50,000 minimizes the change in the number of sensitive areas, because the way the Turkish regulation is applied (S3) on a de facto basis sets the standards very close to that of sensitive areas in most urban areas. It is important to note that the impact on additional investments is comparatively much lower than the associated impact on yearly incremental O&M.

The Iceberg effect: the importance of considering the total cost

It is common knowledge that investments generally capture more attention. They are usually implemented as part of large and visible programs, often with concessional loans or grants, and are procured on the basis of the lowest cost of construction, without consideration of O&M costs. Yet, whether the utility will be able to sustain the additional investments over time depends on its capacity to recover the O&M costs during the useful life of the investments, and their cumulated amount is allegedly greatly superior to that of the investment cost. This has direct impacts on the tariff levels that will need to be charged to customers and has consequences in terms of political and social sensitivities, which in essence drive decision-making. The paradox, illustrated by the image of the iceberg, is that infrastructure development decisions are made on the basis of the cost of investments alone (the top of the iceberg), while the cumulated O&M costs (the part of the iceberg which is under water) is usually not considered in the decision-making process, although it represents a much greater share of the total cost of investment.

Further analysis of the data available was performed to quantify cumulated O&M costs, amortization costs, and the cost of debt (using IlBank loan terms). Table 4.3 shows the results for scenarios S1A and S3A It documents that the additional EUR900 million in investments costs needed to reach the standards applied in Turkey (S3A) translates into an additional EUR56 billion in O&M over the lifetime of the investment. (See Appendix G – "Results of Cost Estimates and Tariff Impacts" – for the results in all scenarios. Appendix H describes the "Results of Cost Estimates in River Basins and Financial Impacts per Person").

Table 4.3: Disaggregated Total Costs for Scenarios S1A and S3A at the National Level

Sensitivity	Scenario	Item	Total Value (million EUR)	Variation to S1A
		Existing infrastructure	8,710	-
		Estimated O&M of existing infrastructure	762	-
A	S1A	Additional Investment Required	5,229	0%
		Incremental O&M required per year	844	0%
		Cumulative O&M of required investments for the useful life	95,216	0%
		Amortization costs of required investments	15,930	0%
		If Ilbank Finances Required Investments	8,761	0%
	S3A	Additional Investment Required	6,111	17%
		Incremental O&M required per year	1,341	59%
		Cumulative O&M of required investments for the useful life	151,250	59%
		Amortization costs of required investments	19,007	19%
		If Ilbank Finances Required Investments	10,238	18%

The analysis also allows quantifying the "iceberg effect". The cumulated O&M of the required investments represents over 18 times the cost of investments for scenario S1A. The ratio reaches 25 times for scenario S3A. While the additional investment cost represents EUR5.2 billion, the related incremental O&M costs over the lifetime of the investment represents EUR95 billion. Considering amortization and the cost of debt (IlBank loan terms), the total cost reaches EUR120 billion, of which the additional investment represents only 4.2 percent for scenario S1A. For scenario S3A, the total cost reaches EUR180 billion of which the additional investment represents only 3.5 percent. This means that the total cost of reaching Turkish standards would cost EUR60 billion (50 percent) more than just complying with EU requirements, which affects sustainability and tariff levels by just as much.

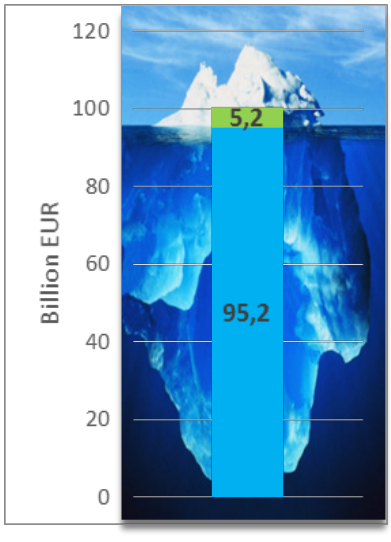


Table 4.4 presents the distribution of the total additional investments and O&M per category of service provider. Results in Table 4.2 show that the costs distribution between metropolitan municipalities and other settlements do not follow the same pattern as the population distribution (77 percent for MMs).

Table 4.4: Incremental Investments and O&M Costs for All Scenarios per Type of Municipality

Sensitivity	Scenario	Item	Metropolitan Municipalities Total Results	Metropolitan Areas	Metropolitan Municipalities Subprovince	Other Municipalities Total Results	BELDE	PROVINCE	SUB-PROVINCE
		Existing infrastructure	**6,328**	3,590	2,739	**2,384**	250	1,042	1,092
A	S1A	**Additional Investment Required**	**3,335**	1,280	2,055	**1,894**	326	744	824
		Incremental O&M required per year	**715**	565	150	**129**	10	69	50
	S2A	**Additional Investment Required**	**3,372**	1,280	2,091	**2,061**	409	744	907
		Incremental O&M required per year	**721**	565	156	**154**	22	69	63
	S3A	**Additional Investment Required**	**3,888**	1,631	2,258	**2,223**	409	874	940
		Incremental O&M required per year	**1,111**	890	221	**230**	22	132	75
B	S1B	**Additional Investment Required**	**3,873**	1,572	2,301	**2,133**	348	820	964
		Incremental O&M required per year	**1,075**	843	232	**207**	14	106	88
	S2B	**Additional Investment Required**	**3,896**	1,572	2,323	**2,244**	409	820	1,015
		Incremental O&M required per year	**1,079**	843	236	**224**	22	106	96
	S3B	**Additional Investment Required**	**4,009**	1,631	2,379	**2,314**	409	882	1,023
		Incremental O&M required per year	**1,157**	899	258	**258**	22	137	99

Appendix G presents additional data and analysis, including incremental costs and their financial impact per capita for each scenario, disaggregated by category of service provider, by MM or SKI, and by river basin. The results are presented in table and graphs format.

The disaggregated analysis shows that:

- Additional investment requirements per capita are comparatively lower in SKI service areas than for other service providers, which presumably makes the challenges of service extension and sustainability much more difficult for those other non-SKI service providers which are not structured as a utility with autonomous budget and management;

- The additional investments and O&M costs vary greatly between service providers and amongst SKIs. The incremental investments are the highest in Istanbul and Şanlıurfa MM, and the lowest in Kayseri (see Table G.1 in Appendix G for details);

- The incremental costs per river basin vary widely, from EUR15 million in Burdur River Basin to EUR1.9 billion in the Marmara River Basin, as do the related costs per capita that range from EUR3 or 4 per capita in the Kucuk, Menderes, Sakarya, Seyhan, and Antalya river basins to EUR79 in the Van Golu river basin.

4.3. Financial implication of SKIs' balance sheets

This section analyzes the impacts of incremental costs required to comply with scenarios S1A and S3A on SKIs' financial situations, using the following assumptions:[10]

- The revenues and costs are assumed to remain at their 2015 levels.[11]
- Incremental investments under each scenario are funded by IlBank credits with current conditions, namely a repayment period of 15 years and a 7 percent interest rate per annum.[12]

- The liabilities related to the required investments are added to the total liabilities as reported in the SKI balance sheet for 2015 and are compared to 2015 revenues.
- The impact analysis on annual result of SKIs includes the amortization of assets and yearly incremental O&M costs in addition to the 2015 costs as a benchmark of upcoming burden of these investments on SKIs financial situation.[13]

Table 4.5: Main Financial Indicators for SKIs for Scenarios S1A and S3A.[14]

Municipality	SKİ	Annual Result (Costs-Revenues) S1A (€ million)	Cost Coverage Ratio S1A (Revenues/ Cost)	Total Debt/ Revenues S1A	Annual Result (Costs-Revenues) S3A (€ million)	Cost Coverage Ratio S3A (Revenues/ Cost)	Total Debt/ Revenues S3A
Adana	ASKİ	-19,260	86%	117%	-84,504	58%	168%
Ankara	ASKİ	147,674	144%	56%	-29,833	96%	87%
Antalya	ASAT	53,275	133%	183%	52,831	133%	184%
Aydın	ASKİ	-11,738	84%	504%	-23,874	72%	542%
Balıkesir	**BASKİ**	-19,177	59%	352%	-26,600	55%	375%
Bursa	BUSKİ	-10,540	111%	176%	-17,805	107%	184%
Denizli	DESKİ	-56,785	51%	248%	-57,739	50%	253%
Diyarbakır	DİSKİ	-49,706	62%	409%	-51,881	61%	414%
Erzurum	ESKİ	-35,981	51%	1098%	-40,161	48%	1117%
Eskişehir	ESKİ	-0,124	100%	143%	-1,322	97%	151%
Gaziantep	GASKİ	-17,102	89%	361%	-74,814	64%	400%
Hatay	**HATSU**	-56,341	56%	502%	-64,195	52%	521%
İstanbul	İSKİ	-511,429	76%	83%	-513,923	76%	84%
İzmir	İZSU	14,195	105%	83%	7,954	103%	87%
Kahramanmaraş	KASKİ	-15,162	-	-	-23,717	-	-
Kayseri	KASKİ	-2,363	97%	121%	-41,144	63%	175%
Kocaeli	İSU	-2,255	67%	151%	-2,255	67%	151%
Konya	KOSKİ	-8,453	93%	199%	-8,795	93%	200%
Malatya	MASKİ	-27,822	-	-	-34,865	-	-
Manisa	MASKİ	-5,224	59%	177%	-18,657	53%	212%
Mardin	MARSU	-28,776	48%	658%	-34,571	43%	696%
Mersin	MESKİ	-2,511	55%	356%	-8,074	53%	377%
Muğla	**MUSKİ**	-1,088	98%	611%	-5,570	92%	626%
Ordu	OSKİ	5,800	117%	238%	3,884	111%	250%
Sakarya	SASKİ	-4,058	95%	459%	-8,615	89%	474%
Samsun	SASKİ	-35,380	67%	288%	-40,922	64%	304%
Şanlıurfa	ŞUSKİ	-161,034	25%	812%	-175,630	23%	853%
Tekirdağ	TESKİ	-31,857	65%	247%	-37,378	62%	261%
Trabzon	TİSKİ	-14,189	43%	660%	-19,171	39%	709%
Van	VASKİ	-39,685	40%	699%	-39,898	40%	702%

10 Impacts of all scenarios are presented in Appendix G.
11 For Ankara, Erzurum, and Trabzon SKIs, 2014 data has been used, since 2015 data was not available.
12 http://www.ilbank.gov.tr/index.php?Sayfa=iceriksayfa&icId=340
13 The economic life of civil works assets and electromechanical assets were taken as 50 years and 15 years respectively.
14 No cost, revenues and debt data were available for SKIs of Kahramanmaraş and Malatya and therefore the calculations above include only the scenarios, not an addition to the current situation.

Table 4.5 reveals that the SKIs which are already facing a budget deficit will have to cover a much higher deficit if the investment scenarios are implemented. For the SKIs which had a modest budget surplus (4 to 20 percent), new investments and related O&M costs are likely to generate a deficit, depending on the selected scenario. Although the budget could be balanced with an improved revenue policy, the debt ratios of these SKIs are already too high to allow further debts.

The SKIs, which have a budget surplus of 20 percent or more, on the other hand, are able to cover additional O&M and operate with a budget surplus in all scenarios. However, their debt ratios, and thus their capacity to absorb additional investments, vary due to their current high liabilities levels.

Considering all parameters, only the largest SKIs of Antalya, Izmir, and Ordu appear to be able to carry out additional investments without major consequences on their finances. Moreover, if one adds the existing total liabilities of these SKIs to the new debt burden of the scenario investments, almost none of these SKIs could implement such investments, regardless of the scenario. The cases of Balikesir and Hatay, which showed the highest NRW levels, noticeably stand out as particularly unable to absorb the required investments in their current situation.

4.3.1. Cost Recovery Tariffs, Affordability

Cost recovery and affordable tariffs are essential for the sustainability of an SKI, because it directly affects its ability to make and sustain new investments. While Turkey's sector policy with respect to standard setting will determine the incremental investment and O&M costs, its policy with respect to infrastructure financing and tariff setting will influence the capacity of SKIs and other utilities to bear all or a share of these costs, while keeping the tariff in keeping with affordability levels.

Appendix G shows to what extent SKIs could transfer the incremental costs on household tariffs, as households represent the greatest highest share of the water consumed and wastewater generated.

4.4. Implementation Challenges of the 2014 SKI reform

In March 2014, the government implemented the consolidation of municipalities into MM in provinces with a population or 750,000 people of more. As part of this process, the different water utilities within each MM have been aggregated and merged into the larger municipality, consistent with the model initially developed in Istanbul and later extended to Ankara and other provinces. All SKIs, except Istanbul and Kocaeli, have therefore taken responsibility for a large number of additional systems. Many of them did not have the same level of infrastructure, maintenance, and capacity as they had previously, and in some cases there were important differences among them.

The purpose of this reform was to take advantage of the capacity of the SKI operating in the larger municipality to expand capacity, infrastructure quality, and operations of the smaller ones, in an effort to bridge the gap of service provision and quality among them. Although this objective was in line with logical sector development objectives, the reform put a large additional responsibility onto the larger utilities of each province, which in effect formed the core of the newly created SKIs. In terms of scale, the smaller municipalities that were aggregated and merged into the larger SKI represent about 19.8 million people, of which about 14.1 million live in urban centers. In comparison, larger municipalities have a total population of 40.1 million, of which 35.2 live in the urban center. In their new aggregated form, SKIs have to serve about 50 percent more people. Although 41 percent of the people are in urban areas, the additional population is spread out over a much larger area than the service area that the SKIs were previously managing. This introduced tremendous technical, financial, and managerial challenges.

There is little information available that allows assessing the scope of these additional demands and the challenges facing the newly formed SKIs, which makes it difficult to precisely assess the issue. Using the assessment of existing infrastructure, an attempt was made to quantify the investments needed to update and expand the wastewater collection and treatment infrastructure to bring all municipalities into compliance with the adopted norms, and the related O&M costs. As an example, for the scenario S1A, the total investment needed to upgrade existing wastewater management infrastructure in these smaller systems is estimated to be EUR4.3 billion, with a total O&M cost of about EUR390 million per year. This represents EUR306 per capita for investment and EUR28 per capita per year for O&M. In comparison, the average cost of coming into compliance with scenario S1A for the population served by an SKI represents EUR85 per capita for investments (3.6 times less) and EUR13.6 per capita per year for O&M (50 percent).

This represents a total cost of about EUR14 billion over a 25 year period just for wastewater management. If we add to these figures the required additional investments and O&M that will be also necessary to upgrade water supply systems, reduce NRW, and pay for the increased costs of managing and ensuring the sustainability of a much larger system, the challenges faced by the newly created SKIs are without doubt very significant.

The decision to charge newly consolidated areas a lower tariff, sometimes 50 percent lower than was charged in the pre-2014 SKI service area, generates an additional stress on the balance sheet of the SKIs. Indeed, it reduces their revenues from areas which are likely to cost comparatively more to manage (expected lower density of customers, network length per customer and therefore NRW per km of network likely to be higher, and so forth). In short, the result was more investment and O&M, more management costs, a staff spread thinner, and less revenue.

It is therefore critical to guarantee efficient investments and efficiency in the operation of these utilities so that the benefits of synergies and scale derived from consolidation can be better used and applied. It is also critical to put in place mechanisms to support the transition with concrete measures to avoid a loss of service sustainability by the utility in the process.

Conclusion: The cost assessment of the proposed scenario and its analysis in the context of the technical and financial situation of each of the 30 SKIs is proving a powerful tool to initiate a discussion within the government, and with the metropolitan municipalities and the SKIs, on many fundamental aspects of utility management, service provision, and capacity and performance improvement. It also is fostering a comparative analysis of capital expenditures (CAPEX versus O&M costs during the useful life of the infrastructure. The public private partnership (PPP) approach promoted by Turkey appears to be an interesting avenue to explore as its combines optimizing CAPEX and O&M costs, capacity performance and sustainability improvements, and leveraging private sector financing, so that additional costs could be offset by resulting improvement in performance.

Chapter 5 - Sector issues can turn into opportunities for Turkey - Questions for discussion and areas for further analysis

5.1. Why Questions for Discussion?

The ultimate objective of this work is to contribute to Turkey's efforts to make the country's actions on water infrastructure and environmental protection consistent with the WFD, (which is also consistent with its overall goal of meeting the SDGs), especially on aspects related to potable water and sanitation. This EU directive has been a driving force for the EU water legislation around the key principle that all EU water-related directives should be coordinated to contribute to the goal of reaching EU "good ecological status" in each river basin, a principle to which Turkey adheres. Adopting a single system of water management at the river basin level and achieving "good" status in all waters within a given timeline are also keystones of this spirit.

Previous chapters analyzed the institutional setting currently in place in Turkey to address this challenge and the differences between the Turkish and EU regulations that determine the actions needed and their costs. The report has shown the relative impact on costs and affordability of applying one set of regulations or another, as modeled by the scenarios (see Appendix G for detailed results). Moreover, with respect to MMs,[15] the report evaluated and quantified potential financial impacts of the required investments in each scenario on SKIs, now provincial utilities, and on other operators country-wide. Yet, a number of areas could be further analyzed.

The analysis has also shown that, in the process of implementing the aspects of the WFD dealing with WSS (DWD and more importantly UWWD) and assessing the relative contribution they make to reaching the "good ecological status" of the environment, Turkey has the opportunity to further develop the "spirit" of these directives and thus expand and improve water related regulations and directives.[16] This chapter also identifies areas that could expand the initial scope of the assessment, and thus contribute to Turkey's effort to reach the "Good Ecological Status" for each river basin efficiently and in a sustainable manner. Box 5.1 lists a number of potential areas where WFD implementation could be improved.

5.2. Which Criteria for Actions?

In previous chapters, where the regulations have been compared and scenarios for action have been analyzed, two points come out clearly: (i) investment decisions are based on effluent standards/treatment options; and (ii), the criteria for selection takes into consideration individual requirements of particular urban areas on the basis of their population, with more or less stringent requirements depending on whether the area where treated wastewater is discharged is considered "sensitive" or "less sensitive." Consistent with the spirit of the WFD, sanitation is important and the improvements it brings have to be documented. Thus, initial questions worth asking include: whether investment decisions should take into consideration the actual ecological status and water quality in rivers, lakes, or shores receiving the treated wastewater; to what extent the ecological status, water quality objectives, and planned uses in the treated wastewater discharge area would be or are impacted by such discharges in the corresponding river basin; and which monitoring system should be put in place to adequately measure the environmental benefits achieved.

15 Available financial data is only limited to these utilities, thus limiting the scope of this analysis.

16 One example could be incorporating into water-related regulations the recommendations contained in the EU guidance on water scarcity and drought allocation, which is left to Member States to regulate on, consistent with the principle of subsidiarity. (This principle of subsidiarity becomes a difficult issue since according to the EU treaty all quantitative issues have to be agreed to unanimously by the all Member States, and is also a reason why the WFD is not strong on quantitative issues).

With regard to criteria for setting "sensitive" and "less-sensitive" areas, a related immediate question refers to the current way sensitive areas are selected and their geographical extent and borders are set: is the assessment of "sensitivity" of the receiving bodies, which determines wastewater treatment standards, related to a rigorous assessment and monitoring of water quality over time and to the actual economic impact of the pollution discharged?

The EU directive links the sensitivity of the receiving environment mostly to its level of eutrophication. The Aegean and Mediterranean Seas are not eutrophic, except in very specific and identified areas, even when most wastewaters were discharged without treatment. Does it make economic and environmental sense to impose nutrient removal on most of Turkey's coastline along those seas?

The Marmara and Black Seas have eutrophication problems, but are all the rivers and lakes of Turkey's river basin discharging into these seas eutrophic or polluted? Are the main sources of pollution identified, the related pollution known, and their corresponding impact quantified? Is it clear and documented that the pollution leading to eutrophication is primarily attributable to point sources (municipal wastewater, industrial wastewater) versus non-point sources (agricultural run-off, large river inputs)? What is the comparative impact of agricultural and industrial sources of pollution in comparison to municipal contributions? In light of these questions, to what extent does it make economic and environmental sense to require small communities to install and sustain complex and expensive nutrient removal technology when the pollution that is generated is presumably negligible in comparison to larger pollution sources which remain untreated, and that even when the pollution is treated, it will most probably remain minimal at the scale of the river basins?

Often the definition of sensitive areas is too broad, resulting in the generation of additional investments and operations costs. Interestingly enough, the WFD foresees this issue.[17] It states the following: "Uses or objectives for which water is protected apply in specific areas, not everywhere. Therefore, the obvious way to incorporate them is to designate specific protection zones within the river basin, which must meet these different objectives. The overall objectives planning for the river basin will define minimal ecological and chemical protection requirements everywhere, but where more stringent requirements are needed for particular uses, zones will be established and higher objectives set within them." One way to do this is to take into consideration differences among regions in terms, inter alia, of challenges, demands, environmental constraints, environmental capacity,[18] and potential for economic development by sectors.[19] Turkey is a large country with noticeable differences among its regions, thus the approach could not be the same everywhere.

5.3. Opportunities related to Institutional Issues

Earlier chapters underlined issues of duplication and competency and different interpretations of regulations and requirements. This section identifies possible improvements to increase the efficiency of the actions Turkey undertakes to achieve the "good ecological status" of its waters.

Focusing on investments rather than on operations costs can jeopardize the long-term sustainability of operations. It is clear that the actions contributing to achieve the "good ecological status" in all river basins need to be part of an integrated plan which looks at the investments, but also which considers modernizing the institutions responsible for implementing such plan, as well as the utilities responsible for operating the new wastewater infrastructure, so as to increase efficiency. Turkey has made significant improvements in this respect in recent years,

17 http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

18 Environmental capacity is a term developed and used as part of the Mediterranean Action Plan to define the capacity a certain area has to receive degradable pollutants without losing its good ecological status

19 Another important step in this direction could be the use of the economic analysis of pollution, measured as the reduction of beneficial uses. In other words, could the uses assigned to a river basin district, or a particular area within it, be used to assess the need and justification for water pollution control investments?

particularly with the creation of provincial utilities for the major 30 metropolitan areas and the municipalities that form their respective province. Nonetheless, further reform could be carried out to provide more incentives for the provincial utilities to operate more efficiently and ensure sustainability of infrastructure and associated environmental benefits. Bringing about proper management responsibilities, particularly in terms of WWTP design, financing, and operation decisions, is the logical next step for all of the new utilities under the SKI model.

Incorporating proper project design and contractual incentives are keys for reaching the economic optimum for the utility over the infrastructure's useful life and for ensuring that its operation does not represent a challenge for SKI staff. It is therefore important to assess whether management and technical capacities are consistent with the complexity of the proposed designs and whether a utilities' staff is provided with adequate training on how to run the facilities. How should the utility's capacity (or limitation thereof) be weighed in the decision process of setting treatment requirements, contractual arrangements, or deciding on a phased approach? Are proposed designs, standardized or not, adapted enough to the local context, in terms of phased investments opportunity, embedding capacity building in works contracts, sludge management options, and energy efficiency potential?

Which institutional arrangements are best suited to develop large-scale infrastructure or ensure quality operation for long-term technical and financial sustainability? Turkey announced a large PPP program on water and sanitation, but which arrangements would make sense and where? How do one put in place an efficient incentives framework and ensure a proper balance between public and private interests? How do one empower basin committees and authorities to undertake key investments, in, for instance, bulk water supply, wastewater planning, management, and financing? Would it make sense to consider in Turkey a system similar to the one used in EU countries like Spain whereby municipalities can delegate a large part of the management and responsibility for wastewater treatment infrastructure to the river basin authorities, recognizing the public and regional nature of their function (benefits are received often by those who do not generate the effluent, and impacts have a regional scope)?

All these questions relate directly to the spirit of the WFD. They are known by sector specialists and most authorities with responsibilities over the sector, and so are the benefits and added sustainability they could represent. The challenge is to identify what the constraints are that prevent investments from being applied and to determine how to develop the right set of incentives in the action plans to promote reforms. Turkey could not only benefit, but also make a substantial contribution to improving EU directives by incorporating these principles in the next phases of its actions in this field.

5.4. Questions on Sanitation Technical Solutions

The science and practice of wastewater treatment has advanced significantly in recent years. Technology has contributed to this advance by providing better monitoring and management tools, and the science behind treatment processes has also improved considerably. Several of these advances could have direct impact on the implementation of the WFD in Turkey.

Sanitation in Tourist Areas. Touristic areas represent an important case on their own for two main reasons: (i) the direct link between the uses that make such areas viable and so important from an economic point of view and the ecological status of rivers and coastal waters; (ii) the seasonality of the flows and demands, which exert significantly larger peak demands in limited periods of the year, when local permanent population figures increase due to the influx of tourists.

Box 5.1: Other Potential Areas where WFD Implementation could be Improved

Other set of questions could also be put forward on aspects that could benefit Turkey's actions to improve its water's quality and achieve good ecological status, which are also consistent with related EU directives. The most important among these are:

- Are holistic river basin districts approaches, such as grouping treatment plants for economies of scale or setting treatment priorities (and requirements) on the basis of water quality modeling at the river basin district level, being analyzed?
- Which are the criteria for decision-making, particularly in setting priority among different investments in the same river basin district?
- Are design alternatives analyzed and are public stakeholders' consultations sufficient?
- Is performance monitoring of existing infrastructure or utility performance adequate?
- Are climate smart investments (NRW reduction, biogas generation, composting, reuse, energy efficiency improvement, and micro-hydroelectricity) adequately considered?
  What are the constraints or minimal scale for such investments to make sense?
- Are centralized versus decentralized approaches for wastewater collection and treatment systematically analyzed? Is the new organizational structure which gives SKI utilities the overall responsibility over both urban and rural areas of a province effectively conducive to integrate piped and on-site sanitation approaches?
- Is the potential for treated wastewater reuse and the seasonality of demand by irrigation considered in the decision process? Is reuse properly considered in tourist areas, where water demand peaks (as well as wastewater flows) in the periods of lowest availability of the resources?

Several EU countries (for instance Croatia) adopted a gradual approach to address the urgency of securing the "good ecological status" of their inland waters and coastal waters (EU marine strategy). The key element of this approach consists of reserving land for upper levels of treatment that the directives could require, but designing and implementing the wastewater management system in phases. The objective is to adapt the wastewater treatment option based on demographic and economic growth, and seasonal variations, by using modular solutions allowing winter flows to be treated by a dedicated treatment, to limit fixed costs, and introduce re-use as much as possible.

Turkey could follow a similar approach. It could even incorporate a next step that could, in line with what has been underlined before, adopt discharge options and treatment requirement adapted to the different sensitivity of the different areas of the receiving environment, recognizing that "uses or objectives for which water is protected apply in specific areas, not everywhere."

It could, for instance, adopt different "sensitivity" levels for different parts of the same coastal area, designating as "sensitive" the first nautical mile from the shoreline, and "less-sensitive" areas beyond that line. Therefore different treatment standards would be required for WWTPs which discharge treated wastewater within this limit and for WWTPs discharging further away from the shore (less stringent), as long as good dispersion is guaranteed through properly designed and constructed discharge systems and no other specific uses are present. This could greatly reduce costs without jeopardizing the achievement of the desired ecological status. Complementing this approach with state-of-the-art modeling and monitoring to guarantee that quality objectives are achieved and maintained (and taking additional steps if they are not), such phased approach could have a significant impact on costs and sustainability, while ensuring compliance with the "spirit" and objectives of the EU directives.

5.5. Financing and Management Options for Service Delivery Improvement

The traditional approach for building new wastewater treatment plants (WWTP) is to use standard construction contracts and to transfer the plant, once commissioned, to the utility to operate. This approach has several shortcomings:

- Tendering is usually based on the lowest construction cost. In practice capital expenditures (CAPEX) represent only about one-third of the life cycle cost (LCC) of a WWTP. The other two-thirds correspond to the cumulated O&M costs (without amortization). While projected O&M costs based on various technical options are usually analyzed during design, there are no real incentives to minimize them. Therefore, selecting bidders based on lowest CAPEX cost without considering the LLC may not lead to the optimal economic choice for the utility.
- Standard construction contracts are often subject to construction delays and cost overruns, which are usually borne by the contracting public agency. The actual CAPEX ends up being much higher than planned and environmental benefits materialize later because of delays.
- The utility which takes over the plant may not have the capacity to operate it efficiently (especially for cost-saving technologies such as cogeneration). It may not have included the training of its staff in the construction contract and there is no guarantee that it will be able to set aside sufficient funds to properly carry out O&M over the plant's useful life.

While managing these shortcomings can very well be done in the context of a publicly managed utility, international experience shows that, in addition to technical capacity and expertise, it requires strong leadership by the utility senior management, continuous support from the municipality and central government to the utility management to mature and implement such reforms, and significant time to implement reforms. Experience shows that such reforms usually take a long time to translate into measurable results, and that ensuring that these factors will all be met is usually a major challenge.

In an attempt to mitigate these shortcomings, many countries around the world have relied on a combination of public utility management and partnering with the private sector through "design, build and operate (DBO) and "build, operate, and transfer" (BOT) approaches for the development of new WWTPs, in areas where it makes sense from a practical and economic viewpoint. Under these approaches, the private sector is contracted under a turnkey contract to build and operate the new plant (usually for 20 to 30 years), with a contractual commitment to deliver treated wastewater according to a fixed standard, and where payment is based on a tariff per m^3 of treated wastewater. Under a BOT scheme the financing comes from the private sector, whereas under a DBO scheme the financing comes from public funds. The BOT approach puts more risks on the private sector, and conversely fewer risks on the public counterpart, and holds several advantages:

- The choice of the private contractor is based on the lowest LCC, instead of lowest CAPEX, resulting in a more economical proposition for the government. The private sector has the flexibility to choose (at its own risk) the best technological option to reduce LCC (that is, the combination of CAPEX and cumulated O&M costs) over the duration of the contract;
- The private sector takes on the risks related to delays, costs overruns, and non-compliance of treatment infrastructure.
- The private sector remains in place to operate the plant at its own risk, being liable for compliance with discharge standards. The contractual obligation of the utility to pay the tariff per m^3 of treated wastewater usually result in the public contracting agency making sure that sufficient funds are set aside for this (usually setting tariff at sufficient level), as opposed to cutting necessary maintenance expenditures.

DBO-BOTs have been used with success in several large countries embarked on national WWTP investment programs – such as in Brazil, Mexico, China, and India – as well as countries in Europe (France, Belgium and Slovenia) and the Mediterranean (Jordan). This usually resulted in developing a new business line for national construction companies who became BOT operators. There is an opportunity in exploring the DBO-BOT options for the implementation of a portion of Turkey's investment program in WWTP, as discussed at the workshop (see Appendix I – "Summary of the High-Level Workshop").

5.6. Can Integrated Urban Water Management help manage costs and water quality and quantity constraints?

One main approach stands out as potentially having a significant impact on the costs and benefits of more integrated approaches for water quality and quantity constraints management, if properly implemented. It is called Integrated Urban Water Management (IUWM).

The IUWM approach is based on the widely-recognized theory that the management of wastewaters could be greatly optimized and costs reduced through a holistic approach at the city level. IUWM consists of the holistic, integrated and sustainable management of urban and water resources at the scale of urban areas. It is not a new concept, but rather a set of principles to better integrate the multisectoral aspects related to water resources and management in an urban area, which face the impacts of broader issues related to water scarcity and security and/or flood management. It links infrastructure solution to urban planning and regulations, and considers the whole "water cycle" in the solution finding process.

IUWM deals not only with planning, design, and construction, but also with efficiency improvement. In practice, it usually achieves positive specific results, including: better adequation of capacity increase with spatial demand growth; closer linkages with drainage and solid waste management; finding opportunities to turn waste into products by reusing treated wastewater, biodigesting and composting sludge; and determining and working to achieve an economic optimum of water losses. For instance this could include working to figure out what level makes it more beneficial to invest in NRW reduction versus investing in new costly mechanisms to increase production capacity which is likely to involve more and more desalination.

In Turkey, the reform leading to the creation of the SKIs was derived from a water crisis and the March 2014 directive seems motivated in part by the need to harmonize water service levels and to improve management at the scale of major urban centers and their surrounding areas. Large urban centers are growing fast, both demographically and economically. Istanbul and Ankara alone represent about 30 percent of the Turkish population and most likely a larger share of the country GDP. In the meantime water resources are becoming increasingly scarce and expensive to mobilize. This trend is expected to worsen with the impacts of climate change. A water crisis would have dramatic social and economic consequences. Because this places water security at the top of municipal and government priorities, it should also make IUWM approaches for optimized solutions a priority.

Therefore, related questions worth analyzing include: to what extent are water and wastewater facilities development embedded into the master plans and strategic plans of utilities integrated into urban plans? Are these investments implemented in an integrated or coordinated fashion? What incentives and mechanisms can be put in place to facilitate the adoption of IUWM approaches in major urban centers throughout Turkey as part of the plans to implement actions coherent with EU directives related to water?[20]

20 Although storm water management, flood management and perimeter of protection of water catchment areas are important aspects related to urban planning and river basin planning within IUWM, this report does not analyze in more detail its relations to the objective of achieving good ecological status because of time constraints. It could be the focus of another phase of this assessment, pending the conclusions of the proposed workshop

The ideas presented above were illustrated at the workshop by presentations of selected good practice examples in areas where Turkey's utilities have done particularly well, such as design and operation, phasing of investments, quality of operations, climate smart investments, biogas digestion, reuse of treated wastewater and allocation mechanisms between uses (primarily agriculture versus water supply), and identifying those "no regret" measures that could have a systematic application. Appendix I presents a short summary of the highlights of the workshop.

Conclusion:

Turkey has a long history in dealing with water supply and sanitation, and has set a clear and ambitious roadmap for the sector. The considerable efforts and investments made in the last 15 years to expand access to water supply, wastewater collection, and treatment has placed Turkey at a level equivalent to or above that of EU member states in the Danube River Basin. However, this has impacted the balance sheet of most SKIs, both in terms of debt levels and increased O&M costs. As a result, tariff levels set to cover expenditures are close to or above the tariff level defined as affordable. Yet, additional investments are needed to bring about compliance with the standards set in Turkey. These will result in debt repayment and additional incremental O&M costs that could result in tariff increases which will challenge the limit of affordable tariffs. This is a real challenge on the sustainability of a WSS service provider. It will become an even greater challenge as demographic and economic growths increase demand and as climate changes negatively affects the resources available to meet the demand. This situation calls for more investment efficiency for new infrastructure and operations performance improvement for existing facilities. The above section presents fundamental questions worth further analysis, so that the great efforts being undertaken in the water supply and sanitation sector can lead to provision of sustainable service to the entire population in order to support Turkey's efforts to bring about a better environmental and economic future. The World Bank has provided support to help countries tackle these challenges all over the world, and stands ready to support Turkey in its endeavor.

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12. www.kalkinma.gov.tr
13. www.mevzuat.gov.tr
14. www.ormansu.gov.tr
15. www.pro-wat.com
16. www.resmigazete.gov.tr
17. www.suyonetimi.ormansu.gov.tr/AnaSayfa.aspx?sflang=tr
18. Annual Activity Reports of SKIs for 2014 (downloaded from relevant SKIs web-page)
19. Tariff tables of SKIs for 2014 (downloaded from relevant SKIs web-page)
20. Audit Reports of Selected SKIs for 2014 by Court of Account (downloaded from web-page of Court of Accounts, http://www.sayistay.gov.tr/rapor/sayrapor2.asp?id=20164)
21. TURKSTAT's data for population and total system input (m3) in 2014
22. Projected Water Demand for Istanbul and Ankara, Turkey, published in Political ecology of inter-basin water transfers in Turkish water governance, December 2014, https://www.researchgate.net/figure/274138081_fig1_Fig-1-Projected-water-demand-for-Istanbul-and-Ankara-Turkey
23. http://iklim.ormansu.gov.tr/ckfinder/userfiles/files/2_Hidrolojik%20Modelleme%20ve%20De%C4%9Ferlendirme.pdf

Appendixes

Appendix A: Maps and Population Breakdown

Figure A.1. Map of Metropolitan Municipalities in Turkey

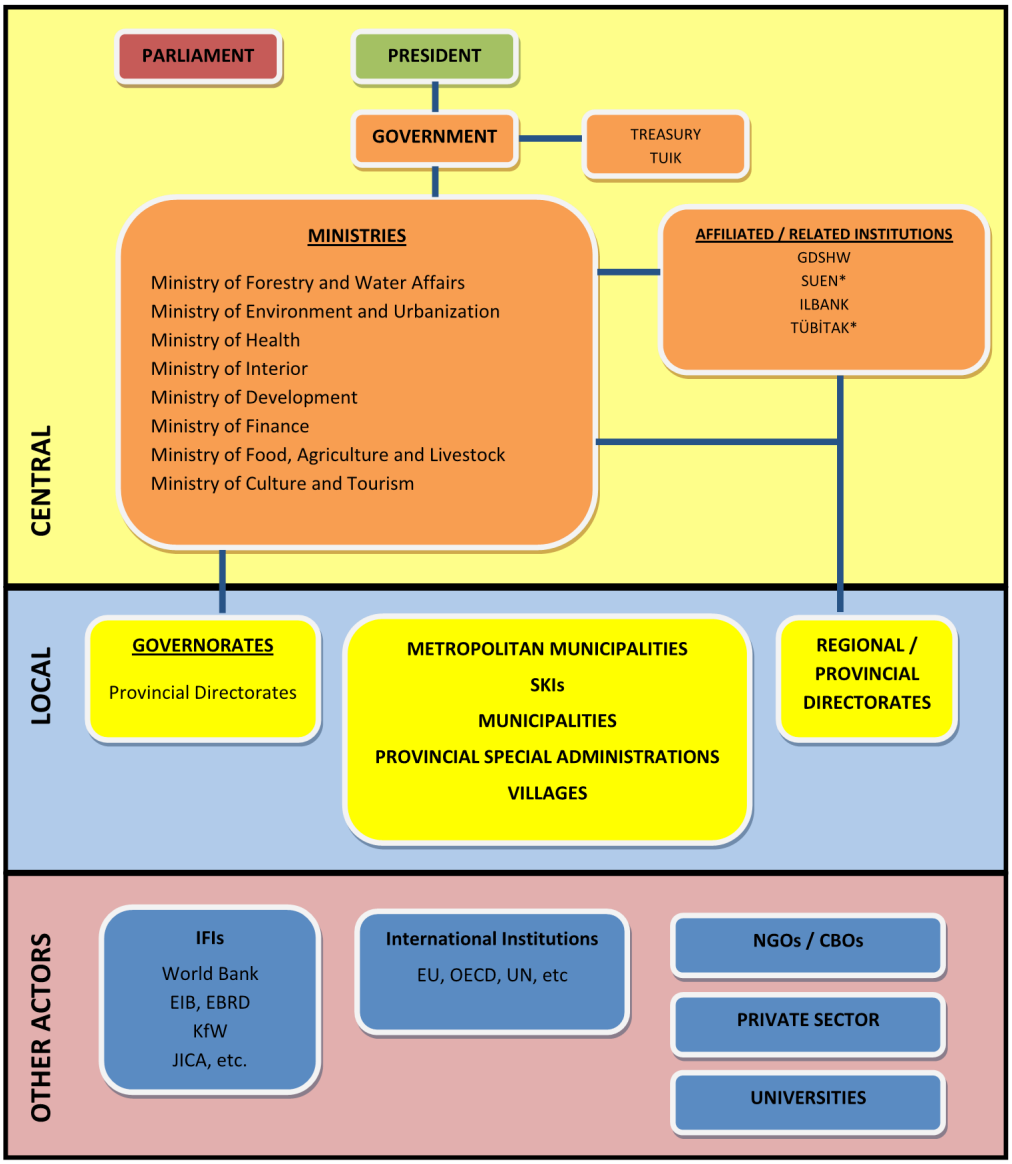
Source: http://emlakansiklopedisi.com/wiki/buyuksehir-belediyesi (modified to include Ordu MM)

Note: The Metropolitan Municipalities created before 1993 are in blue color, those created in 2014 in red.

Figure A.2. Map of River Basins in Turkey

Source: National Basin Management Strategy Document, MoFWA, 2014.

Figure A.3. Institutional Set-up of the Water Sector in Turkey



*SUEN (the Turkish Water Institute) and TÜBİTAK do not have regional or provincial directorates.

Table A.1: Distribution of Number of Different Service Providers and their Service Population

WSS Service Provider	Number	Serviced Population in 2014 (inhabitants)	Percentage of total population of Turkey**
Metropolitan Municipality / SKI	30	59,968,496	77
Other Municipalities*	847	12,538,736	16
Special Provincial Administrations	51	5,188,672	7

Source: Consultant calculation based on data from www.migm.gov.tr/Dokumanlar/belediye_listesi_2014.xlsx (October 2016).
* The sub-province municipalities within the borders of metropolitan municipalities are not included.

** Total population of Turkey in 2014 was 77,695,904 according to TURKSTAT data.

Appendix B: Main Sector Indicators from 2006 to 2014

Table B.1: Main Drinking Water Indicators for Municipalities in Turkey between 2006 and 2014

	2006	2008	2010	2012	2014
Türkiye nüfusu - Turkeypopulation	70 586 256	70 586 256	73 722 988	75 627 384	77 695 904
Toplam belediye sayısı - Total number ofmunicipalities	3 225	3 225	2 950	2 950	1 396
Toplam belediye nüfusu - Total municipal population	58 581 515	58 581 515	61 571 332	63 743 047	72 505 107
İçme ve kullanma suyu şebekesi ile hizmet verilen belediye sayısı	3 167	3 190	2 925	2 928	1 394
Number of municipalities served bywater supplynetwork					
İçme ve kullanma suyu şebekesi ile hizmet verilen belediye nüfusu	57 686 003	58 052 383	60 664 687	62 649 551	69 871 650
Municipal population served bywater supplynetwork					
İçme ve kullanma suyu şebekesi ile hizmet verilen nüfus un toplam nüfusa oranı (%)	82	82	82	83	91
Rate ofpopulation served bywater supplynetwork in total population (%)					
İçme ve kullanma suyu şebekesi ile hizmet verilen nüfus un toplam belediye nüfusuna oranı (%)	98	99	98	98	97
Rate ofpopulation served bywater supplynetwork in total municipal population (%)					
İçme ve kullanma suyu şebekesi iç in çekilen toplam su miktarı (bin m^3/yıl)	5 163 500	4 546 574	4 784 734	4 936 342	5 237 407
Water abstraction for municipal water supplynetwork (thousand m^3/year)					
Baraj - Dam	1 843 736	1 810 188	2 252 421	2 416 018	1 886 617
Kuyu - Well	1 401 815	1 275 691	1 273 822	1 395 957	1 423 751
Kaynak - Spring	1 380 057	1 060 963	1 015 865	948 133	984 869
Akarsu - River	305 271	173 928	159 472	78 282	652 370
Göl-göletdeniz [1] - Lake - artificial lake /sea [1]	232 621	225 805	83 154	97 953	289 800
İçme ve kullanma suyu şebekesi iç in çekilen yüzey suyu miktarı (bin m^3/yıl)	2 381 628	2 209 921	2 495 047	2 592 253	2 828 787
Fresh surface water abstraction for municipal water supplynetwork (thousand m^3/year)					
İçme ve kullanma suyu şebekesi iç in çekilen yeraltı suyu miktarı (bin m^3/yıl)	2 781 872	2 336 654	2 289 687	2 344 090	2 408 620
Fresh ground water abstraction for municipal water supplynetwork (thousand m^3/yearr)					
Kişi başı çekilen günlük su miktarı (litre/kişi-gün)	245	215	216	216	203
Water abstraction per capita in municipalities (liters/capita-day)					
İçme ve kullanma suyu şebekesi ile dağıtılan su miktarı (bin m^3/yıl)	2 375 043	2 400 522	2 579 676	2 801 939	3 394 545
Water distribution bymunicipal water supplynetwork (thousand m^3/year)					
İçme ve kullanma suyu arıtma tesisi sayısı	139	170	206	258	381
Number of drinking water treatment plants					
Fiziksel - Physical	69	71	77	79	69
Konvansiyonel - Conventional	68	84	96	132	165
Gelişmiş - Advanced	2	15	33	47	147
İçme ve kullanma suyu arıtma tesisi kapasitesi (bin m^3/yıl)	3 994 060	4 422 745	4 499 508	4 629 842	6 133 100
Total capacityof drinking water treatment plants (thousand m^3/year)					
Fiziksel - Physical	163 128	136 743	156 490	132 800	148 052
Konvansiyonel - Conventional	3 829 791	4 166 692	4 172 571	4 291 360	4 955 564
Gelişmiş - Advanced	1 142	119 310	170 447	205 681	1 029 484
İçme ve kullanma suyu arıtma tesislerinde arıtılan su miktarı (bin m^3/yıl)	2 426 639	2 120 561	2 520 085	2 729 430	2 995 001
Amount of drinking water treated (thousand m^3/year)					
Fiziksel - Physical	63 528	54 425	54 615	43 314	47 875
Konvansiyonel - Conventional	2 362 437	2 019 619	2 401 093	2 602 102	2 860 041
Gelişmiş - Advanced	675	46 517	64 378	84 015	87 085
İçme ve kullanma suyu arıtma tesisi ile hizmet verilen belediye sayısı	413	434	346	411	436
Number of municipalities served bydrinking water treatment plants					
İçme ve kullanma suyu arıtma tesisi ile hizmet verilen belediye nüfusu	28 839 265	29 074 451	32 992 877	35 868 415	41 610 124
Municipal population served bydrinking water treatment plants					
İçme ve kullanma suyu arıtma tesisi ile hizmet verilen nüfus un toplam nüfusa oranı (%)	41	41	45	47	54
Rate ofpopulation served bydrinking water treatment plants in total population (%)					
İçme ve kullanma suyu arıtma tesisi ile hizmet verilen nüfus un toplam belediye nüfusuna oranı (%)	49	50	54	56	58
Rate ofpopulation served bydrinking water treatment plants in total municipal population (%)					

... Bilgi elde edilememiştir.

... Data not available.

(1) 2010 yılından itibaren denizden çekilen su miktarı dahil edilmiştir.

(1) Water abstracted from sea is included since 2010.

Source: http://tuikapp.tuik.gov.tr/cevredagitimapp/belediyeicme_ing.zul

Table B.2: Results of Life Satisfaction Survey regarding Municipal WSS Network Services

Year	Satisfaction from network water services of the municipality (%)				Satisfaction from sewer services of the municipality (%)			
	Satisfied	Not satisfied	No idea	No such service	Satisfied	Not satisfied	No idea	No such service
2012	79.32	19.33	0.86	0.49	71.51	20.02	3.91	4.56
2011	78.26	19.49	1.76	0.48	73.01	19.27	4.53	3.18
2010	77.56	20.55	1.52	0.38	71.59	21.91	3.58	2.93
2009	76.82	21.2	0.93	1.05	69.54	21.14	3.45	5.88
2008	66.35	31.12	1.32	1.21	71.07	22.47	3.05	3.41
2007	73.74	23.81	0.95	1.5	67.74	22.77	2.82	6.68
2006	69.81	25.58	1.55	3.07	63.35	24.68	3.02	8.95
2005	75.06	21.46	1.5	1.98	68.13	19.02	3.46	9.39
2004	74.63	21.72	1.76	1.9	69.03	20.11	4.16	6.7

Source: http://tuikapp.tuik.gov.tr/yasamapp/yasam_ing.zul, downloaded on 12.08.2014

Table B.3: Main Wastewater Indicators for Municipalities in Turkey between 2006 and 2014

	2006	2008	2010	2012	2014
Türkiye nüfusu Turkey population	**70 586 256**	**70 586 256**	**73 722 988**	**75 627 384**	**77 695 904**
Toplam belediye sayısı Total number of municipalities	3 225	3 225	2 950	2 950	1 396
Toplam belediye nüfusu Total municipal population	58 581 515	58 581 515	61 571 332	63 743 047	72 505 107
Kanalizasyon şebekesi ile hizmet verilen belediye sayısı Number of municipalities served bys ewerage system	2 321	2 421	2 235	2 300	1 309
Kanalizasyon şebekesi ile hizmet verilen belediye nüfusu Municipal population served bys ewerage system	50 856 943	51 673 078	54 017 052	58 754 795	65 071 589
Kanalizasyon şebekesi ile hizmet verilen nüfusun toplam nüfusa oranı (%) Rate of population served by sewerage system in total population (%)	72	73	73	78	84
Kanalizasyon şebekesi ile hizmet verilen nüfusun toplam belediye nüfusuna oranı (%) Rate of population served by sewerage system in total municipal population (%)	87	88	88	92	90
Alıcı ortamlara göre şebekeden deşarj edilen atıksu miktarı(bin m^3/yıl) Amount of wastewater discharged from municipal sewerage to receiving bodies (thous and m^3/year)	3 366 894	3 261 455	3 582 131	4 072 563	4 296 851
Denize Sea	1 522 695	1 458 461	1 498 728	1 843 115	1 915 294
Göl-Gölete Lake-artificial lake	46 415	67 193	76 024	75 116	93 595
Akarsuya River	1 410 614	1 404 164	1 741 078	1 817 352	1 898 895
Araziye Land	120 525	50 374	35 091	35 770	17 954
Baraja Dam	121 532	115 405	130 224	114 199	120 781
Diğer Other	145 113	165 857	100 985	187 011	250 333
Atıksu arıtma tesisi sayısı Number of wastewater treatment plants	184	236	326	460	604
Fiziksel Physical	26	29	39	57	49
Biyolojik Biological	135	158	199	244	345
Gelişmiş Advanced	23	32	53	70	92
Doğal Natural	...	17	35	89	118
Atıksu arıtma tesisi kapasitesi (bin m^3/yıl) Total capacity of wastewater treatment plants (thous and m^3/year)	3 648 198	4 143 140	5 293 204	5 562 075	5 940 579
Fiziksel Physical	1 329 470	1 537 719	1 838 627	1 904 642	1 823 038
Biyolojik Biological	1 510 835	1 594 640	1 732 674	1 703 694	2 074 215
Gelişmiş Advanced	807 893	1 000 814	1 709 415	1 918 697	1 984 915
Doğal Natural	...	9 967	12 488	35 042	58 411
Atıksu arıtma tesislerinde arıtılan atıksu miktarı (bin m^3/yıl) Amount of wastewater treated by wastewater treatment plants (thous and m^3/year)	2 140 494	2 251 581	2 719 151	3 256 980	3 483 787
Fiziksel Physical	714 404	735 710	751 101	929 334	869 248
Biyolojik Biological	926 581	861 428	931 356	1 072 873	1 155 353
Gelişmiş Advanced	499 509	648 536	1 031 616	1 245 977	1 450 494
Doğal Natural	...	5 906	5 079	8 795	8 692
Atıksu arıtma tesisi ile hizmet verilen belediye sayısı Number of municipalities served bywastewater treatment plants	362	442	438	536	513
Atıksu arıtma tesisi ile hizmet verilen belediye nüfusu Municipal population served bywastewater treatment plants	29 643 258	32 518 318	38 050 717	43 543 737	49 358 266
Atıksu arıtma tesisi ile hizmet verilen nüfusun toplam nüfusa oranı(%) Rate of population served by wastewater treatment plants in total population (%)	42	46	52	58	64
Atıksu arıtma tesisi ile hizmet verilen nüfusun toplam belediye nüfusuna oranı (%) Rate of population served by wastewater treatment plants in total municipal population (%)	51	56	62	68	68
Belediyelerde deşarj edilen kişi başı günlük atıksu miktarı (litre/kişi-gün) Amount of wastewater discharged per capita in municipalities (liters/capita-day)	181	173	182	190	181
Derin deniz deşarjı yapan belediye sayısı Number of municipalities having marine outfalls	77	92	80	80	36

... Bilgi elde edilememiştir.
... Data is not available.
- Bilgi yoktur.
- Denotes magnitude null.

Source: http://tuikapp.tuik.gov.tr/cevredagitimapp/belediyeatiksu_ing.zul

Appendix C: Water and Wastewater Expenditures 2007 - 2013

Water and Wastewater expenditures. Table C.1 shows the capital and operational expenditures by public institutions (that is, municipalities, government organizations, and SPA) between 2007 and 2013.

Table C.1: Capital and Operational Investments of Municipalities, Government Organizations and Special Provincial Administrations regarding Water Service and Wastewater Management Services between 2007 and 2013, Million TL[21]

Institution	Type of expenditure		2007	2008	2009	2010	2012	2013	Total
MUNICIPALITY	Total water & wastewater	Operational	1,474	2,101	2,062	2,016	2,737	3,558	13,949
		Capital	2,733	1,984	1,658	1,942	2,269	3,222	13,808
		TOTAL	4,207	4,086	3,721	3,958	5,006	6,780	27,757
	Water services	Operational	1,253	1,770	1,499	1,472	2,192	2,858	11,044
		Capital	1,724	1,465	882	1,100	1,341	1,852	8,363
		TOTAL	2,978	3,235	2,380	2,572	3,533	4,709	19,407
	Wastewater management services	Operational	221	332	563	544	545	701	2,905
		Capital	1,009	519	777	842	929	1,370	5,445
		TOTAL	1,229	850	1,340	1,386	1,473	2,071	8,349
GOVERNMENT ORGANIZATIONS	Total water & wastewater	Operational	15	67	18	17	54	72	242
		Capital	713	741	795	879	1,348	1,556	6,032
		TOTAL	728	808	813	896	1,401	1,628	6,274
	Water services	Operational	5	11	6	10	33	47	112
		Capital	332	471	617	533	887	1,057	3,896
		TOTAL	337	482	623	543	920	1,103	4,008
	Wastewater management services	Operational	9	56	12	7	20	25	130
		Capital	382	270	179	346	461	499	2,136
		TOTAL	391	326	190	353	481	524	2,266
SPECIAL PROVINCIAL ADMINISTRATIONS	Total water & wastewater	Operational	63	45	45	43	52	63	312
		Capital	108	68	103	130	181	217	807
		TOTAL	172	113	148	173	233	280	1,119
	Water services	Operational	43	36	34	33	32	38	218
		Capital	62	43	71	79	105	111	472
		TOTAL	106	79	106	112	138	150	689
	Wastewater management services	Operational	20	9	11	10	19	25	95
		Capital	46	26	31	51	76	106	335
		TOTAL	66	35	42	61	95	131	430
TOTAL PUBLIC SECTOR	Total water & wastewater	Operational	1,553	2,213	2,125	2,077	2,842	3,693	14,503
		Capital	3,554	2,793	2,556	2,950	3,798	4,995	20,647
		TOTAL	5,107	5,007	4,682	5,027	6,640	8,688	35,150
	Water services	Operational	1,302	1,816	1,539	1,516	2,258	2,943	11,374
		Capital	2,118	1,979	1,570	1,711	2,333	3,020	12,731
		TOTAL	3,420	3,796	3,109	3,227	4,591	5,962	24,105
	Wastewater management services	Operational	250	397	586	561	585	751	3,129
		Capital	1,436	814	987	1,239	1,465	1,975	7,916
		TOTAL	1,687	1,211	1,573	1,800	2,049	2,726	11,045

Source: http://tuikapp.tuik.gov.tr/cevredagitimapp/cevreselharcama_ing.zul

21 The investment values for 2011 are not included because they are not publicly available.

Appendix D: Provincial Population Figures for Metropolitan Municipalities

Table D.1 below shows provincial population of metropolitan municipality provinces. The values for 2013 and 2014 also represent the service population as of March 31, 2014.

Table D.1: Provincial Population Figures for Metropolitan Municipalities between 2007 and 2014.

No	Metropolitan Municipality	2007	2008	2009	2010	2011	2012	2013	2014
1	İstanbul	12,573,836	12,697,164	12,915,158	13,255,685	13,624,240	13,854,740	14,160,467	14,377018
2	Ankara	4,466,756	4,548,939	4,650,802	4,771,716	4,890,893	4,965,542	5,045,083	5,150,072
3	İzmir	3,739,353	3,795,978	3,868,308	3,948,848	3,965,232	4,005,459	4,061,074	4,113,072
4	Bursa	1,760,022	1,819,470	1,854,285	1,905,970	1,948,744	1,983,880	2,740,970	2,787,539
5	Antalya	1,789,295	1,859,275	1,919,729	1,978,333	2,043,482	2,092,537	2,158,265	2,222,562
6	Adana	2,006,650	2,026,319	2,062,226	2,085,225	2,108,805	2,125,635	2,149,260	2,165,595
7	Konya	1,959,082	1,969,868	1,992,675	2,013,845	2,038,555	2,052,281	2,079,225	2,108,808
8	Gaziantep	1,560,023	1,612,223	1,653,670	1,700,763	1,753,596	1,799,558	1,844,438	1,889,466
9	Şanlıurfa	1,523,099	1,574,224	1,613,737	1,663,371	1,716,254	1,762,075	1,801,980	1,845,667
10	Mersin	1,595,938	1,602,908	1,640,888	1,647,899	1,667,939	1,682,848	1,705,774	1,727,255
11	Kocaeli	1,437,926	1,490,358	1,522,408	1,560,138	1,601,720	1,634,691	1,676,202	1,722,795
12	Diyarbakır	1,460,714	1,492,828	1,515,011	1,528,958	1,570,943	1,592,167	1,607,437	1,635,048
13	Hatay	1,386,224	1,413,287	1,448,418	1,480,571	1,474,223	1,483,674	1,503,066	1,519,836
14	Manisa	1,319,920	1,316,750	1,331,957	1,379,484	1,340,074	1,346,162	1,359,463	1,367,905
15	Kayseri	1,165,088	1,184,386	1,205,872	1,234,651	1,255,349	1,274,968	1,295,355	1,322,376
16	Samsun	1,228,959	1,233,677	1,250,076	1,252,693	1,251,729	1,251,722	1,261,810	1,269,989
17	Balıkesir	1,118,313	1,130,276	1,140,085	1,152,323	1,154,314	1,160,731	1,162,761	1,189,057
18	Kahramanmaraş	1,004,414	1,029,298	1,037,491	1,044,816	1,054,210	1,063,174	1,075,706	1,089,038
19	Van	979,671	1,004,369	1,022,310	1,035,418	1,022,532	1,051,975	1,070,113	1,085,542
20	Aydın	946,971	965,500	979,155	989,862	999,163	1,006,541	1,020,957	1,041,979
21	Denizli	907,325	917,836	926,362	931,823	942,278	950,557	963,464	978,700
22	Sakarya	835,222	851,292	861,570	872,872	888,556	902,267	917,373	932,706
23	Tekirdağ	728,396	770,772	783,310	798,109	829,873	852,321	874,475	906,732
24	Muğla	766,156	791,424	802,381	817,503	838,324	851,145	866,665	894,509
25	Eskişehir	724,849	741,739	755,427	764,584	781,247	789,750	799,724	812,320
26	Mardin	745,778	750,697	737,852	744,606	764,033	773,026	779,738	788,996
27	Erzurum	784,941	774,967	774,207	769,085	780,847	778,195	766,729	763,320
28	Malatya	722,065	733,789	736,884	740,643	757,930	762,366	762,538	769,544
29	Trabzon	740,569	748,982	765,127	763,714	757,353	757,898	758,237	766,782
30	Ordu	715,409	719,278	723,507	719,183	714,390	741,371	731,452	724,268

Source: http://tr.wikipedia.org/wiki/T%C3%BCrkiye%27deki_b%C3%BCy%C3%BCk%C5%9Fehir_belediyelerinin_n%C3%BCfuslar%C4%B1

Appendix E: Detailed Methodology for Cost Calculations

Purpose

The purpose of the modeling exercise is to estimate the investments and O&M costs of bringing wastewater collection and treatment in Turkey into compliance with standards under different scenarios. This section presents the detailed methodology used to build the model and carry out the cost estimate calculations, and it documents the origin of the data.

Data used

The data used for the cost assessment was drawn from publicly available sources documented below.

List of Municipalities and Population Data

Data from the General Directorate of Local Administration (GDLA) of the Ministry of Interior (MoI) was downloaded on March 24, 2016, from the following website:

http://www.migm.gov.tr/kurumlar/migm.gov.tr/BELED%C4%B0YELER/Belediye_listesi_2015.xlsx

The data includes a list of Municipalities in Turkey with a breakdown of different types (Metropolitan Municipality, Metropolitan Sub-Province, Province, Sub-Province, and Belde) together with population figures for 2015 published by TURKSTAT. The data also provides information on the Geographical Region where each municipality is located and the names of mayors and political parties.

2013 and 2014 Municipal population data was downloaded from the GDLA website on May 27, 2015:

http://www.migm.gov.tr/kurumlar/migm.gov.tr/BELED%C4%B0YELER/belediye_listesi_2014_site.xlsx

The 2014 population data was used for the assessments to ensure consistency with the use of financial information from published 2014 annual reports of General Directorates of Water and Sewage Administrations (SKIs) of Metropolitan Municipalities and to insure comparability of the ratios calculated.

Existing Infrastructure

The existing infrastructure data was collected mainly from two sources:

- The River Basin Protection Action Plans (RBPAP) reports; and

- The draft By-law on Sensitive Water Bodies (hereinafter referred to as “draft By-law”).

RBPAP reports: Only 20 of the 25 RBPAP reports were publicly available on the website of the General Directorate of Water Management (GDWM) of the MoFWA:

http://www.suyonetimi.gov.tr/AnaSayfa/eylemplanlari/eylem_planlari.aspx?sflang=tr

RBPAPs were not available online for the Meriç-Ergene, Asi, Dicle-Fırat, Çoruh, and Aras river basins.

The reports provide information on existing infrastructure for wastewater treatment plants (WWTPs) and wastewater collection networks. On WWTPs, they provide the status and the treatment level as defined in Table E.1 below. They also present if wastewater networks exist and the coverage rate.

Table E.1: Indicators Used in RBPAP Reports for Wastewater Treatment Plant (WWTP) Status

WWTP Status	Description
0	No WWTP
1	Primary Treatment (Physical / Natural treatment)
2	Secondary Treatment (Carbon Removal)
3	Tertiary Treatment (N, P Removal)

Draft By-law: Announced by GDWM-MoFWA on May 4, 2016, it is publicly available at the link:

http://www.suyonetimi.gov.tr/Libraries/su/Hassas_Alan_Yc3b6netmelik__Taslac49fc4b1_3.sflb.ashx

The draft By-law proposes a revised list of "sensitive water bodies". Annex 7 of the draft (see below) provides data on existing WWTP and level of treatment for each municipality. It also suggests treatment levels and protection measures for areas identified as "Urban Vulnerable Zones" in all 25 river basins.

For the purpose of the assessment:

- WWTP treatment levels were coded as presented in Table E.2.

Table E.2: Existing WWTP Status Information from Draft By-law and Code Used in the Assessment

Draft By-law classification of WWTP treatment levels	Code used for the cost assessment	Process Description
Advanced WWTP	3	Tertiary Treatment (N, P Removal)
Con. stage, N & P removal	3	Tertiary Treatment (N, P Removal)
Construction stage	0	No WWTP
N & P removal	3	Tertiary Treatment (N, P Removal)
No WWTP	0	No WWTP
Primary	1	Primary Treatment (Physical / Natural treatment)
Secondary WWTP	2	Secondary Treatment (Carbon Removal)

- Existing wastewater collection network and coverage data is taken from the published RBPAPs. If plans do not include coverage data, it is assumed that there is no wastewater collection network in place.

- Data on existence and treatment levels of wastewater treatment plants by municipality is derived from the draft By-law on Sensitive Water Bodies. If not available, RBPAP data is used. If there is no RBPAP data, it is assumed that the municipality has no wastewater treatment plant in place.

Data on Sensitive Areas

Data on "Sensitive Areas" is based on 2 sources, which are included as two options in the model:

- The "Communiqué on Sensitive and Less Sensitive Water Areas" related to the By-law on Urban Wastewater Treatment (published on Official Journal dated 27 June 2009 and No. 27271), which informs option A for Sensitive areas in the model; and

- The revised "sensitive areas" defined in the draft By-law on "Sensitive Water Bodies" announced by GDWM on May 4, 2016, (pending approval), which informs option B for Sensitive areas in the model.

The list of areas defined as "Sensitive" in each document is presented in the boxes below, Box E-1 for Option A and Box E.2 for Option B.

Determination of Discharge Location for Municipalities

Google map was used to identify the likely treated wastewater discharge sites for each municipality and the urban population connected to a WWTP. This enabled determination of the required treatment level.

A specific analysis was carried out for municipalities with populations of less than 10,000 and less than 2,000 to determine which municipalities of less than 2,000 are likely to discharge into estuaries and which municipalities with populations of less than 10,000 are likely to discharge into coastal waters. These are important drivers to define their level and costs of treatment. The results are described below.

Estuaries: In order to locate municipalities with populations of less than 2000 and discharging to estuaries:

- A filter was used to isolate municipalities with populations of less than 2,000 and located in coastal areas. Five met these criteria: Bartın (Kurucaşile municipality), Giresun (Çavuşlu municipality); Kastamonu (Doğanyurt municipality); Kırklareli (Kıyıköy municipality) and Zonguldak (Gümeli municipality).

- Out of the five, four are located at estuaries: Giresun; Kastamonu; Kırklareli, and Zonguldak.

Coastal Waters: Municipalities with populations of less than 10,000 and discharging into coastal waters

- A filter was used which isolated 37 such municipalities, including those with less than 2,000.

Box E.1: "Sensitive Areas" as Defined in the Communiqué in Force – Option A in the Model

Annex 1A Sensitive Basins

All municipalities within Akarçay, Burdur, Konya, and Van Lake river basins are defined as "Sensitive"

Using the Ilısu dam reservoir figure from ENCON archives and checking from Google Earth; Batman (Beşiri, İkiköprü, Hasankeyf, Balpınar, Batman municipalities), Diyarbakır (Bağlar, Bismil, Kayapınar, Silvan, Sur, Yenişehir municipalities), Mardin (Dargeçit municipality), Siirt (Kayabağlar, Kurtalan, Siirt, and Gökçebağ municipalities) are assigned as "Sensitive Area".

Annex 1B Sensitive Drinking water

A list of dams constructed by DSI between 1936 and 2014 are publicly available on the DSI webpage. http://www.dsi.gov.tr/docs/resmi-i-statistikler/2-3-1-illere-g%C3%B6reyap%C4%B1m%C4%B1-tamamlanan-barajlar-ve-faydalar%C4%B1-1936-2014.xls?sfvrsn=4

Using Google map, the list of municipalities potentially discharging into dam reservoirs used for drinking water purposes and therefore identified as "Sensitive Drinking Water" are as follows, per province:

- In the province of İstanbul, Alibey, Büyükçekmece, Sazlıdere, and Ömerli dams provide drinking water. İstanbul (Arnavutköy, Büyükçekmece, Çatalca Çekmeköy, and Pendik municipalities) are thus "Sensitive".

- In Diyarbakır, Dicle Dam provides drinking water, and Diyarbakır (Dicle and Eğil municipalities) are "Sensitive".

- Şanlıurfa - Atatürk Dam; Diyarbakır (Çüngüş Municipality), Şanlıurfa (Hilvan, Bozova municipalities), Adıyaman (Gerger, Akıncılar, Kahta, Adıyaman, and Samsat municipalities) are assigned as "Sensitive".

- Samsun - Suat Uğurlu Dam; Samsun (Ayvacık municipality) is assigned as “Sensitive Drinking Water”.

- Kırıkkale - Kapulukaya Dam; Kırıkkale (Hacılar and Karakeçili municipalities) are assigned as “Sensitive”.

- Kahramanmaraş - Kartalkaya Dam; Kahramanmaraş (Pazarcık municipality) is assigned as “Sensitive”.

- Afyon - Akdeğirmen Dam; Afyon (Düzağaç municipality) is assigned as “Sensitive Drinking Water”.

- Yalova - Gökçe Dam; Yalova (Termal municipality) is assigned as “Sensitive Drinking Water”.

- İzmir - Tahtalı Dam; İzmir (Menderes municipality) is assigned as “Sensitive Drinking Water”.

- Denizli - Gökpınar Dam; Denizli (Pamukkale, Merkezefendi municipalities) are assigned as “Sensitive”.

Annex 1C –Bay, Gulf and Coasts and related municipalities identified as “Sensitive Coastal areas”

- İskenderun – Mersin – Mezitli: Hatay (İskenderun and Dörtyol municipalities), Adana (Karataş, Yumurtalık municipalities), Mersin (Akdeniz, Mezitli, Toroslar, and Yenişehir municipalities);

- Mersin Kızkalesi – Taşucu Burnu: No specific municipality;

- Fethiye Bay: Muğla (Fethiye municipality);

- Marmaris Bay: Muğla (Marmaris municipality);

- Güvercinlik Didim: Aydın (Didim municipality);

- Karaburun – İzmir Gulf (Foça): İzmir (Balçova, Bayraklı, Bornova, Buca, Çiğli, Gaziemir, Güzelbahçe, Karabağlar, Karşıyaka, Konak, Narlıdere, and Urla municipalities);

- Aliağa Bay: İzmir (Dikili municipality);

- Ayvalık – Altınoluk: Balıkesir (Ayvalık, Burhaniye, and Edremit municipalities);

- Bandırma Gulf: Balıkesir (Bandırma municipality);

- Gemlik Gulf – İstanbul Bosphorus East entrance: Bursa (Gemlik and Mudanya municipalities), Yalova (Armutlu, Çınarcık, Esenköy, Koru, Yalova, Kadıköy, Çiftlikköy, Taşköprü, Altınova, Kaytazdere, Subaşı, and Tavşanlı municipalities), Kocaeli (Başiskele, Çayırova, Darıca, Derince, Dilovası, Gebze, Gölcük, İzmit, Kandıra, Karamürsel, Kartepe, and Körfez municipalities), İstanbul (Ataşehir, Beykoz, Çekmeköy, Sancaktepe, Sultanbeyli, Ümraniye, Üsküdar, Kadıköy, Kartal, Maltepe, Pendik, and Tuzla municipalities);

- İstanbul Bosphorus West entrance – Büyükçekmece: İstanbul (Avcılar, Arnavutköy, Bağcılar, Bahçelievler, Bakırköy, Başakşehir, Bayrampaşa, Beylikdüzü, Büyükçekmece, Çatalca, Esenler, Esenyurt, Fatih, Güngören, Küçükçekmece, and Zeytinburnu);

- Between Ünye – Samsun – Bafra: Ordu (Ünye municipality), Samsun (Ondokuzmayıs, Atakum, Canik, İlkadım, and Tekkeköy municipalities);

- Haliç Gulf: İstanbul (Beşiktaş, Beyoğlu, Gaziosmanpaşa, Sarıyer, Sultangazi, Şişli, Kağıthane, Eyüp, and Fatih municipalities);

1-Other

Are assigned as “1-Other” all municipalities which have:

- A population of less than 2,000 but NOT discharging to an estuary

- A population of less than 10,000 but NOT discharging to coastal water

- A population of more than 10,000 but NOT identified in any of the above Annex 1A, 1B and 1C

1,062 municipalities are in this category, which means that they discharge in a non-sensitive area.

Box E.2. "Sensitive Areas" according to the Draft By-law – Option B in the Model

The draft By-law includes in its Annex 7 a comprehensive list of areas defined for each river basin as "Urban Vulnerable Zones". The Annex defines vulnerability according to three main criteria:

- Urban Wastewater Management Measures
- Industrial Wastewater Management
- Solid Waste Management

For the purpose of the assessment, urban zones listed as vulnerable because they need "Urban Wastewater Management Measures" were considered as "Sensitive areas". For each municipality listed in the "Urban Vulnerable Zone" table, Annex 7 also presents information regarding "Existing Status," "WWTP name," and "Measure required." The measures required suggest the treatment system to implement including "Secondary treatment," "N&P removal," "Monitoring & Audit" or "Sea Outfall."

This data was entered into the model to define the "Sensitive Areas" and the respective treatment levels.

Determination of Urban Centers (MAs)

In order to be able to determine the required level of treatment, it is necessary to determine the population that will be connected to a treatment plant. It is known that in metropolitan sub-province municipalities, the address-based population figures from TURKSTAT represent the entire population living in the sub-province. However, a portion of this population is living in smaller and dispersed settlements, which may be subject to less stringent treatment requirements than larger and densely populated urban settlements. The latter urban settlements often cover more than one metropolitan sub-province municipality, yet it may make sense to channel their wastewater to a common WWTP. Therefore, the appropriate approach to determine wastewater treatment is to define the "Metropolitan Areas" (MA) which will share the same WWTP in each MM. This concerned only municipalities consolidated into MMs as part of the March 2014 reform.

Population data for municipalities now belonging to MMs was adjusted by multiplying the urban population percentage from 2012 with the population figures in 2014. The address-based population data in 2012 for the 30 provinces, where metropolitan municipalities exist, was obtained from TURKSTAT (source: https://biruni.tuik.gov.tr/medas/?kn=95&locale=en). The treatment level required is determined according to the adjusted population estimate.

Furthermore, in order not to overestimate the investment requirements in metropolitan municipalities, a correcting factor was introduced to account for the share of the population living in smaller and dispersed settlements and in rural areas, so that only the population located in an urban area is considered in the determination of the treatment level and the collection and treatment costs. This calculation was made using TURKSTAT population data for 2012 includes percentages of urban versus rural population, adjusted to account for 2014 population figures.

For municipalities outside MM borders, it is known that the municipal population represents the urban settlement around a nucleus and the population is considered concentrated. Thus, the entire municipal population was used to determine the treatment levels in each scenario.

Scenarios and the Required Treatment Levels

The calculation was made based on three main scenarios and two options for "sensitive area" (A or B), resulting in cost calculations in six different scenarios. These are shown in Table E.3 below.

Table E.3: Description of Scenarios Used in the Assessment

Scenario No	Scenario Name	Scenario Description
S1A	EU-UWWD Requirements (sensitive areas as in Communique)	Treatment level determined in accordance with the requirements of the EU- Urban Wastewater Directive
S2A	Turkish regulation-1 (sensitive areas as in Communique)	Both By-law on Urban Wastewater Treatment and By-law on Water Pollution Control are considered, and treatment level is determined considering whichever is more stringent. In this scenario, no additional Nitrogen removal is assumed if the discharge location is not in a sensitive area.
S3A	Turkish regulation-2 (sensitive areas as in Communique)	As for S2, both the By-law on Urban Wastewater Treatment and the By-law on Water Pollution Control are considered, and treatment level is determined considering whichever is more stringent for each parameter. In this scenario, Nitrogen removal is imposed in addition to secondary treatment for any discharge, even outside sensitive areas, for settlements having a population above 50,000.
S1B	EU-UWWD Requirements (urban sensitive areas: draft By-law)	Same treatment levels as above for each scenario. The sensitivity areas are as defined in the draft By-law prepared by GDWM MoFWA and pending approval.
S2B	Turkish regulation-1 (urban sensitive areas: draft By-law)	
S3B	Turkish regulation-2 (urban sensitive areas: draft By-law)	

The difference between scenarios S1A & S1B, S2A & S2B, and S3A & S3B is the determination of sensitive areas. In Option A, sensitive areas are determined according to the communiqué in force. In Option B, sensitive areas correspond to the draft-By-law published as described above.

The S1 group mainly considers the EU UWWD requirements for wastewater treatment levels, whereas S2 and S3 correspond to published and applied Turkish regulations, respectively. The main difference between S2 and S3 groups is the practice of requiring that Nitrogen removal be added to secondary treatment for all settlements with populations above 50,000; even if not within a sensitive area.

The treatment level required for each scenario was decided based on the population of the Metropolitan Areas or Municipalities, as relevant, and the sensitivity of the discharge location. (See Table E.4)

Table E.4: Treatment Requirements for the Scenarios

Population	Discharge location	SCENARIO 1A & 1B EU requirements	SCENARIO 2A & 2B TR requirements 1	SCENARIO 3A & 3B TR requirement 2
< 2,000	Fresh water / estuary	Primary treatment	Secondary treatment	Secondary treatment
< 2,000	Coastal water	Primary treatment	Secondary treatment	Secondary treatment
< 2,000	Sensitive area	Secondary treatment	Secondary treatment	Secondary treatment
< 2,000	Other		Secondary treatment	Secondary treatment
2,000 – 10,000	Fresh water / estuary	Secondary treatment	Secondary treatment	Secondary treatment
2,000 – 10,000	Coastal water	Primary treatment	Secondary treatment	Secondary treatment
2,000 – 10,000	Sensitive area	Secondary treatment	Secondary treatment	Secondary treatment
2,000 – 10,000	Other		Secondary treatment	Secondary treatment
10,000 – 50,000	Fresh water / estuary	Secondary treatment	Secondary treatment	Secondary treatment
10,000 – 50,000	Coastal water	Secondary treatment	Secondary treatment	Secondary treatment
10,000 – 50,000	Sensitive area	Tertiary treatment	Tertiary treatment	Tertiary treatment
10,000 – 50,000	Other	Secondary treatment	Secondary treatment	Secondary treatment
50,000 – 100,000	Fresh water / estuary	Secondary treatment	Secondary treatment	Secondary treatment + Nitrogen Removal
50,000 – 100,000	Coastal water	Secondary treatment	Secondary treatment	Secondary treatment + Nitrogen Removal
50,000 – 100,000	Sensitive area	Tertiary treatment	Tertiary treatment	Tertiary treatment
50,000 – 100,000	Other	Secondary treatment	Secondary treatment	Secondary treatment + Nitrogen Removal
> 100,000	Fresh water / estuary	Secondary treatment	Secondary treatment	Secondary treatment + Nitrogen Removal
> 100,000	Coastal water	Secondary treatment	Secondary treatment	Secondary treatment + Nitrogen Removal
> 100,000	Sensitive area	Tertiary treatment	Tertiary treatment	Tertiary treatment
> 100,000	Other	Secondary treatment	Secondary treatment	Secondary treatment + Nitrogen Removal

Cost Calculations

The cost calculations consider both investment costs and operation and maintenance (O&M) costs for WWTP and wastewater collection networks facilities. For the calculations FEASIBLE[22] model cost functions and the cost functions used in RBPAP reports[23] were evaluated. It was decided to use the cost functions from the FEASIBLE model as they provide differentiated costs per treatment levels for WWTPs; allow estimating the wastewater collection network investments and evaluate O&M costs.

FEASIBLE Cost Functions Used

The following cost functions listed in Table E.5 were used to calculate the new WWTP investment costs.

Noteworthy: The FEASIBLE model assumes the same investment cost for treatment levels 3 (tertiary treatment) and 4 (nitrogen removal added to secondary treatment).

22 http://www.oecd.org/env/outreach/methodologyandfeasiblecomputermodel.htm
FEASIBLE is a software tool developed to support the preparation of environmental financing strategies for water, wastewater, and municipal solid waste services. The name FEASIBLE stands for: Financing for Environmental, Affordable and Strategic Investments that Bring on Large-scale Expenditure. The FEASIBLE model is freeware and can be obtained through the web pages of the OECD, DEPA/DANCEE and COWI. FEASIBLE can be used to facilitate the iterative process of balancing the required financing with the available financing. It provides a systematic, consistent, and quantitative framework for analyzing feasibility of financing environmental targets. Being a computerized model, FEASIBLE may be used to analyze "what if" a certain policy is changed and to document its financial impacts in a systematic and transparent manner.

23 Annex 5 of the Marmara Basin Protection Action Plan Report, describing the methodology of WWTP cost calculations.

Table E.5: Cost functions to Calculate Capital Expenditure of WWTP Investments

Treatment level	Treatment type	Population range	Function
1	Primary Treatment	400 - 2,000	EUR/cap. = 10^(-0.2745*log(PE)+3.8605)/7.44
1	Primary Treatment	2,000 – 100,000	EUR/cap. = 10^(-0.2073*log(PE)+3.6385)/7.44
2	Secondary Treatment	400 - 2,000	EUR/cap. = 10^(-0.4307*log(PE)+4.6769)/7.44
2	Secondary Treatment	2,000 – 100,000	EUR/cap. = 10^(-0.2808*log(PE)+4.1823)/7.44
2	Secondary Treatment	> 100,000	EUR/cap. = 80,6
3	Tertiary Treatment	400 - 2,000	EUR/cap. = 10^(-0.5015*log(PE)+5.1178)/7.44
3	Tertiary Treatment	2,000 – 100,000	EUR/cap. = 10^(-0.2722*log(PE)+4.3608)/7.44
3	Tertiary Treatment	> 100,000	EUR/cap. = 134,4
4	N removal in addition to Secondary Treatment	400 - 2,000	EUR/cap. = 10^(-0.5015*log(PE)+5.1178)/7.44
4	N removal in addition to Secondary Treatment	2,000 – 100,000	EUR/cap. = 10^(-0.2722*log(PE)+4.3608)/7.44
4	N removal in addition to Secondary Treatment	> 100,000	EUR/cap. = 134,4

Source: FEASIBLE Model, version 2, User Manual and Documentation Appendix 3: Documentation of Expenditure Functions-Wastewater

Since the FEASIBLE model uses international unit prices, the estimates using the above cost functions in Table E.5 results in higher investments costs compared to the WWTP costs known to the team. In order to better align price levels with those of the Turkish market, FEASIBLE unit costs were compared to benchmarks from previous WB and EU feasibility studies and to publicly available award values for recent WWTP contracts.

On the other hand, calculated O&M costs were much lower in comparison with the experience of the team as well as the values published by TUIK for environmental expenditure and the values provided in annual reports of SKIs for expenditures. This analysis allowed developing the adjustments coefficient presented in Table E.6 below.

Table E.6: Coefficients for Converting FEASIBLE Model Cost Estimates to Turkish Market Level

Population range	Investment Coefficients	O&M Coefficients
< 10,000	0.50	2,50
100,000 – 250,000	0.40	3,00
250,000 – 500,000	0.33	3,50
>500,000	0.25	5,00

Investment costs in new wastewater collection networks were estimated based on the total length and distribution of pipe diameter within the network, using the following functions:

- If Pop. < 50 000 then L = Pop.*(-0.00005833*Pop+4.92)
- If 50 001 < Pop. < 500 000 then L = Pop.*(-0.000000278*Pop+2.14)
- If Pop. > 500 001 then L = 0.75*Pop.

Depending on the network size, pipe diameter distribution is given as follows in Table E.7:

Table E.7: Sewage Network Distribution of Length on Diameter Groups and Indicative Costs

Pop.	Length (m)	Distribution of length on diameter groups (%)				Total (%)
		≤ 500	501-1000	1001-1500	>1500	
< 1,000	≤ 5,000	100	0	0	0	100
1,000 – 12,000	5,001 – 50,000	100	0	0	0	100
12,000 – 666,000	50,001 – 500,000	90	7	3	0	100
>666,000	> 500,000	88	8	3,5	0,5	100

Source: FEASIBLE Model, version 2, User Manual and Documentation Appendix 3: Documentation of Expenditure Functions-Wastewater & Consultant's experience

The O&M costs for WWTP and wastewater collection networks were estimated using the functions and estimations shown below in Tables E.8, E.9, and E.10.

Table E.8: Calculation of Operational Expenditure of WWTP Investments

Treatment level	Treatment type	Function
1	Primary Treatment	15 kWh/year/cap. + 3% of CAPEX
2	Secondary Treatment	25 kWh/year/cap. + 3% of CAPEX
3	Tertiary Treatment	40 kWh/year/cap. + 3% of CAPEX
4	N removal in addition to Secondary Treatment	40 kWh/year/cap. + 3% of CAPEX

Source: FEASIBLE Model, version 2, User Manual Appendix 3: Documentation of Expenditure Functions-Wastewater

Table E.9: Calculation of Operational Expenditure of Wastewater Collection Network Investments

Item	Function
Wastewater collection system (for agglomerations ≤ 10,000)	2% of CAPEX
Wastewater collection system (for agglomerations > 10,000)	1% of CAPEX

Source: FEASIBLE Model, version 2, User Manual Appendix 3: Documentation of Expenditure Functions-Wastewater

Unit Costs and Other Assumptions

Table E.10: Unit Costs Used in the Calculation of Operational Expenditure of WWTP investments

Item	Unit	Value
Wastewater collection pipe D<500 mm	EUR/m	90
Wastewater collection pipe 501 < D < 1000 mm	EUR/m	175
Wastewater collection pipe 1001 < D < 1500 mm	EUR/m	400
Wastewater collection pipe D> 1500 mm	EUR/m	700
Useful life of a WWTP	Years	30
Unit cost of electricity	EUR/kWh	0.100

Source: Consultant's estimation based on recent WB & EU feasibility studies and RBPAP reports

The following aspects were not assessed or estimated in the calculations:

- Topographical and geotechnical aspects, due to the lack of data

- The costs of discharge (submarine outfall or discharge pipe) and the costs of sludge management transport and disposal that were not included, due to a lack of benchmarks (estimates were proposed)

- The cost of decentralized or on-site sanitation in rural areas that could not be estimated

- The costs and benefits related to biogas digestion where it makes sense that could not be estimated.

Calculating Costs for Sea Outfalls

All municipalities located at the coastline were screened using Google Earth and the Internet to assess if there is an existing sea outfall used by the municipality and also to decide if the receiving body for wastewater discharge is either a sea or a river. To calculate the costs related to sea outfall investment and operation the team used pipe diameters listed in Table E.11 below for settlements with populations of up to 500,000 inhabitants.

Table E.11: Sea Outfall Pipe Diameter for Different Population Ranges

Population range	Sea outfall pipe diameter (mm)
<20,000	250
20,000 - 50,000	400
50,000 - 100,000	600
100,000 - 500,000	1,000

Source: Consultant's estimation

Then for each sea surrounding the coasts of Turkey, a unique sea outfall length was estimated. The investment cost of the sea outfall was finally determined according to the determined pipe diameter and sea outfall length for each population range as shown in Table E.12 below.

Table E.12: Sea Outfall Investment Costs in EUR for Different Receiving Bodies and Population Ranges

Receiving Body	Length of Sea Outfall (m)	Population range			
		<20k	20-50k	50-100k	100-500k
Black Sea	1500	680,000	1,000,000	1,500,000	3,500,000
Marmara Sea	1000	630,000	880,000	1,300,000	3,000,000
Aegean Sea	1000	630,000	880,000	1,300,000	3,000,000
Mediterranean Sea	2000	730,000	1,150,000	1,800,000	4,200,000

Source: Consultant's estimations and calculation based on market prices

In eight urban centers with populations of more than 500,000 inhabitants, a calculation was made for those separately and the following costs were used, as shown in Table E.13.

Table E.13: Sea Outfall Investment Costs for Urban Centers with Populations over 500,000 Inhabitants

Metro Urban Centre	Population in Urban Centre (2014)	Receiving Sea Water Name	Outfall Cost (EUR)
Antalya	858,848	Mediterranean Sea	6,000,000
Istanbul W	6,846,458	Marmara Sea	12,000,000
Istanbul S	2,212,156	Marmara Sea	6,000,000
Istanbul ES	1,102,470	Marmara Sea	5,500,000
Istanbul E	2,768,992	Marmara Sea	7,500,000
İzmit	889,898	Marmara Sea	4,500,000
Darica	580,477	Marmara Sea	3,500,000
Mersin	623,893	Mediterranean Sea	4,500,000

Source: Consultant's estimations and calculation based on market prices

The O&M costs for sea outfalls are estimated as 3 percent of the investment costs.

Sludge Disposal Costs

For ease of calculation, it is assumed that the sludge generated in WWTP facilities meets the regulatory requirements for final disposal to landfills. Then the O&M costs for the disposal of sludge will include transport of sludge to landfill and the price for final disposal. The following assumptions shown in Table E.14 were made for cost calculation.

Table E.14: Main Assumptions for Sludge Disposal Costs

Item	Unit	Value
Distance to landfill	Km	20
Unit cost for transportation	EUR/ton/km	15
Unit cost for final disposal	EUR/ton	75

Source: Consultant's estimation based on market prices

In order to calculate the sludge disposal costs, the sludge production rates that were used for different treatment methods are listed in Table E.15, and the wastewater generation rates that were used for different population ranges are listed in Table E.16.

Table E.15: Sludge Production Rate for Different Treatment Types

Treatment level	Treatment type	Sludge produced (kg/1000 m^3 of wastewater)
0	No Treatment	0
1	Primary Treatment	150
2	Secondary Treatment	100*
3	Tertiary Treatment	400
4	N removal in addition to Secondary Treatment	350

Source: Tchobanoglous, Wastewater Engineering: Treatment and Reuse

* Assuming that extended aeration is used for secondary treatment purposes

Table E.16: Wastewater Generation for Different Population Ranges

Population range	Wastewater generation (l/cap/day)
<20,000	120
20,000 - 50,000	140
50,000 - 100,000	160
100,000 - 500,000	180
>500,000	200

Source: Consultant's estimation

Calculations of Costs during Useful Life of Required Investments

To assess the financial impacts, incremental O&M and investment amortization cost calculations were made over the useful life of these investments using the assumptions shown in Table E.17.

Table E.17: Assumptions for O&M and Amortization Cost Calculations

Item	Unit	Value
Inflation rate	%	3
Projection period	years	50
Useful life of civil works	years	50
Useful life of equipment works	years	15
Percentage of civil work in WWTP investments	%	60
Percentage of civil work in WW collector investments	%	80
Percentage of civil work in sea outfall investments	%	80
Percentage of equipment in WWTP investments	%	40
Percentage of equipment in WW collector investments	%	20
Percentage of equipment in sea outfall investments	%	20

Source: Consultant's estimation

Required Investment and O&M Costs

Investment and O&M costs for urban centers were estimated after assessing the existing infrastructure to determine whether it meets treatment level requirements for each scenario, as is shown in Tables E.18 through E.20 below.

Table E.18: Deciding the Required or Existing Investment and O&M Costs for WWTP Facilities

Item	Is WWTP investment required according to the scenario considered?	Is there an existing WWTP sufficient for the requirement?	Investment Cost	O&M cost
WWTP investment	YES	YES	Calculated as existing investment	Calculated as existing O&M
	YES	NO	Calculated as required investment	Calculated as required O&M
	NO	YES	Calculated as existing investment	Calculated as existing O&M
	NO	NO	Not Calculated	Not Calculated

Table E.19: Deciding the Required or Existing Investment and O&M Costs for Wastewater Collection Network

Item	1-Is there an existing network	Investment cost	O&M cost
WW collection network	YES	The covered % is calculated as existing investment Not covered % is calculated as required investment	Existing O&M calculated for covered % Required O&M calculated for not covered %
	NO	Calculated as required investment	Calculated as required O&M cost

Table E.20: Deciding the Required or Existing Investment and O&M Costs for Sea Outfall Facilities

Item	Is the receiving body seawater or not?	Is the existing WWTP sufficient to meet the standard?	Investment Cost	O&M cost
Sea Outfall Investment	YES	YES	Calculated as existing investment	Calculated as existing O&M
	YES	NO	Calculated as required investment	Calculated as required O&M
	NO	YES	Not Calculated	Not Calculated
	NO	NO	Not Calculated	Not Calculated

Appendix F: EU and Turkish Water and Sanitation Standards

Table F.1: Summary of EU and Turkish Drinking Water Treatment Parameters

Parameter (see Note 1)	Parameter Value		Unit
	EU Drinking Water Directive	Turkish Regulation No. 25730	
Microbiological Parameters			
Escherichia coli (E.coli)	0	0	(number/100 ml)
Enterococci	0	0	(number/100 ml)
Chemical Parameters			
Antimony	5.0	5.0	µg/l
Arsenic	10	10	µg/l
Benzene	1.0	1.0	µg/l
Benzo(a)pyrene	0.010	0.010	µg/l
Boron	1.0	1.0	mg/l
Bromate	10	25	µg/l
Cadmium	5.0	5.0	µg/l
Chromium	50	50	µg/l
Copper	2.0	2.0	mg/l
Cyanide	50	50	µg/l
1.2-dichloroethane	3.0	3.0	µg/l
Fluoride	1.5	1.5	mg/l
Lead	10	25	µg/l
Mercury	1.0	1.0	µg/l
Nickel	20	20	µg/l
Nitrate	50	50	mg/l
Nitrite	0.50	0.50	mg/l
Pesticides-individual	0.10	0.10	µg/l
Pesticides – Total	0.50	0.50	µg/l
Polycyclic Aromatic Hydrocarbons	0.10	0.10	µg/l
Selenium	10	10	µg/l
Tetrachloroethene and Trichloroethene	10	10	µg/l
Trihalomethanes – Total	100	150	µg/l
Indicator Parameters			
Aluminium	200	200	µg/l
Ammonium	0.50	0.50	mg/l
Chloride	250	250	mg/l
Clostridium perfringens (including spores)	0	0	(number/100 ml)
Colour	Acceptable	-	-
Conductivity	2 500	2 500	µS/ cm at 20 °C
Hydrogen Ion Concentration	>6.5 and < 9.5	>6.5 and < 9.5	pH units
Iron	200	200	µg/l
Manganese	50	50	µg/l
Odour	Acceptable	-	-

Oxidisability	5.0	5.0	mg/l O2
Sulphate	250	250	mg/l
Sodium	200	200	mg/l
Taste	Acceptable	-	-
Colony count 22 Deg. C	No abnormal change	-	
Coliform bacteria	0	0	number/100 ml
Total organic carbon (TOC)	No abnormal change	-	mg/l
Turbidity	Acceptable (not exceeding 1.0 NTU for surface water treatment)	-	NTU
Free Residual Chlorine	-	0.5	mg/l
Radioactivity Parameters			
Tritium	100		Bq/l
Total Indicative Dose	0.10		mSv/year

Table F.2: Product Specified Parameters Acrylamide. Epichlorohydrin and Vinylchloride

Parameter	EU Drinking Water Directive Parameter Value	Turkey Regulation
Acrylamide	0.10 µg/l	0.10 µg/l
Epichlorohydrin	0.10 µg/l	0.10 µg/l
Vinylchloride	0.50 µg/l	0.50 µg/l

Table F.3. Comparison of Treatment Requirements by EU and TR Legislation and Common Practice

Population (population equivalent)	Discharge location	EU Urban Wastewater Directive Requirements (Base Standard for Scenario 1 in chapter 4)	By-law No. 26047 on Urban WW Treatment (2006) By-law UWWT-1	By-law No. 27271 on Sensitive Areas (2009) By-law UWWT-2[24]	By-law No. 26786 on Water Pollution Control (2008) By-law WPC	Most stringent requirements of By-law UWWT-1 and By-law WPC (Base for Scenario 2)	Most stringent requirements of By-law UWWT-2 and By-law WPC (Base for Scenario 3)
< 84	Fresh water / estuary	Primary treatment BOD_5: min 20% removal COD: TSS: min 50% removal TN: TP:	Decided by relevant administration	Decided by relevant administration		Decided by relevant administration	Decided by relevant administration
< 84	Coastal water	Primary treatment BOD_5: min 20% removal COD: TSS: min 50% removal TN: TP:	Decided by relevant administration	Decided by relevant administration		Decided by relevant administration	Decided by relevant administration
< 84	Sensitive area	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: No set standard TP: No set standard	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: TP:	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: TP:		Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: TP:	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: TP:
< 84	Less Sensitive Area	N/A	N/A	N/A	N/A	N/A	N/A
84 – 2,000	Fresh water / estuary	Primary treatment BOD_5: min 20% removal COD: TSS: min 50% removal TN: TP:	Decided by relevant administration	Decided by relevant administration	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:
84 – 2,000	Coastal water	Primary treatment BOD_5: min 20% removal COD: TSS: min 50% removal TN: TP:	Decided by relevant administration	Decided by relevant administration	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:
84 – 2,000	Sensitive area	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: No set standard TP: No set standard	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: TP:	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:

24 In practice, Turkish authorities request Nitrogen removal in addition to secondary treatment for any discharge, even outside sensitive areas, for settlements having a population above 50,000.

* Consultant interpretation of the treatment level required, based on the BOD5 abatement level required in the EU Urban Wastewater Directive.

Population (population equivalent)	**Discharge location**	**EU Urban Wastewater Directive Requirements** (Base Standard for Scenario 1 in chapter 4)	**By-law No. 26047 on Urban WW Treatment (2006) By-law UWWT-1**	**By-law No. 27271 on Sensitive Areas (2009) By-law UWWT-2[1]**	**By-law No. 26786 on Water Pollution Control (2008) By-law WPC**	**Most stringent requirements of By-law UWWT-1 and By-law WPC** (Base for Scenario 2)	**Most stringent requirements of By-law UWWT-2 and By-law WPC** (Base for Scenario 3)
84 – 2,000	Less Sensitive Area				Secondary treatment BOD5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:	Secondary treatment BOD5: 45 mg/l COD: 120 mg/l TSS: 45 mg/l TN: TP:
2,000 – 10,000	Fresh water / estuary	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 60 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 60 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 60 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:
2,000 – 10,000	Coastal water	Primary treatment BOD_5: min 20% removal COD: TSS: min 50% removal TN: TP:	Decided by relevant administration	Decided by relevant administration	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:
2,000 – 10,000	Sensitive area	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: 60 mg/l TN: No set standard TP: No set standard	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: 60 mg/l TN: TP:	Secondary treatment* BOD_5: 25 mg/l COD: 125 mg/l TSS: 60 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD5: 25 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:
2,000 – 10,000	Less Sensitive Area				Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 110 mg/l TSS: 30 mg/l TN: TP:

* Consultant interpretation of the treatment level required, based on the BOD5 abatement level required in the EU Urban Wastewater Directive.

Population (population equivalent)	Discharge location	EU Urban Wastewater Directive Requirements (Base Standard for Scenario 1 in chapter 4)	By-law No. 26047 on Urban WW Treatment (2006) By-law UWWT-1	By-law No. 27271 on Sensitive Areas (2009) By-law UWWT-2[1]	By-law No. 26786 on Water Pollution Control (2008) By-law WPC	Most stringent requirements of By-law UWWT-1 and By-law WPC (Base for Scenario 2)	Most stringent requirements of By-law UWWT-2 and By-law WPC (Base for Scenario 3)
10,000 – 50,000	Fresh water / estuary	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:
10,000 – 50,000	Coastal water	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:
10,000 – 50,000	Sensitive area	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP: 2 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP: 2 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP: 2 mg/l	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Tertiary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP: 2 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP: 2 mg/l
10,000 – 50,000	Less Sensitive Area	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:
50,000 – 100,000	Fresh water / estuary	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP:	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP:

* Consultant interpretation of the treatment level required, based on the BOD5 abatement level required in the EU Urban Wastewater Directive.

Population (population equivalent)	**Discharge location**	**EU Urban Wastewater Directive Requirements** (Base Standard for Scenario 1 in chapter 4)	**By-law No. 26047 on Urban WW Treatment (2006) By-law UWWT-1**	**By-law No. 27271 on Sensitive Areas (2009) By-law UWWT-2[1]**	**By-law No. 26786 on Water Pollution Control (2008) By-law WPC**	**Most stringent requirements of By-law UWWT-1 and By-law WPC** (Base for Scenario 2)	**Most stringent requirements of By-law UWWT-2 and By-law WPC** (Base for Scenario 3)
50,000 – 100,000	Coastal water	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP:	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP:
50,000 – 100,000	Sensitive area	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP: 2 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP: 2 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP: 2 mg/l	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Tertiary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP: 2 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP: 2 mg/l
50,000 – 100,000	Less Sensitive Area	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP:	Secondary treatment BOD_5: 45 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 100 mg/l TSS: 30 mg/l TN: 15 mg/l TP:
> 100,000	Fresh water / estuary	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP:	Secondary treatment BOD_5: 35 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: 15 mg/l TP:
> 100,000	Coastal water	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP:	Secondary treatment BOD_5: 35 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: 15 mg/l TP:

Population (population equivalent)	**Discharge location**	**EU Urban Wastewater Directive Requirements** (Base Standard for Scenario 1 in chapter 4)	**By-law No. 26047 on Urban WW Treatment (2006) By-law UWWT-1**	**By-law No. 27271 on Sensitive Areas (2009) By-law UWWT-2[1]**	**By-law No. 26786 on Water Pollution Control (2008) By-law WPC**	**Most stringent requirements of By-law UWWT-1 and By-law WPC** (Base for Scenario 2)	**Most stringent requirements of By-law UWWT-2 and By-law WPC** (Base for Scenario 3)
> 100,000	Sensitive area	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 10 mg/l TP: 1 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 10 mg/l TP: 1 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 10 mg/l TP: 1 mg/l	Secondary treatment BOD_5: 35 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Tertiary treatment BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: 10 mg/l TP: 1 mg/l	Tertiary treatment BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: 10 mg/l TP: 1 mg/l
> 100,000	Less Sensitive Area	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 125 mg/l TSS: 35 mg/l TN: 15 mg/l TP:	Secondary treatment BOD_5: 35 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Secondary treatment BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: TP:	Secondary treatment + Nitrogen removal BOD_5: 25 mg/l COD: 90 mg/l TSS: 25 mg/l TN: 15 mg/l TP:

Source: Referred regulations documents, compilation: team

Highlighted in blue are the differences between the standard Turkey set for itself (in practice) and the EU standards

Appendix G: Results of Cost Estimates and Tariff Impacts

Results of Scenarios Aggregated at the National Level:

Table G.1: Aggregated Total Costs for All Scenarios at the National Level

Sensitivity	Scenario	Item	Total Value (million EUR)	Variation to S1A
		Existing infrastructure	8,710	-
		Estimated O&M of existing infrastructure	762	-
A	S1A	Additional Investment Required	5,229	0%
		Incremental O&M required per year	844	0%
		Cumulative O&M of required investments for the useful life	95,216	0%
		Amortization costs of required investments	15,930	0%
		If IlBank Finances required Investments	8,761	0%
	S2A	Additional Investment Required	5,432	4%
		Incremental O&M required per year	875	4%
		Cumulative O&M of required investments for the useful life	98,672	4%
		Amortization costs of required investments	16,636	4%
		If IlBank Finances required Investments	9,101	4%
	S3A	Additional Investment Required	6,111	17%
		Incremental O&M required per year	1,341	59%
		Cumulative O&M of required investments for the useful life	151,250	59%
		Amortization costs of required investments	19,007	19%
		If IlBank Finances required Investments	10,238	17%
B	S1B	Additional Investment Required	6,006	15%
		Incremental O&M required per year	1,283	52%
		Cumulative O&M of required investments for the useful life	144,687	52%
		Amortization costs of required investments	18,643	17%
		If IlBank Finances required Investments	10,062	15%
	S2B	Additional Investment Required	6,139	17%
		Incremental O&M required per year	1,303	54%
		Cumulative O&M of required investments for the useful life	146,920	54%
		Amortization costs of required investments	19,105	20%
		If IlBank Finances required Investments	10,285	17%
	S3B	Additional Investment Required	6,323	21%
		Incremental O&M required per year	1,415	68%
		Cumulative O&M of required investments for the useful life	159,659	68%
		Amortization costs of required investments	19,745	24%
		If IlBank Finances required Investments	10,593	21%

Table G.2: Aggregated Total Costs for All Scenarios per Type of Municipality

Sensitivity	Scenario	Item	Metropolitan Municipalities Total Results	Metropolitan Areas	Metropolitan Municipalities SUBPROVINCE	Other Municipalities Total Results	BELDE	PROVINCE	SUB-PROVINCE
A	S1A	Existing infrastructure	**6,328**	3,590	2,739	**2,384**	250	1,042	1,092
		Additional Investment Required	**3,335**	1,280	2,055	**1,894**	326	744	824
		Incremental O&M required per year	**715**	565	150	**129**	10	69	50
		Cumulative O&M of required investments for the useful life	**80,627**	63,718	16,910	**14,589**	1,169	7,768	5,652
		Amortization costs for the required investments	**10,259**	4,048	6,211	**5,672**	956	2,233	2,482
	S2A	Existing infrastructure	**6,328**	3,590	2,739	**2,384**	250	1,042	1,092
		Additional Investment Required	**3,372**	1,280	2,091	**2,061**	409	744	907
		Incremental O&M required per year	**721**	565	156	**154**	22	69	63
		Cumulative O&M of required investments for the useful life	**81,278**	63,718	17,561	**17,393**	2,532	7,768	7,093
		Amortization costs for the required investments	**10,384**	4,048	6,336	**6,252**	1,245	2,233	2,774
	S3A	Existing infrastructure	**6,325**	3,588	2,737	**2,380**	250	1,042	1,088
		Additional Investment Required	**3,888**	1,631	2,258	**2,223**	409	874	940
		Incremental O&M required per year	**1,111**	890	221	**230**	22	132	75
		Cumulative O&M of required investments for the useful life	**125,304**	100,345	24,959	**25,946**	2,532	14,945	8,470
		Amortization costs for the required investments	**12,189**	5,272	6,917	**6,817**	1,245	2,689	2,884
B	S1B	Existing infrastructure	**6,324**	3,588	2,736	**2,381**	250	1,042	1,089
		Additional Investment Required	**3,873**	1,572	2,301	**2,133**	348	820	964
		Incremental O&M required per year	**1,075**	843	232	**207**	14	106	88
		Cumulative O&M of required investments for the useful life	**121,284**	95,105	26,179	**23,403**	1,528	11,924	9,951
		Amortization costs for the required investments	**12,138**	5,068	7,070	**6,505**	1,033	2,500	2,972
	S2B	Existing infrastructure	**6,324**	3,588	2,736	**2,381**	250	1,042	1,089
		Additional Investment Required	**3,896**	1,572	2,323	**2,244**	409	820	1,015
		Incremental O&M required per year	**1,079**	843	236	**224**	22	106	96
		Cumulative O&M of required investments for the useful life	**121,679**	95,105	26,574	**25,241**	2,518	11,924	10,799
		Amortization costs for the required investments	**12,214**	5,068	7,146	**6,890**	1,243	2,500	3,147
	S3B	Existing infrastructure	**6,323**	3,588	2,735	**2,381**	250	1,042	1,089
		Additional Investment Required	**4,009**	1,631	2,379	**2,314**	409	882	1,023
		Incremental O&M required per year	**1,157**	899	258	**258**	22	137	99
		Cumulative O&M of required investments for the useful life	**130,549**	101,410	29,139	**29,110**	2,518	15,427	11,165
		Amortization costs for the required investments	**12,611**	5,272	7,339	**7,134**	1,243	2,715	3,176

A comparison of existing assets and required assets in accordance with EU Standards (S1A) and TR standards (S3A) is provided in below.

Disaggregated Results: Results of Scenarios on MMs and Financial Impacts on SKIs

Table G.3: Summary of Results for All Scenarios Representing the Additional Investments Required in Metropolitan Municipalities (EUR)

Sensitivity	A			B		
Scenario	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**3,335,241,862**	**3,371,540,575**	**3,888,287,870**	**3,873,450,549**	**3,895,624,770**	**4,009,293,966**
Adana	38,347,818	38,347,818	98,112,612	103,528,095	103,528,095	103,528,095
Ankara	18,590,083	19,270,023	174,501,080	175,274,843	175,954,783	175,954,783
Antalya	74,875,831	76,328,530	76,328,530	89,309,919	90,762,618	90,762,618
Aydın	64,382,364	65,611,863	87,822,967	97,664,069	97,664,069	99,542,299
Balıkesir	54,272,153	56,109,308	67,409,620	69,051,563	70,201,872	70,201,872
Bursa	47,186,598	47,728,870	62,510,193	70,288,429	70,288,429	70,288,429
Denizli	56,823,215	59,948,245	59,948,245	69,373,003	71,034,539	71,034,539
Diyarbakır	244,782,553	244,782,553	248,870,445	250,183,629	250,917,671	250,917,671
Erzurum	176,859,746	178,877,873	183,781,895	191,809,360	192,756,037	192,756,037
Eskişehir	27,569,341	31,511,133	31,511,133	31,973,485	32,823,911	32,823,911
Gaziantep	207,603,572	208,334,940	259,400,438	261,706,974	262,438,342	262,438,342
Hatay	229,940,798	230,516,824	243,585,080	247,467,694	248,043,720	248,043,720
İstanbul	609,743,918	609,743,918	613,176,084	561,911,149	561,911,149	613,176,084
İzmir	49,439,118	49,439,118	60,148,475	61,097,674	61,097,674	63,292,287
Kahramanmaraş	40,773,797	42,100,927	52,964,546	55,600,078	56,273,750	56,273,750
Kayseri	11,722,828	13,815,726	49,132,155	54,961,818	55,319,599	55,319,599
Kocaeli	64,020,989	64,020,989	64,020,989	62,511,918	62,511,918	62,511,918
Konya	79,763,696	80,877,202	80,877,202	74,116,129	77,174,080	84,730,083
Malatya	151,792,499	154,834,620	161,764,257	153,065,115	155,605,729	162,535,366
Manisa	59,211,467	59,955,568	82,636,408	91,655,489	92,399,590	92,399,590
Mardin	140,825,628	141,517,417	150,885,991	146,276,320	146,968,109	150,893,910
Mersin	86,147,253	88,168,694	100,358,928	95,298,522	97,319,962	103,625,423
Muğla	55,777,371	55,777,371	66,624,215	67,428,760	67,428,760	67,428,760
Ordu	64,762,774	67,784,057	69,664,566	63,375,925	64,555,304	71,122,877
Sakarya	31,648,204	32,867,074	42,231,782	46,042,185	46,528,295	46,528,295
Samsun	51,514,422	51,514,422	62,539,344	62,088,198	62,088,198	69,740,497
Şanlıurfa	278,009,252	278,009,252	299,830,291	290,857,537	290,857,537	299,253,711
Tekirdağ	105,456,198	105,456,198	113,594,179	111,675,257	111,675,257	113,594,179
Trabzon	89,543,714	93,758,794	99,524,971	104,451,480	105,413,251	105,413,251
Van	123,854,661	124,531,251	124,531,251	113,405,932	114,082,522	123,162,069

In the case of Istanbul, although the numbers are presented as aggregated, the analysis has considered six separated metropolitan urban areas to replicate the sanitation/wastewater management areas into which the city can be divided for efficient operation.

Figure G.1 below shows existing versus additional investments that were required in SKI-served MMs for scenarios S1A, S1B, and S3A. These scenarios were selected because S1A means reaching EU standards, S3A represents standards as applied in Turkey ('business as usual') with current 'sensitive areas', while S1B illustrates the new standards and sensitive areas set in the draft by-laws currently circulated for approval.

Figure G.1: Comparison of Existing and Incremental Investments in Metropolitan Municipalities according to Scenarios S1A, S1B and S3A

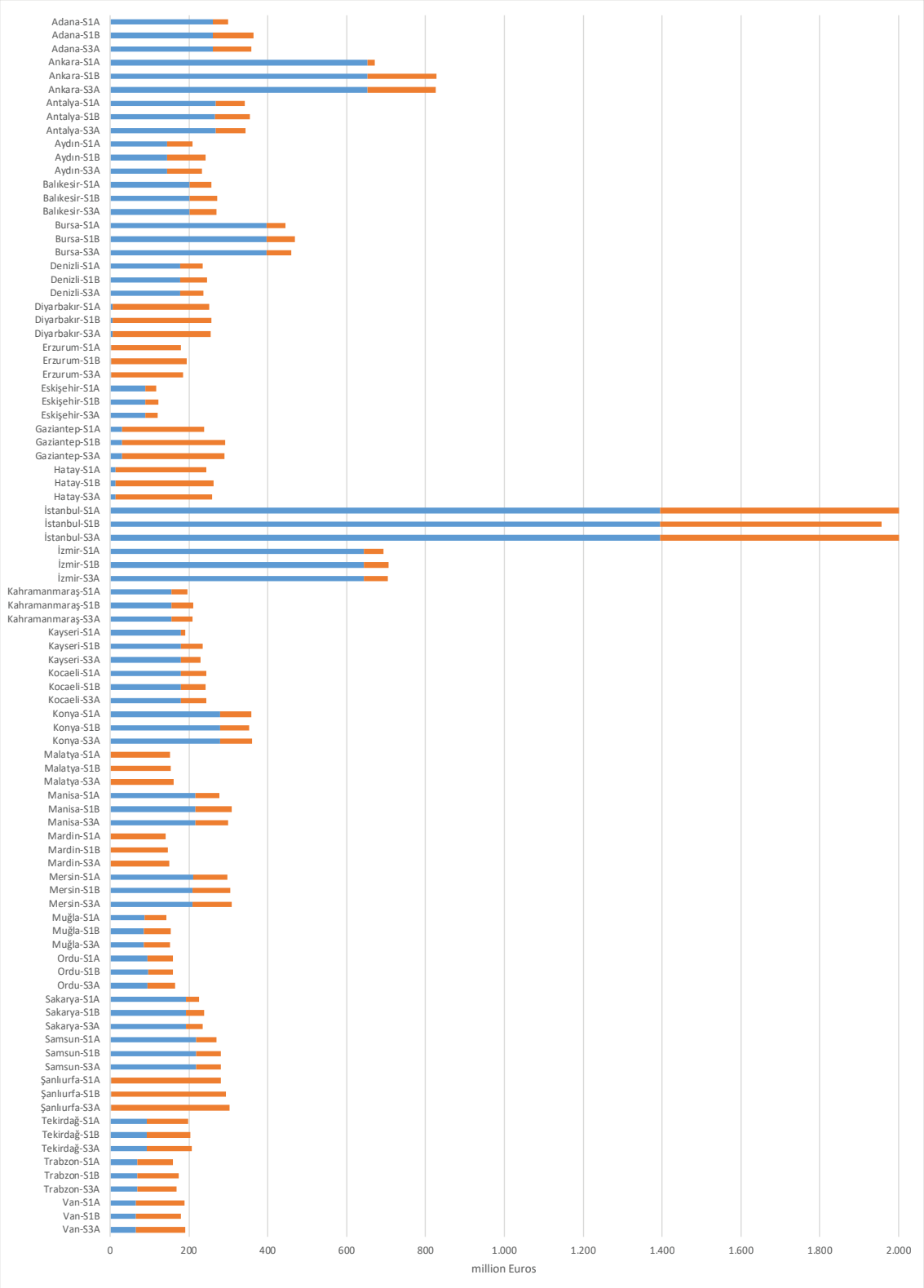


Table G.4: Summary of Results for All Scenarios Representing the Incremental O&M Costs in Metropolitan Municipalities (EUR/year)

Sensitivity	A			B		
Scenario	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**714,801,404**	**720,571,925**	**1,110,880,776**	**1,075,242,385**	**1,078,747,320**	**1,157,378,767**
Adana	4,120,458	4,120,458	60,921,978	64,651,432	64,651,432	64,651,432
Ankara	3,903,534	4,020,919	159,384,702	166,220,425	166,337,809	166,337,809
Antalya	1,419,933	1,658,391	1,658,391	4,776,876	5,015,335	5,015,335
Aydın	3,671,456	3,879,104	12,496,421	15,230,901	15,230,901	15,941,607
Balıkesir	9,469,899	9,692,427	15,044,420	16,187,124	16,290,810	16,290,810
Bursa	7,613,058	7,702,199	12,713,115	15,452,102	15,452,102	15,452,102
Denizli	14,691,981	15,204,323	15,204,323	18,247,979	18,524,248	18,524,248
Diyarbakır	35,796,538	35,796,538	37,394,008	38,002,250	38,131,149	38,131,149
Erzurum	7,431,070	7,762,142	10,632,584	13,243,210	13,394,544	13,394,544
Eskişehir	877,697	1,519,102	1,519,102	1,743,408	1,880,082	1,880,082
Gaziantep	5,274,778	5,403,102	55,668,889	58,636,771	58,765,095	58,765,095
Hatay	12,663,618	12,759,536	18,589,946	20,344,085	20,440,003	20,440,003
İstanbul	454,025,126	454,025,126	456,034,056	402,624,686	402,624,686	451,943,487
İzmir	3,999,788	3,999,788	8,727,171	8,870,080	8,870,080	9,737,770
Kahramanmaraş	9,579,123	9,807,019	16,411,417	18,024,083	18,140,148	18,140,148
Kayseri	1,289,599	1,634,182	34,785,653	37,835,215	37,889,236	37,889,236
Kocaeli	35,768,715	35,768,715	35,768,715	35,218,840	35,218,840	35,218,840
Konya	12,980,436	13,165,161	13,165,161	10,339,222	10,837,631	13,835,775
Malatya	8,061,043	8,559,435	13,695,755	8,361,194	8,778,493	13,914,813
Manisa	4,106,671	4,237,736	14,229,867	17,389,081	17,520,145	17,520,145
Mardin	7,065,734	7,185,621	11,439,667	10,086,227	10,206,114	11,710,491
Mersin	5,494,464	5,737,097	9,081,614	7,910,341	8,152,973	10,245,289
Muğla	1,908,227	1,908,227	4,874,187	5,242,305	5,242,305	5,242,305
Ordu	4,387,613	4,899,054	5,610,864	4,188,942	4,388,255	6,012,656
Sakarya	1,959,233	2,165,950	5,020,811	6,506,534	6,584,628	6,584,628
Samsun	15,152,553	15,152,553	19,137,230	15,887,235	15,887,235	20,864,114
Şanlıurfa	15,728,187	15,728,187	27,241,552	23,545,754	23,545,754	27,722,557
Tekirdağ	5,925,667	5,925,667	10,296,317	9,921,832	9,921,832	10,652,316
Trabzon	5,925,704	6,527,988	9,506,679	11,347,625	11,502,149	11,502,149
Van	14,509,499	14,626,178	14,626,178	9,206,627	9,323,306	13,817,832

Table G.5: Summary of Results for All Scenarios Representing the Cumulative Incremental O&M Costs Projected over the Useful Life of Investments in Metropolitan Municipalities (EUR)

Sensitivity	A			B		
Scenario	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**80,627,359,054**	**81,278,255,790**	**125,303,871,475**	**121,283,972,652**	**121,679,318,322**	**130,548,699,233**
Adana	464,774,797	464,774,797	6,871,808,278	7,292,478,956	7,292,478,956	7,292,478,956
Ankara	440,306,441	453,547,014	17,978,095,127	18,749,143,210	18,762,383,784	18,762,383,784
Antalya	160,163,951	187,061,348	187,061,348	538,816,655	565,714,052	565,714,052
Aydın	414,128,728	437,550,753	1,409,557,176	1,717,997,913	1,717,997,913	1,798,163,318
Balıkesir	1,068,174,965	1,093,275,371	1,696,963,474	1,825,856,879	1,837,552,349	1,837,552,349
Bursa	858,729,093	868,783,927	1,433,999,557	1,742,948,646	1,742,948,646	1,742,948,646
Denizli	1,657,209,411	1,714,999,999	1,714,999,999	2,058,314,872	2,089,477,136	2,089,477,136
Diyarbakır	4,037,737,303	4,037,737,303	4,217,926,966	4,286,534,695	4,301,074,099	4,301,074,099
Erzurum	838,201,428	875,545,287	1,199,322,207	1,493,792,634	1,510,862,630	1,510,862,630
Eskişehir	99,001,493	171,349,935	171,349,935	196,650,940	212,067,345	212,067,345
Gaziantep	594,978,401	609,453,035	6,279,276,285	6,614,044,041	6,628,518,675	6,628,518,675
Hatay	1,428,416,444	1,439,235,709	2,096,887,702	2,294,749,025	2,305,568,290	2,305,568,290
İstanbul	51,212,611,892	51,212,611,892	51,439,212,854	45,414,803,271	45,414,803,271	50,977,809,547
İzmir	451,163,528	451,163,528	984,397,574	1,000,517,280	1,000,517,280	1,098,389,933
Kahramanmaraş	1,080,495,118	1,106,200,974	1,851,156,451	2,033,060,090	2,046,151,828	2,046,151,828
Kayseri	145,462,694	184,330,638	3,923,712,693	4,267,693,768	4,273,787,155	4,273,787,155
Kocaeli	4,034,598,965	4,034,598,965	4,034,598,965	3,972,574,878	3,972,574,878	3,972,574,878
Konya	1,464,152,493	1,484,988,964	1,484,988,964	1,166,231,896	1,222,450,843	1,560,632,104
Malatya	909,260,398	965,477,500	1,544,838,267	943,116,482	990,186,566	1,569,547,334
Manisa	463,219,670	478,003,303	1,605,084,458	1,961,433,879	1,976,217,512	1,976,217,512
Mardin	796,992,704	810,515,576	1,290,358,608	1,137,694,836	1,151,217,708	1,320,906,746
Mersin	619,758,334	647,126,520	1,024,377,606	892,261,674	919,629,860	1,155,636,474
Muğla	215,242,073	215,242,073	549,792,983	591,315,527	591,315,527	591,315,527
Ordu	494,909,002	552,597,920	632,887,925	472,499,506	494,981,439	678,208,708
Sakarya	220,995,401	244,312,397	566,331,705	733,916,701	742,725,379	742,725,379
Samsun	1,709,160,486	1,709,160,486	2,158,619,628	1,792,030,350	1,792,030,350	2,353,406,738
Şanlıurfa	1,774,090,215	1,774,090,215	3,072,761,772	2,655,887,283	2,655,887,283	3,127,017,610
Tekirdağ	668,396,686	668,396,686	1,161,392,316	1,119,151,519	1,119,151,519	1,201,547,913
Trabzon	668,400,890	736,336,649	1,072,323,622	1,279,976,534	1,297,406,358	1,297,406,358
Van	1,636,626,051	1,649,787,028	1,649,787,028	1,038,478,714	1,051,639,692	1,558,608,208

Table G.6: Amortization Costs for Required Investments in MMs for All Scenarios (EUR)

Sensitivity	A			B		
Scenarios	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**10,258,514,068**	**10,384,181,407**	**12,189,273,777**	**12,137,736,555**	**12,214,433,830**	**12,610,993,411**
Adana	119,121,976	119,121,976	328,113,743	347,051,168	347,051,168	347,051,168
Ankara	61,962,421	64,340,106	607,168,268	609,874,042	612,251,727	612,251,727
Antalya	217,258,542	222,338,491	222,338,491	266,306,058	271,386,007	271,386,007
Aydın	193,084,788	197,384,230	275,054,334	309,467,728	309,467,728	316,035,718
Balıkesir	177,038,461	183,071,910	222,588,020	228,720,642	232,352,260	232,352,260
Bursa	151,622,863	153,519,136	205,208,011	232,407,759	232,407,759	232,407,759
Denizli	182,590,094	193,518,023	193,518,023	226,475,500	232,285,732	232,285,732
Diyarbakır	737,650,854	737,650,854	751,945,821	756,537,901	759,104,774	759,104,774
Erzurum	522,108,502	529,165,698	546,314,595	574,385,872	577,696,312	577,696,312
Eskişehir	81,147,338	94,931,406	94,931,406	96,548,205	99,522,064	99,522,064
Gaziantep	604,209,282	606,766,805	785,337,970	793,403,704	795,961,228	795,961,228
Hatay	681,551,408	683,565,716	729,264,156	742,841,286	744,855,595	744,855,595
İstanbul	2,032,367,851	2,032,367,851	2,044,369,807	1,865,101,233	1,865,101,233	2,044,369,807
İzmir	151,028,416	151,028,416	188,478,014	191,797,275	191,797,275	199,471,626
Kahramanmaraş	133,733,387	138,374,234	176,363,270	185,579,474	187,935,241	187,935,241
Kayseri	37,466,811	44,785,476	168,283,650	188,669,423	189,920,548	189,920,548
Kocaeli	209,856,957	209,856,957	209,856,957	204,579,882	204,579,882	204,579,882
Konya	255,582,092	259,475,917	259,475,917	235,833,090	246,526,453	272,949,074
Malatya	446,640,335	457,278,341	481,510,619	451,090,553	459,974,837	484,207,114
Manisa	178,703,560	181,305,608	260,618,338	292,157,202	294,759,250	294,759,250
Mardin	418,158,548	420,577,667	453,338,673	437,219,096	439,638,215	453,366,366
Mersin	255,247,199	261,863,029	303,374,244	286,131,441	292,747,271	314,796,864
Muğla	163,978,179	163,978,179	201,101,929	203,915,344	203,915,344	203,915,344
Ordu	195,336,144	205,901,282	212,477,243	191,417,191	195,541,368	217,576,816
Sakarya	95,828,526	100,090,794	132,838,284	146,162,898	147,862,780	147,862,780
Samsun	170,858,226	170,858,226	209,411,324	207,833,707	207,833,707	234,593,068
Şanlıurfa	822,805,507	822,805,507	899,111,591	867,734,729	867,734,729	897,095,348
Tekirdağ	312,215,245	312,215,245	340,672,987	333,962,700	333,962,700	340,672,987
Trabzon	268,649,316	282,967,116	303,130,886	320,358,418	323,721,638	323,721,638
Van	380,711,240	383,077,209	383,077,209	344,173,034	346,539,004	378,289,313

Table G.7: Total Incremental Costs, Composed of Incremental Investments, Lifetime O&M and Amortization Costs for Metropolitan Municipalities for Scenarios S1A, S3A and S1B (in EUR million).

Province	S1A				S3A				S1B			
	Total cost	Investments Required	O&M during lifetime	Amortization	Total cost	Investments Required	O&M during lifetime	Amortization	Total cost	Investments Required	O&M during lifetime	Amortization
Adana	622	38	465	119	7,298	98	6,872	328	7,743	104	7,292	347
Ankara	521	19	440	62	18,760	175	17,978	607	19,534	175	18,749	610
Antalya	452	75	160	217	486	76	187	222	894	89	539	266
Aydın	672	64	414	193	1,772	88	1,410	275	2,125	98	1,718	309
Balıkesir	1,299	54	1,068	177	1,987	67	1,697	223	2,124	69	1,826	229
Bursa	1,058	47	859	152	1,702	63	1,434	205	2,046	70	1,743	232
Denizli	1,897	57	1,657	183	1,968	60	1,715	194	2,354	69	2,058	226
Diyarbakır	5,020	245	4,038	738	5,219	249	4,218	752	5,293	250	4,287	757
Erzurum	1,537	177	838	522	1,929	184	1,199	546	2,260	192	1,494	574
Eskişehir	208	28	99	81	298	32	171	95	325	32	197	97
Gaziantep	1,407	208	595	604	7,324	259	6,279	785	7,669	262	6,614	793
Hatay	2,340	230	1,428	682	3,070	244	2,097	729	3,285	247	2,295	743
İstanbul	53,855	610	51,213	2,032	54,097	613	51,439	2,044	47,842	562	45,415	1,865
İzmir	652	49	451	151	1,233	60	984	188	1,253	61	1,001	192
Kahramanmaraş	1,255	41	1,080	134	2,080	53	1,851	176	2,274	56	2,033	186
Kayseri	195	12	145	37	4,141	49	3,924	168	4,511	55	4,268	189
Kocaeli	4,308	64	4,035	210	4,308	64	4,035	210	4,240	63	3,973	205
Konya	1,799	80	1,464	256	1,825	81	1,485	259	1,476	74	1,166	236
Malatya	1,508	152	909	447	2,188	162	1,545	482	1,547	153	943	451
Manisa	701	59	463	179	1,948	83	1,605	261	2,345	92	1,961	292
Mardin	1,356	141	797	418	1,895	151	1,290	453	1,721	146	1,138	437
Mersin	961	86	620	255	1,428	100	1,024	303	1,274	95	892	286
Muğla	435	56	215	164	818	67	550	201	863	67	591	204
Ordu	755	65	495	195	915	70	633	212	727	63	472	191
Sakarya	348	32	221	96	741	42	566	133	926	46	734	146
Samsun	1,932	52	1,709	171	2,431	63	2,159	209	2,062	62	1,792	208
Şanlıurfa	2,875	278	1,774	823	4,272	300	3,073	899	3,814	291	2,656	868
Tekirdağ	1,086	105	668	312	1,616	114	1,161	341	1,565	112	1,119	334
Trabzon	1,027	90	668	269	1,475	100	1,072	303	1,705	104	1,280	320
Van	2,141	124	1,637	381	2,157	125	1,650	383	1,496	113	1,038	344

The following Figure G.2 shows the compared total costs and relative share represented by the sum of additional investments required, the cumulated incremental O&M for the lifetime of the investments and the amortization costs in provinces of Metropolitan Municipalities for scenario S1A, S1B, and S3A.

Figure G.2. Comparison of Total Incremental Costs in MMs under Scenarios S1A, S1B, and S3A.

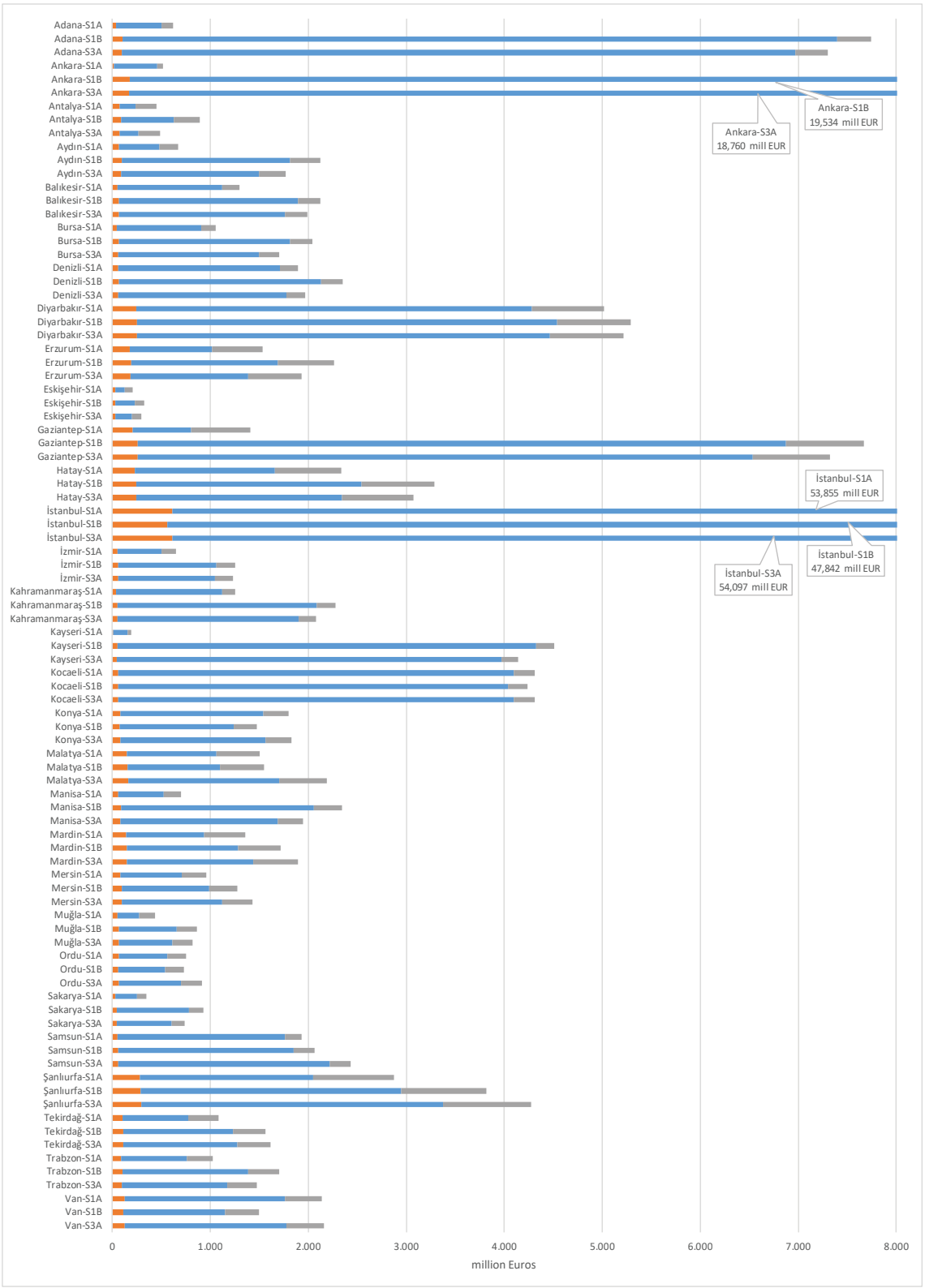


Table G.8: Main Financial Indicators for SKIs for Scenarios 1A, 2A, and 3A

Municipality	SKİ	Annual Result S1A (Revenues- Costs) (mil €)	Cost Coverage Ratio S1A (Revenues/Cost)	Total Debt/ Revenues S1A	Annual Result S2A (Revenues- Costs) (mil €)	Cost Coverage Ratio S2A (Revenues/Cost)	Total Debt/ Revenues S2A	Annual Result S3A (Revenues- Costs) (mil €)	Cost Coverage Ratio S3A (Revenues/Cost)	Total Debt/ Revenues S3A
Adana	ASKİ	-19,260	86%	117%	-19,260	86%	117%	-84,504	58%	168%
Ankara	ASKİ	147,674	144%	56%	147,460	144%	56%	-29,833	96%	87%
Antalya	ASAT	53,275	133%	183%	52,831	133%	184%	52,831	133%	184%
Aydın	ASKİ	-11,738	84%	504%	-12,119	83%	506%	-23,874	72%	542%
Balıkesir	BASKİ	-19,177	59%	352%	-19,652	58%	355%	-26,600	55%	375%
Bursa	BUSKİ	-10,540	111%	176%	-10,706	111%	176%	-17,805	107%	184%
Denizli	DESKİ	-56,785	51%	248%	-57,739	50%	253%	-57,739	50%	253%
Diyarbakır	DİSKİ	-49,706	62%	409%	-49,706	62%	409%	-51,881	61%	414%
Erzurum	ESKİ	-35,981	51%	1098%	-36,598	51%	1103%	-40,161	48%	1117%
Eskişehir	ESKİ	-0,124	100%	143%	-1,322	97%	151%	-1,322	97%	151%
Gaziantep	GASKİ	-17,102	89%	361%	-17,334	89%	362%	-74,814	64%	400%
Hatay	HATSU	-56,341	56%	502%	-56,519	56%	502%	-64,195	52%	521%
İstanbul	İSKİ	-511,429	76%	83%	-511,429	76%	83%	-513,923	76%	84%
İzmir	İZSU	14,195	105%	83%	14,195	105%	83%	7,954	103%	87%
Kahramanmaraş	KASKİ	-15,162	-	-	-15,578	-	-	-23,717	-	-
Kayseri	KASKİ	-2,363	97%	121%	-3,003	96%	124%	-41,144	63%	175%
Kocaeli	İSU	-2,255	67%	151%	-2,255	67%	151%	-2,255	67%	151%
Konya	KOSKİ	-8,453	93%	199%	-8,795	93%	200%	-8,795	93%	200%
Malatya	MASKİ	-27,822	-	-	-28,750	-	-	-34,865	-	-
Manisa	MASKİ	-5,224	59%	177%	-5,460	59%	178%	-18,657	53%	212%
Mardin	MARSU	-28,776	48%	658%	-28,994	48%	660%	-34,571	43%	696%
Mersin	MESKİ	-2,511	55%	356%	-3,030	55%	359%	-8,074	53%	377%
Muğla	MUSKİ	-1,088	98%	611%	-1,088	98%	611%	-5,570	92%	626%
Ordu	OSKİ	5,800	117%	238%	4,862	114%	245%	3,884	111%	250%
Sakarya	SASKİ	-4,058	95%	459%	-4,437	94%	461%	-8,615	89%	474%
Samsun	SASKİ	-35,380	67%	288%	-35,380	67%	288%	-40,922	64%	304%
Şanlıurfa	ŞUSKİ	-161,034	25%	812%	-161,034	25%	812%	-175,630	23%	853%
Tekirdağ	TESKİ	-31,857	65%	247%	-31,857	65%	247%	-37,378	62%	261%
Trabzon	TİSKİ	-14,189	43%	660%	-15,378	42%	681%	-19,171	39%	709%
Van	VASKİ	-39,685	40%	699%	-39,898	40%	702%	-39,898	40%	702%

Table G.9: Main Financial Indicators for SKIs for Scenarios 1B, 2B, and 3B

Municipality	SKİ	Annual Result S1B (Revenues- Costs) (mil €)	Cost Coverage Ratio S1B (Revenues/Cost)	Total Debt/ Revenues S1B	Annual Result S2B (Revenues- Costs) (mil €)	Cost Coverage Ratio S2B (Revenues/Cost)	Total Debt/ Revenues S2B	Annual Result S3B (Revenues- Costs) (mil €)	Cost Coverage Ratio S3b (Revenues/Cost)	Total Debt/ Revenues S3B
Adana	ASKİ	-88,999	57%	173%	-88,999	57%	173%	-88,999	57%	173%
Ankara	ASKİ	-36,778	95%	87%	-36,992	95%	87%	-36,992	95%	87%
Antalya	ASAT	47,907	129%	190%	47,463	128%	191%	47,463	128%	191%
Aydın	ASKİ	-27,999	68%	559%	-27,999	68%	559%	-28,975	68%	562%
Balıkesir	BASKİ	-27,983	54%	378%	-28,241	54%	380%	-28,241	54%	380%
Bursa	BUSKİ	-21,643	105%	187%	-21,643	105%	187%	-21,643	105%	187%
Denizli	DESKİ	-62,114	48%	269%	-62,625	48%	272%	-62,625	48%	272%
Diyarbakır	DİSKİ	-52,675	61%	415%	-52,907	61%	416%	-52,907	61%	416%
Erzurum	ESKİ	-43,906	46%	1139%	-44,191	46%	1141%	-44,191	46%	1141%
Eskişehir	ESKİ	-1,612	97%	152%	-1,869	96%	154%	-1,869	96%	154%
Gaziantep	GASKİ	-78,107	63%	401%	-78,339	63%	402%	-78,339	63%	402%
Hatay	HATSU	-66,498	51%	526%	-66,675	51%	527%	-66,675	51%	527%
İstanbul	İSKİ	-453,272	78%	80%	-453,272	78%	80%	-509,833	76%	84%
İzmir	İZSU	7,677	102%	87%	7,677	102%	87%	6,500	102%	88%
Kahramanmaraş	KASKİ	-25,702	-		-25,913	-		-25,913	-	
Kayseri	KASKİ	-45,017	60%	184%	-45,122	60%	184%	-45,122	60%	184%
Kocaeli	İSU	-1,492	67%	150%	-1,492	67%	150%	-1,492	67%	150%
Konya	KOSKİ	-5,014	96%	194%	-5,944	95%	197%	-10,010	92%	204%
Malatya	MASKİ	-28,302	-		-29,078	-		-35,193	-	
Manisa	MASKİ	-23,090	51%	226%	-23,326	51%	227%	-23,326	51%	227%
Mardin	MARSU	-32,567	45%	678%	-32,784	45%	681%	-34,843	43%	696%
Mersin	MESKİ	-6,197	54%	369%	-6,716	54%	372%	-9,699	52%	382%
Muğla	MUSKİ	-6,052	92%	628%	-6,052	92%	628%	-6,052	92%	628%
Ordu	OSKİ	6,176	118%	234%	5,810	117%	237%	3,277	109%	254%
Sakarya	SASKİ	-10,639	87%	479%	-10,786	87%	480%	-10,786	87%	480%
Samsun	SASKİ	-37,608	66%	303%	-37,608	66%	303%	-43,666	62%	313%
Şanlıurfa	ŞUSKİ	-170,667	24%	836%	-170,667	24%	836%	-176,030	23%	852%
Tekirdağ	TESKİ	-36,732	62%	257%	-36,732	62%	257%	-37,734	61%	261%
Trabzon	TİSKİ	-21,708	37%	733%	-21,999	37%	738%	-21,999	37%	738%
Van	VASKİ	-32,906	45%	660%	-33,119	45%	663%	-38,896	41%	696%

Table G.10: Tariff Increase Margin and Additional Unit Operation Costs to be Covered for All Scenarios

Municipality	SKİ	Affordable HH Tariff – HH Tariff Applied (€/m3)	Additional Unit Operational Cost (€/m3)					
			Scenario S1A	Scenario S2A	Scenario S3A	Scenario S1B	Scenario S2B	Scenario S3B
Adana	ASKİ	**-0.256**	0.029	0.029	0.432	0.459	0.459	0.459
Ankara	ASKİ	**-0.374**	0.010	0.010	0.407	0.425	0.425	0.425
Antalya	ASAT	**-0.068**	0.006	0.007	0.007	0.021	0.022	0.022
Aydın	ASKİ	**0.281**	0.041	0.044	0.140	0.171	0.171	0.179
Balıkesir	BASKİ	**-0.551**	0.065	0.067	0.104	0.112	0.112	0.112
Bursa	BUSKİ	**-0.755**	0.071	0.072	0.119	0.144	0.144	0.144
Denizli	DESKİ	**-0.670**	0.179	0.186	0.186	0.223	0.226	0.226
Diyarbakır	DİSKİ	**-0.392**	0.469	0.469	0.490	0.498	0.500	0.500
Erzurum	ESKİ	**0.185**	0.153	0.159	0.218	0.272	0.275	0.275
Eskişehir	ESKİ	**0.224**	0.020	0.035	0.035	0.040	0.043	0.043
Gaziantep	GASKİ	**-1.318**	0.035	0.036	0.367	0.386	0.387	0.387
Hatay	HATSU	**-0.228**	0.089	0.090	0.130	0.143	0.143	0.143
İstanbul	İSKİ	**-0.687**	0.470	0.470	0.472	0.417	0.417	0.468
İzmir	İZSU	**-0.091**	0.020	0.020	0.043	0.043	0.043	0.048
Kahramanmaraş	KASKİ	**0.054**	0.121	0.124	0.208	0.228	0.229	0.229
Kayseri	KASKİ	**-0.496**	0.014	0.018	0.376	0.409	0.409	0.409
Kocaeli	İSU	**-0.454**	0.233	0.233	0.233	0.229	0.229	0.229
Konya	KOSKİ	**-0.061**	0.155	0.157	0.157	0.123	0.129	0.165
Malatya	MASKİ	**-0.120**	0.201	0.214	0.342	0.209	0.219	0.347
Manisa	MASKİ		0.055	0.057	0.191	0.234	0.236	0.236
Mardin	MARSU	**-0.122**	0.102	0.103	0.165	0.145	0.147	0.168
Mersin	MESKİ	**-0.531**	0.044	0.046	0.072	0.063	0.065	0.081
Muğla	MUSKİ	**-0.207**	0.021	0.021	0.054	0.059	0.059	0.059
Ordu	OSKİ	**-0.351**	0.063	0.070	0.080	0.060	0.063	0.086
Sakarya	SASKİ	**0.141**	0.024	0.027	0.062	0.080	0.081	0.081
Samsun	SASKİ	**-0.185**	0.270	0.270	0.341	0.283	0.283	0.372
Şanlıurfa	ŞUSKİ	**-0.106**	0.141	0.141	0.244	0.211	0.211	0.248
Tekirdağ	TESKİ	**0.178**	0.124	0.124	0.216	0.208	0.208	0.224
Trabzon	TİSKİ	**0.091**	0.093	0.102	0.149	0.177	0.180	0.180
Van	VASKİ	**-0.138**	0.152	0.154	0.154	0.097	0.098	0.145

Source: Web-pages of each SKI;
TURKSTAT Data: Income and Living Conditions Survey, Distribution of annual equalized household disposable income by quintiles ordered by equalized household disposable income, - Turkey, SR, Level 2, 2014-2015; Exchange rates: http://ec.europa.eu/budget/inforeuro/index.cfm?fuseaction=currency_historique&currency=504&Language=en
Calculations: Authors
* WSS tariff for Manisa SKI was not available;
** For affordable tariff calculation, the household size is set at 4 people and the water consumption is 133 l/cap./day;
*** The tariff applied by SKI is the respective block tariff charged to customers located in the city center of relevant SKIs in 2016.

As seen in Table G.10 above, for the SKIs or MMs that apply a household tariff below the affordability level, it is possible to increase tariffs to cover some of the additional operational cost. It is however preferable to first look into the potential for performance improvement of existing assets because increasing tariffs may lead to aggravating existing inefficiencies and reducing the capacity to increase tariffs in the future.

For the SKIs charging household tariffs above the affordable rate, further actions should be taken to improve the revenues, such as improving the revenue collection rate, improving operational efficiency (network efficiency, water loss reduction, energy efficiency, and so forth). There may be options to explore an alternative well-defined tariff scheme, which could combine the need to support the poor and to meet the cost-recovery tariff level. Such actions are likely to incur costs, which would further aggravate the situation of the less performing SKIs, and could in turn translate into a degradation of the service provision.

Disaggregated Results: Results of Scenarios on the 51 Provinces not Structured as MMs

Table G.11: Additional Investment Required in Provinces Outside of MMs for All Scenarios (EUR)

Sensitivity	A			B		
Scenarios	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**1,894,006,914**	**2,060,851,799**	**2,223,147,566**	**2,132,938,841**	**2,243,748,439**	**2,313,602,173**
Adıyaman	122,023,087	127,105,858	127,105,858	118,189,789	122,234,848	129,266,893
Afyonkarahisar	32,809,091	36,134,825	36,134,825	31,739,189	38,597,897	38,597,897
Ağrı	91,713,724	94,423,693	100,955,848	100,073,292	100,073,292	102,286,284
Aksaray	60,702,713	61,394,278	61,394,278	44,541,710	50,415,859	60,952,282
Amasya	8,731,612	9,696,515	14,069,065	19,353,943	19,353,943	19,353,943
Ardahan	17,126,139	19,121,004	19,121,004	18,719,379	19,925,012	19,925,012
Artvin	34,809,469	36,280,445	36,280,445	38,740,187	39,252,712	39,252,712
Bartın	5,988,964	8,084,837	9,996,346	9,653,455	9,996,346	9,996,346
Batman	132,966,746	134,265,461	134,265,461	135,172,866	135,729,743	135,729,743
Bayburt	17,703,029	18,938,073	18,938,073	19,025,238	20,260,282	20,260,282
Bilecik	7,122,363	9,459,256	13,133,973	13,968,951	15,415,364	15,415,364
Bingöl	50,478,157	53,057,553	58,618,541	56,731,969	58,618,541	58,618,541
Bitlis	56,152,751	57,892,077	57,892,077	54,316,754	56,441,588	58,461,821
Bolu	5,036,657	7,709,953	15,497,841	7,759,720	10,122,006	17,909,895
Burdur	21,314,076	23,562,489	23,562,489	20,312,772	21,338,531	26,811,202
Çanakkale	21,064,330	23,868,242	26,446,467	23,677,427	26,222,349	28,800,574
Çankırı	7,010,197	9,306,883	11,507,335	12,038,255	12,038,255	12,038,255
Çorum	9,643,316	11,808,628	24,909,832	29,338,103	30,021,578	30,021,578
Düzce	6,851,859	10,879,467	10,879,467	13,268,533	13,268,533	13,268,533
Edirne	83,101,743	86,306,866	89,591,421	87,690,180	89,591,421	89,591,421
Elazığ	136,800,832	143,866,262	150,169,900	136,800,832	143,866,262	150,169,900
Erzincan	56,514,569	64,206,195	66,845,212	58,691,225	64,206,195	66,845,212
Giresun	52,827,437	58,889,519	61,165,216	57,762,276	61,708,108	63,983,805
Gümüşhane	6,784,861	10,485,978	10,485,978	9,377,475	11,322,649	11,322,649
Hakkari	53,130,272	55,614,758	59,431,227	56,626,225	58,079,705	60,113,098
Iğdır	36,361,379	39,295,610	41,707,333	36,361,379	39,295,610	41,707,333
Isparta	9,344,856	12,697,807	23,840,427	22,547,648	27,861,582	27,861,582
Karabük	5,806,947	7,743,219	13,832,990	6,540,624	7,743,219	13,832,990
Karaman	22,303,555	23,572,954	23,572,954	19,621,519	21,757,164	24,949,914
Kars	46,262,042	48,239,581	50,499,404	50,048,560	52,026,098	52,026,098
Kastamonu	12,256,180	18,191,167	20,423,308	19,818,819	23,272,656	23,272,656
Kırıkkale	8,364,094	10,854,628	10,854,628	11,221,591	11,606,778	11,606,778
Kırklareli	75,620,460	79,341,046	79,341,046	78,182,859	79,341,046	79,341,046
Kırşehir	10,590,465	12,466,929	12,466,929	13,058,493	13,921,162	13,921,162
Kilis	25,633,526	26,211,854	28,700,744	25,802,840	26,211,854	28,700,744
Kütahya	7,293,000	13,983,560	16,005,088	16,427,114	19,797,800	19,797,800
Muş	76,335,049	81,848,839	84,298,472	80,932,488	84,141,404	86,591,037
Nevşehir	8,957,307	13,652,917	20,147,692	24,164,356	24,779,869	24,779,869
Niğde	38,402,701	40,731,242	40,731,242	34,069,594	40,731,242	40,731,242
Osmaniye	39,492,849	42,610,460	56,770,265	59,598,458	60,353,911	60,353,911
Rize	39,951,472	43,848,915	46,160,271	46,152,510	49,352,868	49,352,868
Siirt	71,831,243	75,492,820	75,492,820	73,591,146	75,492,820	75,492,820
Sinop	15,622,895	16,986,749	16,986,749	18,403,391	18,610,505	18,610,505
Sivas	25,967,417	30,020,312	44,335,346	47,969,228	49,366,877	49,366,877
Şırnak	106,493,454	112,642,796	119,418,794	115,480,448	120,420,723	120,420,723
Tokat	15,980,037	21,993,251	23,887,336	25,172,831	26,892,336	26,892,336
Tunceli	20,870,472	23,467,620	23,467,620	24,227,485	26,483,035	26,483,035
Uşak	9,146,048	12,168,021	12,168,021	13,173,358	13,495,961	13,495,961
Yalova	7,205,424	7,205,424	7,205,424	3,589,493	3,833,335	3,833,335
Yozgat	23,169,401	29,073,947	36,376,456	39,368,404	40,867,256	40,867,256
Zonguldak	36,336,648	44,151,015	56,058,026	53,844,457	57,990,311	60,319,055

Figure G.3. Existing versus Required Investment Costs in Provinces Outside Metropolitan Municipalities in accordance with Scenario S1A

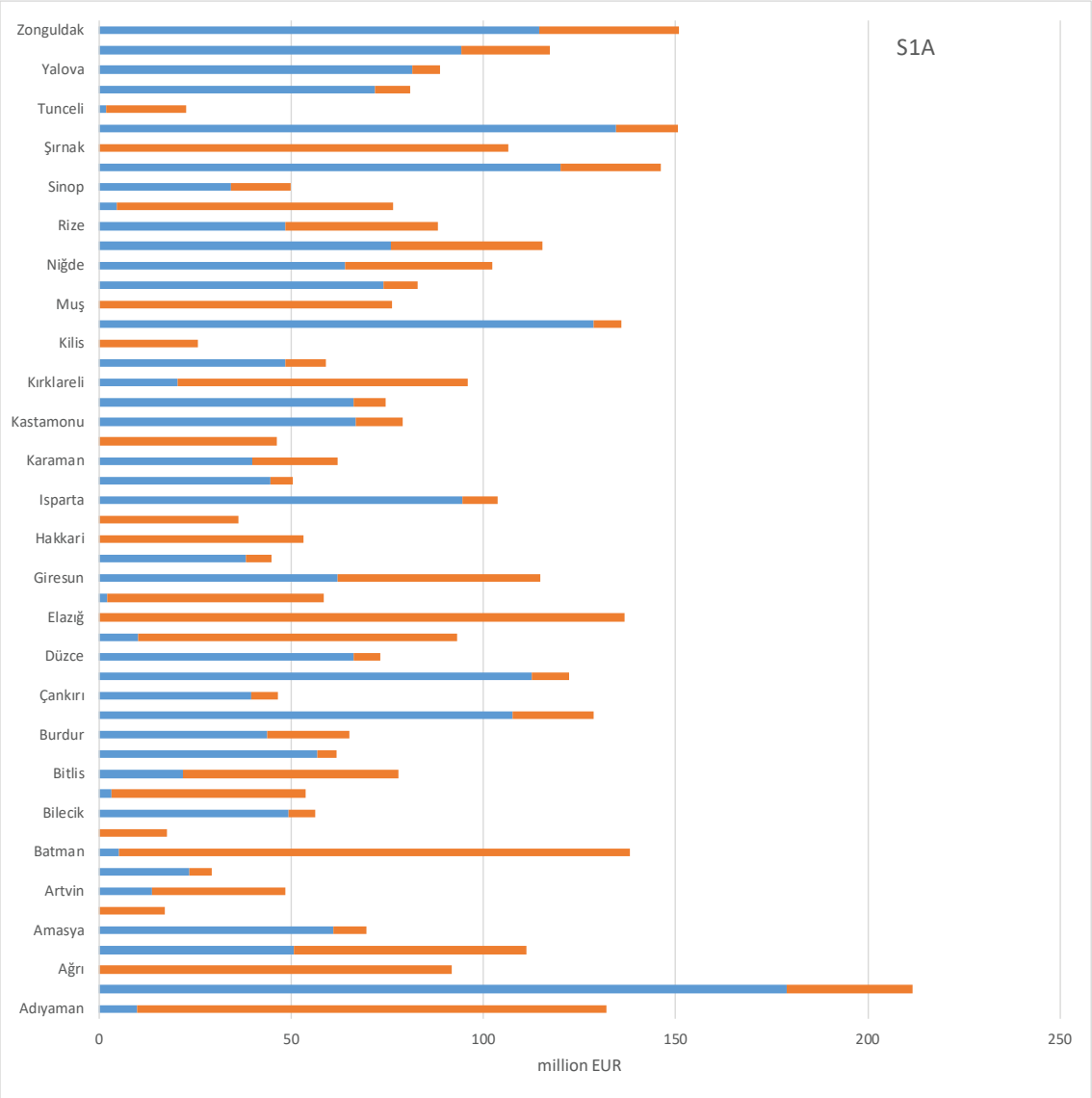


Figure G.4. Existing versus Required Investment Costs in Provinces Outside Metropolitan Municipalities in accordance with Scenario S3A

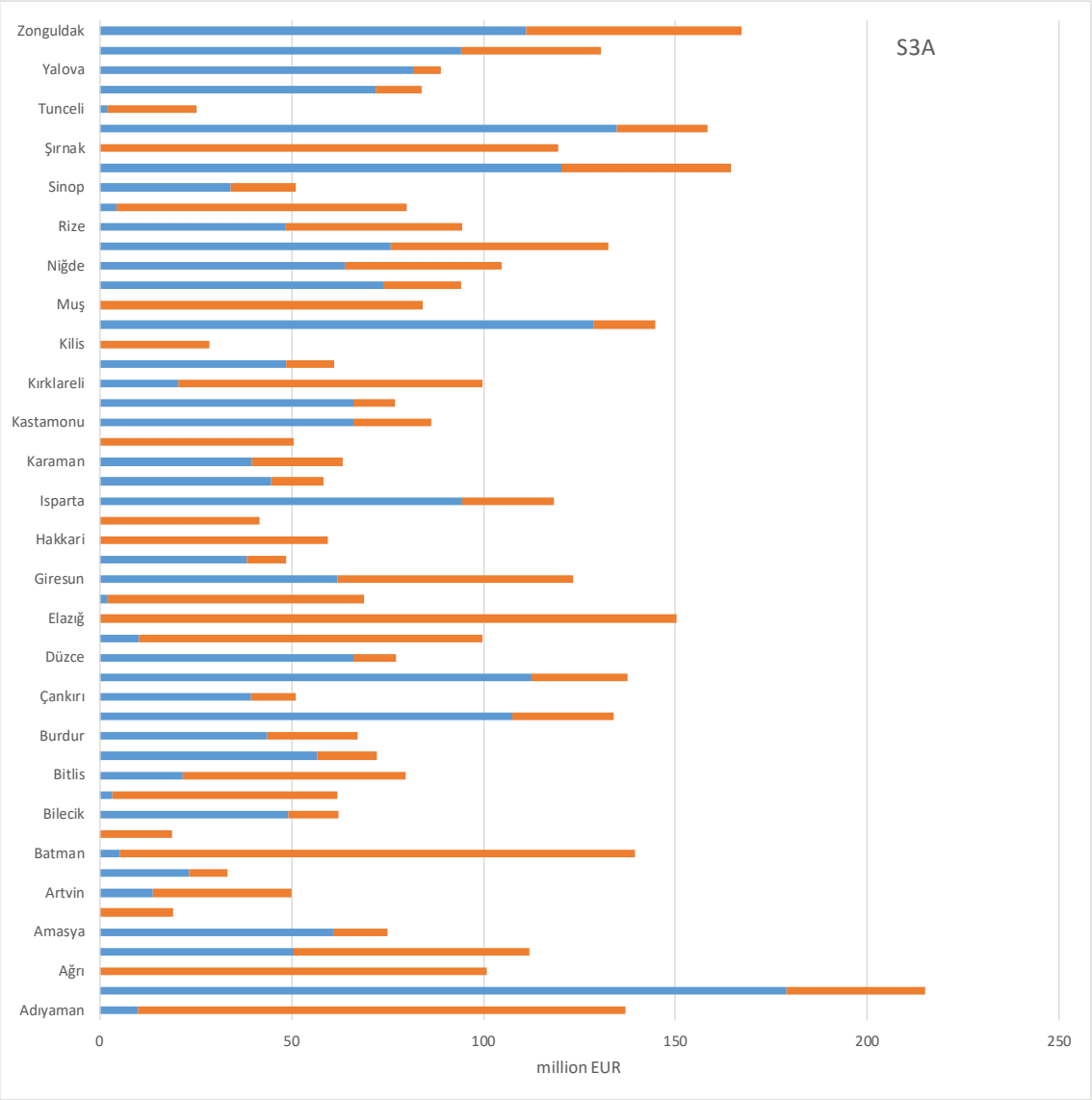


Figure G.5. Existing versus Required Investment Costs in Provinces Outside Metropolitan Municipalities in accordance with Scenario S1B

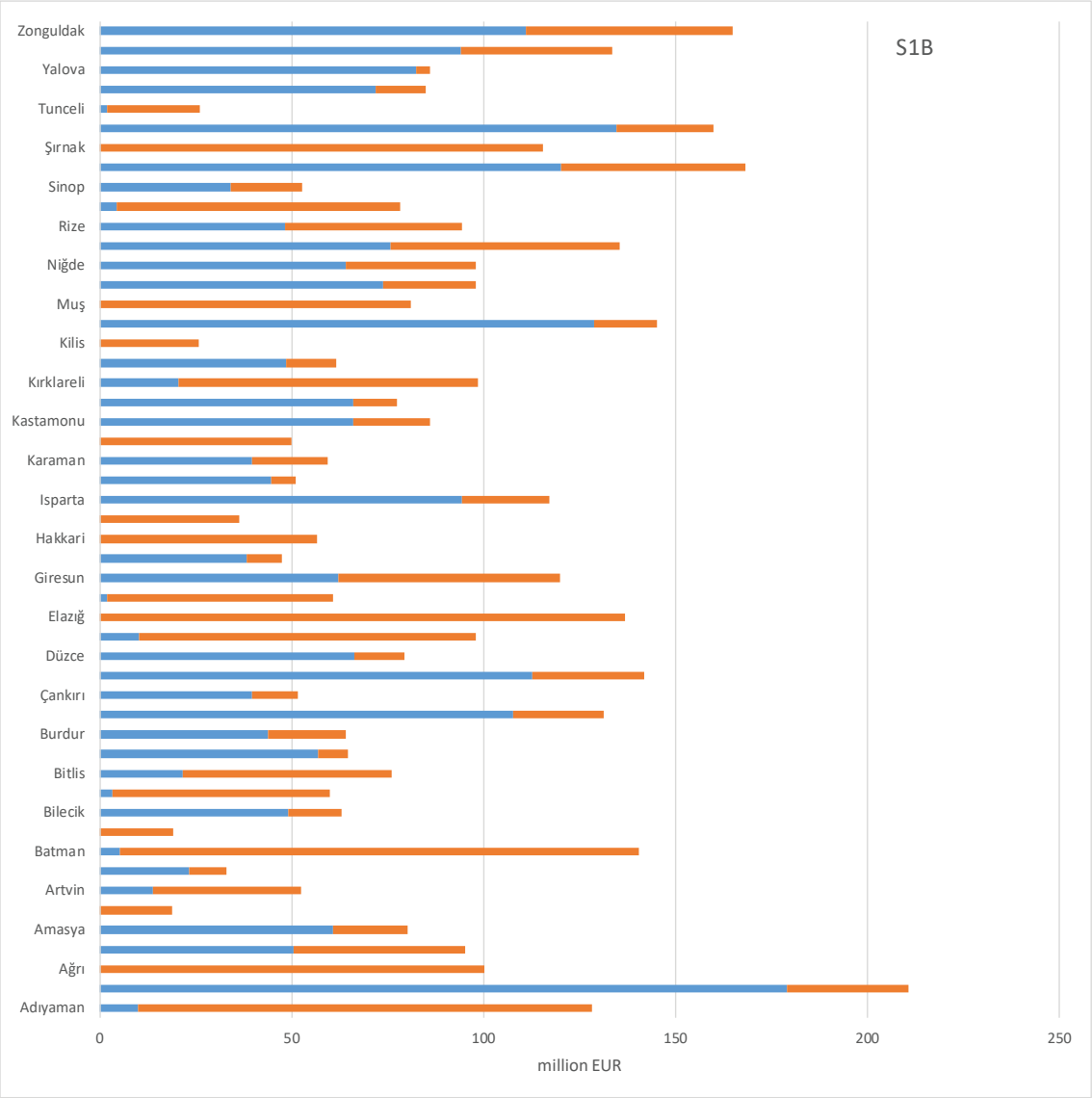


Table G.12: Yearly O&M Costs in Provinces Outside of MMs for All Scenarios (EUR/year)

Sensitivity	A			B		
Scenarios	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**129,339,890**	**154,201,044**	**230,026,610**	**207,477,521**	**223,771,273**	**258,074,916**
Adıyaman	9,980,834	10,741,213	10,741,213	6,776,189	7,389,065	11,098,561
Afyonkarahisar	3,510,938	3,999,819	3,999,819	3,606,413	4,632,322	4,632,322
Ağrı	4,412,372	4,834,124	7,848,256	7,563,236	7,563,236	8,440,264
Aksaray	7,512,183	7,616,007	7,616,007	1,402,042	2,277,173	7,267,377
Amasya	1,988,617	2,131,939	3,874,626	5,410,726	5,410,726	5,410,726
Ardahan	488,456	788,573	788,573	843,044	1,019,447	1,019,447
Artvin	1,532,974	1,771,448	1,771,448	2,552,432	2,635,685	2,635,685
Bartın	903,850	1,207,660	1,934,532	1,952,451	2,003,794	2,003,794
Batman	12,876,003	13,069,584	13,069,584	13,423,478	13,503,680	13,503,680
Bayburt	671,390	853,495	853,495	1,135,896	1,318,002	1,318,002
Bilecik	1,627,840	1,983,442	3,365,705	3,806,087	4,031,906	4,031,906
Bingöl	1,050,456	1,436,653	4,070,419	3,915,621	4,197,845	4,197,845
Bitlis	4,221,687	4,484,762	4,484,762	3,567,080	3,889,517	4,669,783
Bolu	94,330	496,512	4,184,971	753,392	1,109,873	4,798,332
Burdur	2,778,394	3,113,265	3,113,265	2,047,811	2,214,457	3,957,908
Çanakkale	3,190,124	3,519,916	5,029,013	3,931,317	4,224,338	5,733,435
Çankırı	1,086,255	1,429,545	2,300,199	2,521,223	2,521,223	2,521,223
Çorum	1,047,072	1,378,622	7,583,545	9,263,053	9,366,538	9,366,538
Düzce	128,110	807,742	807,742	1,413,726	1,413,726	1,413,726
Edirne	3,008,386	3,490,391	5,412,920	5,328,459	5,600,939	5,600,939
Elazığ	6,966,788	8,087,986	12,760,309	6,966,788	8,087,986	12,760,309
Erzincan	1,956,249	3,127,963	4,227,716	2,289,669	3,127,963	4,227,716
Giresun	3,721,052	4,586,014	5,918,035	4,862,023	5,389,115	6,721,135
Gümüşhane	506,962	1,064,856	1,064,856	1,033,811	1,324,630	1,324,630
Hakkari	2,281,954	2,690,181	4,141,921	3,368,411	3,605,904	4,392,692
Iğdır	1,465,054	1,945,835	2,925,294	1,465,054	1,945,835	2,925,294
Isparta	697,759	1,214,094	6,491,403	6,885,866	7,703,290	7,703,290
Karabük	60,412	370,578	3,254,783	189,233	370,578	3,254,783
Karaman	4,324,285	4,513,663	4,513,663	2,438,093	2,753,149	4,621,943
Kars	1,877,149	2,172,943	3,073,871	3,297,491	3,593,286	3,593,286
Kastamonu	2,005,665	2,750,658	4,057,184	4,505,682	4,938,247	4,938,247
Kırıkkale	428,865	817,143	817,143	970,439	1,029,454	1,029,454
Kırklareli	945,306	1,488,600	1,488,600	1,328,374	1,488,600	1,488,600
Kırşehir	573,888	853,523	853,523	1,156,062	1,281,139	1,281,139
Kilis	1,280,167	1,355,799	2,375,732	1,301,303	1,355,799	2,375,732
Kütahya	1,316,900	2,314,838	3,095,746	3,698,768	4,196,884	4,196,884
Muş	2,815,278	3,628,102	4,627,398	3,845,423	4,323,317	5,322,613
Nevşehir	472,505	1,192,135	3,365,827	4,423,446	4,514,187	4,514,187
Niğde	5,841,972	6,200,863	6,200,863	5,192,339	6,200,863	6,200,863
Osmaniye	2,145,287	2,619,356	9,162,873	10,440,897	10,547,562	10,547,562
Rize	3,073,382	3,639,838	4,992,730	5,611,825	6,090,364	6,090,364
Siirt	5,432,283	6,021,473	6,021,473	5,725,070	6,021,473	6,021,473
Sinop	1,430,624	1,639,951	1,639,951	2,106,658	2,134,212	2,134,212
Sivas	1,351,317	1,958,672	10,690,563	12,177,959	12,379,292	12,379,292
Şırnak	4,765,353	5,730,632	8,871,444	8,714,428	9,502,248	9,502,248
Tokat	1,907,167	2,816,689	3,535,086	4,335,135	4,593,243	4,593,243
Tunceli	313,082	703,318	703,318	1,178,065	1,517,189	1,517,189
Uşak	483,013	940,872	940,872	1,256,343	1,304,081	1,304,081
Yalova	1,137,289	1,137,289	1,137,289	443,357	471,688	471,688
Yozgat	2,235,880	3,113,100	5,530,857	6,778,149	6,999,266	6,999,266
Zonguldak	3,416,731	4,349,369	8,696,195	8,277,680	8,656,938	10,020,008

Table G.13: Incremental O&M Costs Projected over the Useful Life of Investments in Provinces Outside of Metropolitan Municipalities for All Scenarios (EUR)

Sensitivity	A			B		
Scenarios	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**14,589,134,425**	**17,393,394,728**	**25,946,281,048**	**23,402,814,358**	**25,240,698,582**	**29,110,042,059**
Adıyaman	1,125,806,761	1,211,575,171	1,211,575,171	764,332,882	833,463,366	1,251,882,930
Afyonkarahisar	396,022,843	451,167,043	451,167,043	406,792,133	522,511,358	522,511,358
Ağrı	497,701,742	545,274,000	885,258,714	853,109,353	853,109,353	952,035,387
Aksaray	847,350,726	859,061,711	859,061,711	158,145,992	256,857,929	819,737,340
Amasya	224,309,822	240,476,012	437,045,681	610,312,957	610,312,957	610,312,957
Ardahan	55,096,320	88,948,579	88,948,579	95,092,718	114,990,467	114,990,467
Artvin	172,914,671	199,813,763	199,813,763	287,906,302	297,296,972	297,296,972
Bartın	101,951,497	136,220,295	218,209,189	220,230,319	226,021,729	226,021,729
Batman	1,452,372,758	1,474,208,160	1,474,208,160	1,514,126,261	1,523,172,832	1,523,172,832
Bayburt	75,730,647	96,271,580	96,271,580	128,125,532	148,666,466	148,666,466
Bilecik	183,615,219	223,726,093	379,640,969	429,314,716	454,786,366	454,786,366
Bingöl	118,488,138	162,050,004	459,130,514	441,669,813	473,503,811	473,503,811
Bitlis	476,193,012	505,867,055	505,867,055	402,355,461	438,725,384	526,736,919
Bolu	10,640,158	56,005,040	472,051,588	84,980,265	125,190,225	541,236,773
Burdur	313,394,153	351,166,522	351,166,522	230,986,660	249,783,802	446,439,641
Çanakkale	359,835,953	397,035,472	567,256,925	443,440,296	476,492,051	646,713,503
Çankırı	122,526,136	161,248,153	259,455,218	284,386,015	284,386,015	284,386,015
Çorum	118,106,398	155,504,252	855,400,096	1,044,843,338	1,056,516,157	1,056,516,157
Düzce	14,450,371	91,110,737	91,110,737	159,463,833	159,463,833	159,463,833
Edirne	339,336,527	393,705,203	610,560,452	601,033,482	631,768,363	631,768,363
Elazığ	785,831,886	912,299,452	1,439,322,847	785,831,886	912,299,452	1,439,322,847
Erzincan	220,658,795	352,824,449	476,873,150	258,267,458	352,824,449	476,873,150
Giresun	419,722,959	517,288,049	667,535,768	548,420,954	607,875,300	758,123,018
Gümüşhane	57,183,758	120,112,434	120,112,434	116,610,697	149,414,059	149,414,059
Hakkari	257,397,314	303,443,948	467,195,685	379,946,213	406,734,681	495,481,880
Iğdır	165,253,543	219,484,057	329,964,054	165,253,543	219,484,057	329,964,054
Isparta	78,704,975	136,946,029	732,209,889	776,704,124	868,906,957	868,906,957
Karabük	6,814,306	41,800,027	367,129,334	21,344,870	41,800,027	367,129,334
Karaman	487,765,781	509,127,056	509,127,056	275,009,296	310,546,603	521,340,680
Kars	211,736,473	245,101,179	346,723,013	371,946,647	405,311,353	405,311,353
Kastamonu	226,232,715	310,265,594	457,637,595	508,226,860	557,018,769	557,018,769
Kırıkkale	48,374,643	92,171,148	92,171,148	109,462,516	116,119,189	116,119,189
Kırklareli	106,627,527	167,909,400	167,909,400	149,836,387	167,909,400	167,909,400
Kırşehir	64,732,770	96,274,717	96,274,717	130,400,128	144,508,507	144,508,507
Kilis	144,398,863	152,929,833	267,975,118	146,782,901	152,929,833	267,975,118
Kütahya	148,542,212	261,106,516	349,190,402	417,209,424	473,395,366	473,395,366
Muş	317,554,573	409,238,542	521,955,945	433,751,719	487,656,615	600,374,018
Nevşehir	53,297,137	134,469,125	379,654,731	498,950,882	509,186,103	509,186,103
Niğde	658,956,140	699,437,913	699,437,913	585,679,557	699,437,913	699,437,913
Osmaniye	241,981,688	295,455,134	1,033,543,343	1,177,700,418	1,189,731,991	1,189,731,991
Rize	346,667,855	410,562,289	563,164,288	632,996,332	686,973,940	686,973,940
Siirt	612,744,557	679,203,305	679,203,305	645,769,977	679,203,305	679,203,305
Sinop	161,369,884	184,981,322	184,981,322	237,624,471	240,732,452	240,732,452
Sivas	152,424,362	220,932,086	1,205,862,026	1,373,635,624	1,396,345,371	1,396,345,371
Şırnak	537,516,914	646,397,339	1,000,671,143	982,960,137	1,071,823,850	1,071,823,850
Tokat	215,122,459	317,713,651	398,746,635	488,989,630	518,103,381	518,103,381
Tunceli	35,314,682	79,332,078	79,332,078	132,882,091	171,134,141	171,134,141
Uşak	54,482,407	106,127,443	106,127,443	141,711,549	147,096,304	147,096,304
Yalova	128,282,660	128,282,660	128,282,660	50,009,334	53,204,917	53,204,917
Yozgat	252,200,224	351,147,937	623,863,383	764,553,984	789,495,326	789,495,326
Zonguldak	385,396,509	490,595,169	980,903,557	933,696,420	976,475,536	1,130,225,549

Table G.14: Summary of Results for All Scenarios Representing the Amortization Costs in Provinces Outside of Metropolitan Municipalities (EUR)

Sensitivity	A			B		
Scenarios	S1A	S2A	S3A	S1B	S2B	S3B
Total Values	**5,671,610,720**	**6,252,128,849**	**6,817,489,934**	**6,505,085,223**	**6,890,075,240**	**7,134,347,069**
Adıyaman	364,577,616	382,351,583	382,351,583	351,172,940	365,318,125	389,908,513
Afyonkarahisar	105,369,792	116,999,566	116,999,566	101,628,445	125,612,692	125,612,692
Ağrı	271,212,885	280,689,390	303,531,708	300,445,496	300,445,496	308,184,118
Aksaray	187,034,526	189,452,861	189,452,861	130,521,044	151,062,382	187,907,244
Amasya	29,832,083	33,206,255	48,496,647	66,977,359	66,977,359	66,977,359
Ardahan	50,038,811	57,014,665	57,014,665	55,610,220	59,826,204	59,826,204
Artvin	103,789,483	108,933,347	108,933,347	117,534,830	119,327,078	119,327,078
Bartın	19,294,352	26,623,421	33,307,784	32,108,730	33,307,784	33,307,784
Batman	395,556,471	400,097,954	400,097,954	403,271,059	405,218,408	405,218,408
Bayburt	52,180,237	56,499,066	56,499,066	56,803,874	61,122,703	61,122,703
Bilecik	24,564,405	32,736,297	45,586,431	48,506,266	53,564,234	53,564,234
Bingöl	146,669,423	155,689,326	175,135,570	168,538,405	175,135,570	175,135,570
Bitlis	170,385,614	176,467,873	176,467,873	163,965,310	171,395,650	178,460,210
Bolu	14,487,546	23,835,805	51,069,307	24,009,836	32,270,525	59,504,027
Burdur	67,154,287	75,016,773	75,016,773	63,652,823	67,239,803	86,377,211
Çanakkale	67,457,631	76,871,739	85,887,546	76,595,382	85,103,826	94,119,633
Çankırı	22,747,655	30,778,947	38,473,719	40,330,294	40,330,294	40,330,294
Çorum	30,611,291	38,183,180	83,996,839	99,482,079	101,872,126	101,872,126
Düzce	19,708,829	33,792,990	33,792,990	42,147,325	42,147,325	42,147,325
Edirne	242,346,716	253,554,724	265,040,497	258,392,041	265,040,497	265,040,497
Elazığ	400,826,398	425,533,528	447,576,748	400,826,398	425,533,528	447,576,748
Erzincan	165,022,025	191,918,905	201,147,295	172,633,583	191,918,905	201,147,295
Giresun	159,063,948	179,840,540	187,798,435	176,320,608	189,696,877	197,654,772
Gümüşhane	20,867,748	33,810,201	33,810,201	29,933,872	36,735,959	36,735,959
Hakkari	157,081,638	165,769,648	179,115,474	169,306,652	174,389,333	181,499,913
Iğdır	106,846,795	117,107,522	125,541,086	106,846,795	117,107,522	125,541,086
Isparta	29,210,295	40,935,244	79,899,921	75,379,195	93,961,514	93,961,514
Karabük	16,703,225	23,474,181	44,769,529	19,268,822	23,474,181	44,769,529
Karaman	69,814,179	74,253,147	74,253,147	60,435,356	67,903,503	79,068,245
Kars	136,664,532	143,579,794	151,482,181	149,905,621	156,820,883	156,820,883
Kastamonu	39,037,237	58,947,463	66,753,045	65,061,134	76,716,944	76,716,944
Kırıkkale	25,241,305	33,950,464	33,950,464	35,233,699	36,580,661	36,580,661
Kırklareli	217,590,420	230,600,953	230,600,953	226,550,883	230,600,953	230,600,953
Kırşehir	31,871,131	38,432,949	38,432,949	40,501,591	43,518,260	43,518,260
Kilis	76,059,030	78,081,389	86,784,799	76,651,107	78,081,389	86,784,799
Kütahya	24,339,049	47,735,297	54,804,387	56,280,172	68,067,140	68,067,140
Muş	224,657,131	243,938,328	252,504,461	240,733,937	251,955,209	260,521,341
Nevşehir	26,821,450	43,241,551	65,953,156	79,999,047	82,151,436	82,151,436
Niğde	121,061,746	129,204,428	129,204,428	105,909,284	129,204,428	129,204,428
Osmaniye	117,765,678	128,667,666	178,183,150	188,073,072	190,714,818	190,714,818
Rize	120,430,038	134,059,022	142,141,611	142,114,475	153,305,820	153,305,820
Siirt	213,545,597	226,349,783	226,349,783	219,699,812	226,349,783	226,349,783
Sinop	48,696,614	53,465,878	53,465,878	58,419,742	59,143,998	59,143,998
Sivas	78,268,248	92,440,835	142,499,139	155,206,479	160,093,922	160,093,922
Şırnak	313,617,842	335,121,502	358,816,518	345,044,501	362,320,169	362,320,169
Tokat	50,629,491	71,657,126	78,280,560	82,775,815	88,788,757	88,788,757
Tunceli	60,032,260	69,114,238	69,114,238	71,771,414	79,658,856	79,658,856
Uşak	27,598,222	38,165,774	38,165,774	41,681,340	42,809,450	42,809,450
Yalova	23,563,444	23,563,444	23,563,444	11,464,906	12,317,598	12,317,598
Yozgat	72,514,728	93,162,357	118,698,534	129,161,090	134,402,434	134,402,434
Zonguldak	111,149,622	137,209,932	176,675,918	170,201,064	183,432,932	191,576,327

Table G.15: Total Additional Costs and Breakdown by Incremental Investments, Total O&M and Amortization Costs for Provinces Outside MMs for Scenarios S1A, S3A and S1B (in EUR million)

Province	S1A				S3A				S1B			
	Total cost	Investments Required	Cumulated O&M during lifetime	Amortization cost	Total cost	Investments Required	Cumulated O&M during lifetime	Amortization cost	Total cost	Investments Required	Cumulated O&M during lifetime	Amortization cost
Adıyaman	**1,612**	122	1,126	365	**1,721**	127	1,212	382	**1,234**	118	764	351
Afyonkarahisar	**534**	33	396	105	**604**	36	451	117	**540**	32	407	102
Ağrı	**861**	92	498	271	**1,290**	101	885	304	**1,254**	100	853	300
Aksaray	**1,095**	61	847	187	**1,110**	61	859	189	**333**	45	158	131
Amasya	**263**	9	224	30	**500**	14	437	48	**697**	19	610	67
Ardahan	**122**	17	55	50	**165**	19	89	57	**169**	19	95	56
Artvin	**312**	35	173	104	**345**	36	200	109	**444**	39	288	118
Bartın	**127**	6	102	19	**262**	10	218	33	**262**	10	220	32
Batman	**1,981**	133	1,452	396	**2,009**	134	1,474	400	**2,053**	135	1,514	403
Bayburt	**146**	18	76	52	**172**	19	96	56	**204**	19	128	57
Bilecik	**215**	7	184	25	**438**	13	380	46	**492**	14	429	49
Bingöl	**316**	50	118	147	**693**	59	459	175	**667**	57	442	169
Bitlis	**703**	56	476	170	**740**	58	506	176	**621**	54	402	164
Bolu	**30**	5	11	14	**539**	15	472	51	**117**	8	85	24
Burdur	**402**	21	313	67	**450**	24	351	75	**315**	20	231	64
Çanakkale	**448**	21	360	67	**680**	26	567	86	**544**	24	443	77
Çankırı	**152**	7	123	23	**309**	12	259	38	**337**	12	284	40
Çorum	**158**	10	118	31	**964**	25	855	84	**1,174**	29	1,045	99
Düzce	**41**	7	14	20	**136**	11	91	34	**215**	13	159	42
Edirne	**665**	83	339	242	**965**	90	611	265	**947**	88	601	258
Elazığ	**1,323**	137	786	401	**2,037**	150	1,439	448	**1,323**	137	786	401
Erzincan	**442**	57	221	165	**745**	67	477	201	**490**	59	258	173
Giresun	**632**	53	420	159	**916**	61	668	188	**783**	58	548	176
Gümüşhane	**85**	7	57	21	**164**	10	120	34	**156**	9	117	30
Hakkari	**468**	53	257	157	**706**	59	467	179	**606**	57	380	169
Iğdır	**308**	36	165	107	**497**	42	330	126	**308**	36	165	107
Isparta	**117**	9	79	29	**836**	24	732	80	**875**	23	777	75
Karabük	**29**	6	7	17	**426**	14	367	45	**47**	7	21	19
Karaman	**580**	22	488	70	**607**	24	509	74	**355**	20	275	60
Kars	**395**	46	212	137	**549**	50	347	151	**572**	50	372	150
Kastamonu	**278**	12	226	39	**545**	20	458	67	**593**	20	508	65
Kırıkkale	**82**	8	48	25	**137**	11	92	34	**156**	11	109	35
Kırklareli	**400**	76	107	218	**478**	79	168	231	**455**	78	150	227
Kırşehir	**107**	11	65	32	**147**	12	96	38	**184**	13	130	41
Kilis	**246**	26	144	76	**383**	29	268	87	**249**	26	147	77
Kütahya	**180**	7	149	24	**420**	16	349	55	**490**	16	417	56
Muş	**619**	76	318	225	**859**	84	522	253	**755**	81	434	241
Nevşehir	**89**	9	53	27	**466**	20	380	66	**603**	24	499	80
Niğde	**818**	38	659	121	**869**	41	699	129	**726**	34	586	106
Osmaniye	**399**	39	242	118	**1,268**	57	1,034	178	**1,425**	60	1,178	188
Rize	**507**	40	347	120	**751**	46	563	142	**821**	46	633	142
Siirt	**898**	72	613	214	**981**	75	679	226	**939**	74	646	220
Sinop	**226**	16	161	49	**255**	17	185	53	**314**	18	238	58
Sivas	**257**	26	152	78	**1,393**	44	1,206	142	**1,577**	48	1,374	155
Şırnak	**958**	106	538	314	**1,479**	119	1,001	359	**1,443**	115	983	345
Tokat	**282**	16	215	51	**501**	24	399	78	**597**	25	489	83
Tunceli	**116**	21	35	60	**172**	23	79	69	**229**	24	133	72
Uşak	**91**	9	54	28	**156**	12	106	38	**197**	13	142	42
Yalova	**159**	7	128	24	**159**	7	128	24	**65**	4	50	11
Yozgat	**348**	23	252	73	**779**	36	624	119	**933**	39	765	129
Zonguldak	**533**	36	385	111	**1,214**	56	981	177	**1,158**	54	934	170

Appendix H: Results of Cost Estimates in River Basins and Financial Impacts per Person

The following Tables H.1 through H.7 and Figures H.1 and H.2 show the existing assets, incremental required investments, incremental O&M costs, amortization of incremental assets, and financial impact per capita for each river basin according to the six scenarios assessed.

It should be mentioned again that for the Meriç-Ergene, Asi, Dicle-Fırat, Çoruh, and Aras river basins there was no publicly available data from RBPAPs. This means the existing infrastructure for settlements within these basins are potentially underestimated due to lack of data.

The repayment for loans in the below tables show the amount of money to be paid back, assuming all the required investments (incremental assets) are financed by a loan. For the purposes of this calculation it is assumed that; an IlBank loan with an interest rate of 7 percent and a 15-year repayment period was used for the financing of new investment, and that the replacement costs for equipment in future are to be covered by the relevant SKI or its Metropolitan Municipality using its own resources.

Finally, the financial impact of the additional investments per person is calculated by taking into account the incremental O&M costs, amortization costs for incremental investments, and repayment for loans over the useful life of investments, which is 50 years.

Table H.1: Summary of Results for Scenario S1A in River Basins

Basin	Total Population in Urban Centers	Existing Assets (EUR million)	Incremental Assets (EUR million)	Incremental O&M (EUR/year)	Incremental O&M for 50 years (EUR million)	Incremental assets Amortization (EUR million)	Repayment for loans (EUR million)	Financial Impact per person (EUR/cap/yr)
AKARÇAY	476.293	152	32	5	528	104	53	29
ANTALYA	1.686.696	304	50	1	118	144	83	4
ARAS	477.903	1	168	7	740	495	281	63
ASİ	855.285	15	259	14	1.583	768	434	65
BATI AKDENİZ	584.660	138	79	3	375	235	133	25
BATI KARADENİZ	1.097.059	315	76	6	683	231	127	19
BURDUR	136.265	42	15	3	317	51	25	58
BÜYÜK MENDERES	1.618.944	419	127	18	2.015	392	214	32
CEYHAN	1.422.466	309	99	15	1.662	310	165	30
ÇORUH	180.480	0	75	3	287	222	126	70
DICLE-FIRAT	8.253.383	57	2.085	131	14.722	6.162	3.493	59
DOĞU AKDENİZ	1.441.182	238	93	6	645	276	156	15
DOĞU KARADENİZ	1.580.805	335	255	17	1.966	768	428	40
GEDİZ	1.109.908	282	57	3	331	169	96	11
KIZILIRMAK	3.103.800	751	94	10	1.156	296	157	10
KONYA CLOSED	2.120.197	364	182	29	3.275	575	305	39
KUZEY EGE	588.204	159	51	8	959	165	85	41
KÜÇÜK MENDERES	3.334.304	505	56	3	308	166	93	3
MARMARA	16.991.655	1.898	746	503	56.788	2.475	1.249	71
MERİÇ-ERGENE	863.380	43	242	6	660	702	406	41
SAKARYA	7.201.109	1.124	112	9	992	342	187	4
SEYHAN	1.685.613	213	27	2	233	84	46	4
SUSURLUK	2.580.204	463	37	7	821	124	62	8
VAN GÖLÜ	627.806	87	124	17	1.872	386	208	79
YEŞİLIRMAK	1.780.457	500	88	19	2.179	287	148	29

Table H.2: Summary of Results for Scenario S2A in River Basins

Basin	Total Population in Urban Centers	Existing Assets (EUR million)	Incremental Assets (EUR million)	Incremental O&M (EUR/year)	Incremental O&M for 50 years (EUR million)	Incremental assets Amortization (EUR million)	Repayment for loans (EUR million)	Financial Impact per person (EUR/cap)
AKARÇAY	152	32	5	528	104	53	29	152
ANTALYA	304	56	2	222	165	93	6	304
ARAS	1	175	8	861	519	293	70	1
ASİ	15	260	14	1.599	772	436	66	15
BATI AKDENİZ	138	80	3	395	239	135	26	138
BATI KARADENİZ	314	99	9	1.032	308	165	27	314
BURDUR	42	15	3	317	51	25	58	42
BÜYÜK MENDERES	419	137	19	2.180	425	229	35	419
CEYHAN	309	103	15	1.740	326	173	31	309
ÇORUH	0	80	3	372	238	134	83	0
DICLE-FIRAT	57	2.139	139	15.677	6.351	3.584	62	57
DOĞU AKDENİZ	238	97	6	702	289	162	16	238
DOĞU KARADENİZ	335	274	20	2.274	831	459	45	335
GEDİZ	282	59	3	367	176	99	12	282
KIZILIRMAK	751	117	14	1.549	376	196	14	751
KONYA CLOSED	364	182	29	3.275	575	305	39	364
KUZEY EGE	159	51	9	960	166	85	41	159
KÜÇÜK MENDERES	505	56	3	308	166	93	3	505
MARMARA	1.898	750	504	56.843	2.489	1.257	71	1.898
MERİÇ-ERGENE	43	249	7	769	725	416	44	43
SAKARYA	1.124	125	11	1.223	387	209	5	1.124
SEYHAN	213	29	2	263	90	49	5	213
SUSURLUK	463	43	8	917	144	71	9	463
VAN GÖLÜ	87	124	17	1.872	386	208	79	87
YEŞİLIRMAK	500	103	22	2.427	338	172	33	500

Table H.3: Summary of Results for Scenario S3A in River Basins

Basin	Total Population in Urban Centers	Existing Assets (EUR million)	Incremental Assets (EUR million)	Incremental O&M (EUR/ year)	Incremental O&M for 50 years (EUR million)	Incremental assets Amortization (EUR million)	Repayment for loans (EUR million)	Financial Impact per person (EUR/ cap)
AKARÇAY	152	32	5	528	104	53	29	152
ANTALYA	304	67	7	817	204	112	13	304
ARAS	1	182	10	1.172	543	304	85	1
ASİ	15	275	21	2.333	824	461	85	15
BATI AKDENİZ	137	91	6	729	276	153	40	137
BATI KARADENİZ	311	118	17	1.930	375	198	46	311
BURDUR	42	15	3	317	51	25	58	42
BÜYÜK MENDERES	419	157	27	3.072	496	263	47	419
CEYHAN	309	137	33	3.753	446	230	62	309
ÇORUH	0	80	3	372	238	134	83	0
DICLE-FIRAT	57	2.270	231	26.067	6.809	3.803	89	57
DOĞU AKDENİZ	236	109	10	1.079	330	183	22	236
DOĞU KARADENİZ	335	294	30	3.409	901	492	61	335
GEDİZ	282	80	12	1.402	248	133	32	282
KIZILIRMAK	751	193	65	7.370	643	324	54	751
KONYA CLOSED	364	182	29	3.275	575	305	39	364
KUZEY EGE	159	55	10	1.150	181	93	48	159
KÜÇÜK MENDERES	505	66	7	824	202	111	7	505
MARMARA	1.898	764	512	57.738	2.539	1.280	72	1.898
MERİÇ-ERGENE	43	254	9	1.068	743	425	52	43
SAKARYA	1.124	293	170	19.226	975	491	57	1.124
SEYHAN	213	80	54	6.140	267	133	78	213
SUSURLUK	463	69	18	2.086	235	115	19	463
VAN GÖLÜ	87	124	17	1.872	386	208	79	87
YEŞİLIRMAK	500	125	31	3.521	414	209	47	500

Table H.4: Summary of Results for Scenario S1B in River Basins

Basin	Total Population in Urban Centers	Existing Assets (EUR million)	Incremental Assets (EUR million)	Incremental O&M (EUR/ year)	Incremental O&M for 50 years (EUR million)	Incremental assets Amortization (EUR million)	Repayment for loans (EUR million)	Financial Impact per person (EUR/ cap)
AKARÇAY	152	21	2	217	67	36	13	152
ANTALYA	304	73	9	1.062	224	122	17	304
ARAS	1	176	9	1.039	525	295	78	1
ASİ	15	280	23	2.582	841	469	91	15
BATI AKDENİZ	134	107	10	1.152	328	178	57	134
BATI KARADENİZ	311	111	15	1.664	352	186	40	311
BURDUR	42	5	0	20	14	8	6	42
BÜYÜK MENDERES	419	181	34	3.889	579	303	59	419
CEYHAN	309	144	37	4.170	469	242	69	309
ÇORUH	0	82	4	473	244	137	95	0
DICLE-FIRAT	57	2.213	213	23.989	6.609	3.707	83	57
DOĞU AKDENİZ	236	104	8	955	312	174	20	236
DOĞU KARADENİZ	337	281	27	3.008	859	471	55	337
GEDİZ	282	89	16	1.756	281	149	39	282
KIZILIRMAK	751	214	74	8.353	715	358	61	751
KONYA CLOSED	364	142	15	1.744	436	238	23	364
KUZEY EGE	159	51	9	984	166	85	42	159
KÜÇÜK MENDERES	505	68	8	874	208	113	7	505
MARMARA	1.899	705	457	51.555	2.334	1.181	65	1.899
MERİÇ-ERGENE	43	249	9	965	727	417	49	43
SAKARYA	1.124	306	182	20.528	1.020	512	61	1.124
SEYHAN	213	86	58	6.572	291	145	83	213
SUSURLUK	463	79	22	2.530	272	133	23	463
VAN GÖLÜ	87	108	10	1.074	331	182	51	87
YEŞİLIRMAK	500	132	31	3.531	440	221	47	500

Table H.5: Summary of Results for Scenario S2B in River Basins

Basin	Total Population in Urban Centers	Existing Assets (EUR million)	Incremental Assets (EUR million)	Incremental O&M (EUR/ year)	Incremental O&M for 50 years (EUR million)	Incremental assets Amortization (EUR million)	Repayment for loans (EUR million)	Financial Impact per person (EUR/ cap)
AKARÇAY	152	25	3	288	82	43	17	152
ANTALYA	304	76	10	1.115	235	127	18	304
ARAS	1	182	10	1.146	547	306	84	1
ASİ	15	281	23	2.595	843	470	91	15
BATI AKDENİZ	134	107	10	1.152	328	178	57	134
BATI KARADENİZ	311	120	16	1.779	382	201	43	311
BURDUR	42	10	1	111	32	16	23	42
BÜYÜK MENDERES	419	183	35	3.931	587	307	60	419
CEYHAN	309	146	37	4.194	475	244	69	309
ÇORUH	0	84	5	520	253	141	101	0
DICLE-FIRAT	57	2.252	219	24.686	6.746	3.773	85	57
DOĞU AKDENİZ	236	107	9	1.008	324	180	21	236
DOĞU KARADENİZ	337	291	28	3.176	894	488	58	337
GEDİZ	282	91	16	1.787	287	152	40	282
KIZILIRMAK	751	219	75	8.445	734	367	62	751
KONYA CLOSED	364	157	18	2.006	489	263	26	364
KUZEY EGE	159	51	9	986	166	86	42	159
KÜÇÜK MENDERES	505	68	8	874	208	113	7	505
MARMARA	1.899	709	458	51.608	2.348	1.189	65	1.899
MERİÇ-ERGENE	43	252	9	1.007	736	422	50	43
SAKARYA	1.124	314	183	20.665	1.048	525	62	1.124
SEYHAN	213	86	58	6.572	291	145	83	213
SUSURLUK	463	80	23	2.550	276	135	23	463
VAN GÖLÜ	87	109	10	1.085	333	183	51	87
YEŞİLIRMAK	500	138	32	3.634	461	231	49	500

Table H.6: Summary of Results for Scenario S3B in River Basins

Basin	Total Population in Urban Centers	Existing Assets (EUR million)	Incremental Assets (EUR million)	Incremental O&M (EUR/ year)	Incremental O&M for 50 years (EUR million)	Incremental assets Amortization (EUR million)	Repayment for loans (EUR million)	Financial Impact per person (EUR/ cap)
AKARÇAY	152	31	4	476	100	51	26	152
ANTALYA	304	76	10	1.115	235	127	18	304
ARAS	1	187	12	1.355	563	313	93	1
ASİ	15	281	23	2.595	843	470	91	15
BATI AKDENİZ	134	107	10	1.152	328	178	57	134
BATI KARADENİZ	311	129	20	2.258	411	215	53	311
BURDUR	42	15	3	308	51	25	56	42
BÜYÜK MENDERES	419	183	35	3.931	587	307	60	419
CEYHAN	309	146	37	4.194	475	244	69	309
ÇORUH	0	84	5	520	253	141	101	0
DICLE-FIRAT	57	2.294	242	27.292	6.894	3.844	92	57
DOĞU AKDENİZ	236	114	11	1.244	346	191	25	236
DOĞU KARADENİZ	335	308	35	3.925	951	516	68	335
GEDİZ	282	91	16	1.787	287	152	40	282
KIZILIRMAK	751	219	75	8.445	734	367	62	751
KONYA CLOSED	364	173	26	2.930	545	290	36	364
KUZEY EGE	159	53	10	1.084	174	89	46	159
KÜÇÜK MENDERES	505	70	8	954	214	117	8	505
MARMARA	1.899	763	508	57.342	2.536	1.279	72	1.899
MERİÇ-ERGENE	43	254	10	1.089	743	425	52	43
SAKARYA	1.124	314	183	20.665	1.048	525	62	1.124
SEYHAN	213	86	58	6.572	291	145	83	213
SUSURLUK	463	80	23	2.550	276	135	23	463
VAN GÖLÜ	87	120	15	1.680	372	201	72	87
YEŞİLIRMAK	500	146	37	4.196	488	244	55	500

Figure H.1: Comparison of Existing and Incremental Investments in River Basins according to Scenarios S1A, S1B, and S3A

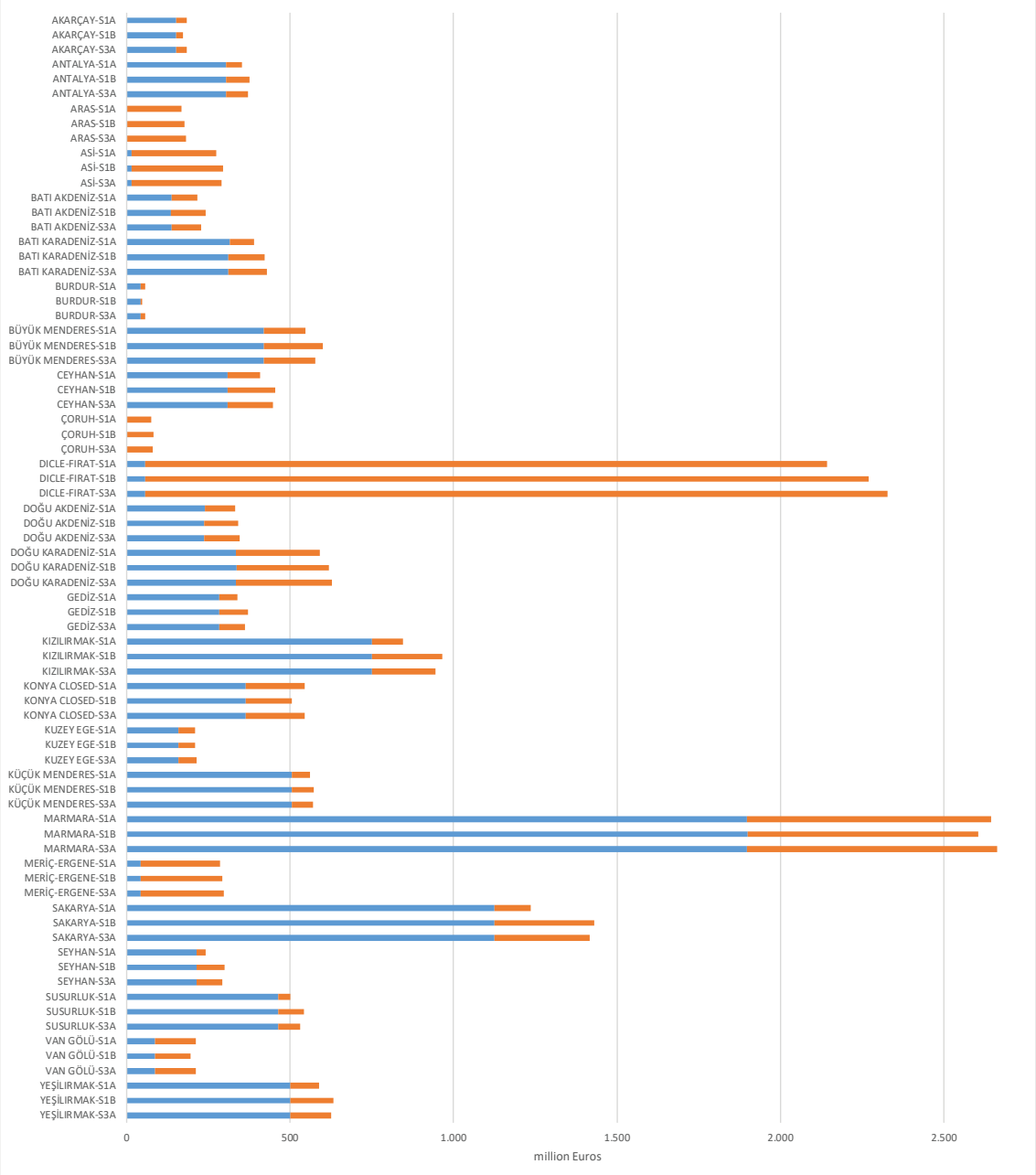
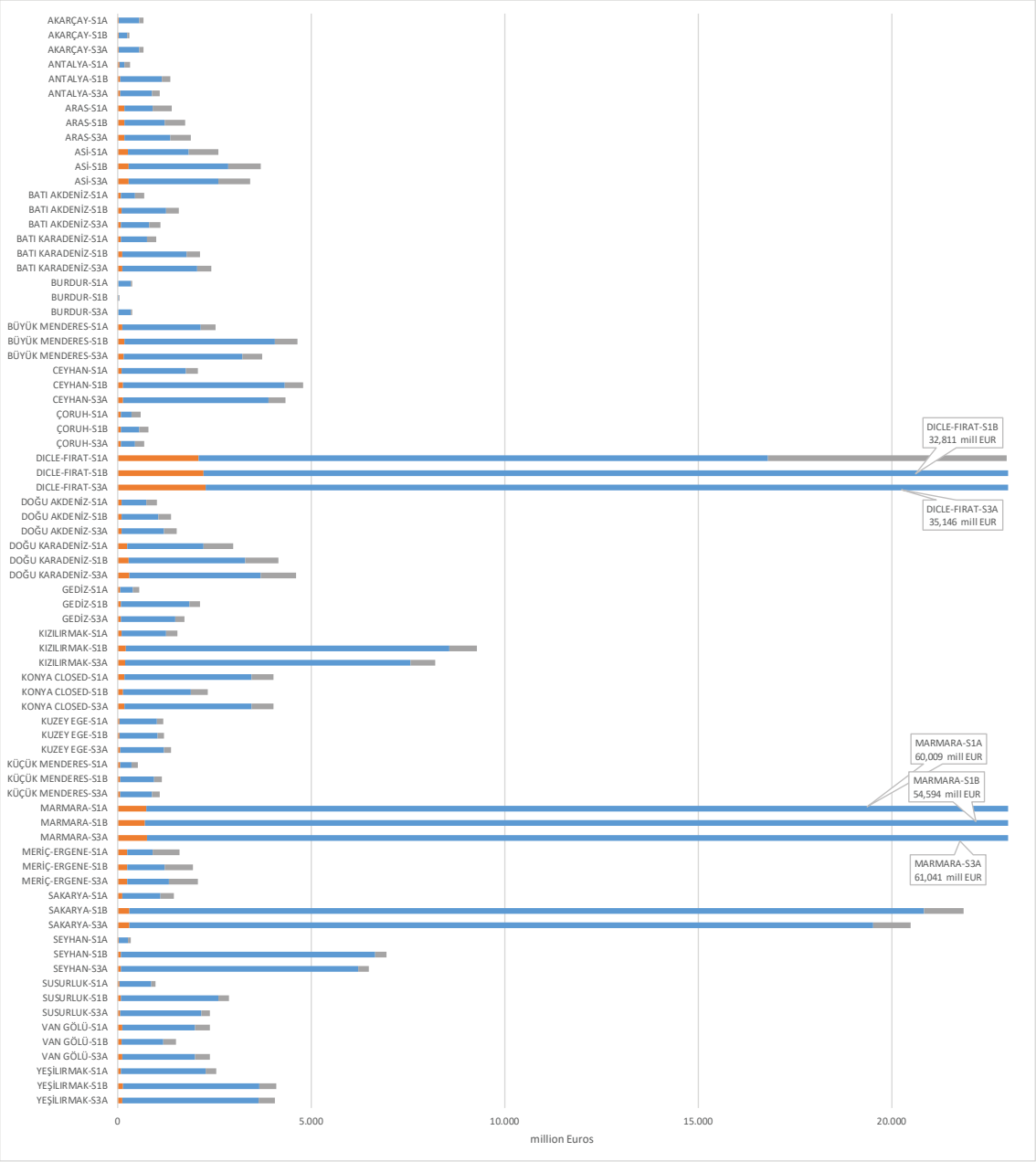


Table H.7: Total Incremental Costs including Incremental Investment, Cumulated O&M during Lifetime of the Investments and Amortization Costs for River Basins for Scenarios S1A, S3A, and S1B (EUR million).

River Basin	S1A				S3A				S1B			
	Total costs	Investments Required	Cumulated O&M during lifetime	Amortization costs	Total costs	Investments Required	Cumulated O&M during lifetime	Amortization costs	Total costs	Investments Required	Cumulated O&M during lifetime	Amortization costs
AKARÇAY	664	32	528	104	664	32	528	104	306	21	217	67
ANTALYA	312	50	118	144	1,088	67	817	204	1,359	73	1,062	224
ARAS	1,403	168	740	495	1,897	182	1,172	543	1,740	176	1,039	525
ASİ	2,610	259	1,583	768	3,431	275	2,333	824	3,702	280	2,582	841
BATI AKDENİZ	690	79	375	235	1,096	91	729	276	1,587	107	1,152	328
BATI KARADENİZ	990	76	683	231	2,423	118	1,930	375	2,127	111	1,664	352
BURDUR	383	15	317	51	383	15	317	51	38	5	20	14
BÜYÜK MENDERES	2,535	127	2,015	392	3,726	157	3,072	496	4,650	181	3,889	579
CEYHAN	2,071	99	1,662	310	4,336	137	3,753	446	4,784	144	4,170	469
ÇORUH	585	75	287	222	691	80	372	238	798	82	473	244
DICLE-FIRAT	22,969	2,085	14,722	6,162	35,145	2,270	26,067	6,809	32,810	2,213	23,989	6,609
DOĞU AKDENİZ	1,014	93	645	276	1,519	109	1,079	330	1,371	104	955	312
DOĞU KARADENİZ	2,989	255	1,966	768	4,605	294	3,409	901	4,149	281	3,008	859
GEDİZ	557	57	331	169	1,730	80	1,402	248	2,125	89	1,756	281
KIZILIRMAK	1,545	94	1,156	296	8,206	193	7,370	643	9,281	214	8,353	715
KONYA CLOSED	4,032	182	3,275	575	4,032	182	3,275	575	2,322	142	1,744	436
KUZEY EGE	1,175	51	959	165	1,386	55	1,150	181	1,201	51	984	166
KÜÇÜK MENDERES	530	56	308	166	1,092	66	824	202	1,149	68	874	208
MARMARA	60,009	746	56,788	2,475	61,042	764	57,738	2,539	54,594	705	51,555	2,334
MERİÇ-ERGENE	1,605	242	660	702	2,065	254	1,068	743	1,942	249	965	727
SAKARYA	1,446	112	992	342	20,494	293	19,226	975	21,854	306	20,528	1,020
SEYHAN	344	27	233	84	6,486	80	6,140	267	6,949	86	6,572	291
SUSURLUK	983	37	821	124	2,389	69	2,086	235	2,881	79	2,530	272
VAN GÖLÜ	2,383	124	1,872	386	2,383	124	1,872	386	1,513	108	1,074	331
YEŞİLIRMAK	2,554	88	2,179	287	4,060	125	3,521	414	4,103	132	3,531	440

Figure H.2: Comparison of Total Incremental Costs in River Basins according to Scenarios S1A, S1B, and S3A



Appendix I: Summary of the High-Level Workshop

A high-level workshop entitled **"Reaching Compliance with EU Requirements on Water Supply and Sanitation in a Sustainable Way: Challenges and Opportunities for Turkey"** took place on October 18, 2016 in Ankara, Turkey. Organized jointly by the World Bank (WB) and the General Directorate for Water Management (GDWM) of the Ministry of Forestry and Water Affairs (MoFWA), the workshop was funded by the Water Partnership Program. It built on a Preliminary Report independently carried out by the World Bank, which was disseminated by the GDWM of the MoFWA in the letter of invitation to the workshop.

The workshop was made up of 97 participants, of which 78 were from Turkish key sector institutions, four officials were from Croatia, and one attendee from France, and seven World Bank and organizing team staff. Twenty-four of the 30 SKIs were represented at the workshop, 15 of them by their General Director and 5 by their Deputy General Director. The workshop was designed to be a platform to discuss and analyze the challenges and opportunities linked to providing water supply and sanitation services in a sustainable way to the entire population in Turkey.

The workshop was opened by the Country Director for Turkey Johannes Zutt and by the Deputy General Director for Water Management of the MoFWA, Abdurrahman Uluirmak.

Mr. Xavier Chauvot de Beauchene, from the World Bank, presented the main findings of the Preliminary Report and set the stage for a broad discussion of sustainable service provision in Turkey. The main point of the presentation was to demonstrate that developing sustainable access and service provision requires efficient investment, which entails not only considering the investment cost, but also considering the total cost, including costs of operations performance and of improvement of existing infrastructure.

National good practices

The workshop showcased three cases of good WSS management practices in Turkey: The water efficiency improvement in Konya; treated wastewater reuse for green areas irrigation in Konya; and highly integrated sludge drying and co-generation in Antalya.

KOSKI (Konya) officials reported on two good practices: (i) the use of an advanced SCADA system for the improvement of the company's efficiency, with significant results on staff use, energy consumption, and reduction of Non-Revenue Water (NRW); and (ii) the treated wastewater reuse system, currently at a pilot scale, for the watering of vegetation along main roads and streets in the city as well as reforested areas.

Konya Efficiency Improvement

Konya is in the driest part of Turkey and only receives 250 mm of precipitation a year. This places Konya at the limit between the commonly accepted definitions of semi-arid and desert land. The combination of population growth, rapid urbanization, and economic growth increased industrial and agricultural water demand much beyond the forecasted demand. This translated into high overconsumption of the scarce water resources available to supply Konya, way beyond the renewable water levels. Three different resources are used for domestic and industrial water demand: surface water, groundwater, and spring water. 90 percent of water demand is supplied from groundwater. Predicted groundwater regeneration was 2.4 billion m^3/year in 2010 while water withdrawal was 3.83 billion m^3/year. The 1.43 billion m^3 yearly deficit caused a 27 m decrease in groundwater level over 30 years. High water losses are a paradox in a place where water is so scarce. It worsens groundwater overexploitation. Aiming for more sustainable water management practices is an absolute necessity for KOSKİ. It requires achieving more efficiency in water resources and distribution management and raising awareness of the public on the need to save water and promote rainwater harvesting.

To develop more sustainable water management practices in Konya requires that KOSKI must be able to improve its monitoring of its large water supply network and facilities. Therefore, a SCADA system was established in 2007 for more efficient use of water resources. KOSKI used SCADA to identify where leaks were occurring. KOSKI worked on network repair and renewal activities, from big diameters to house connections. It created pressure zones, replaced pumps to ensure they worked close to peak efficiency, and optimized pressure management to save energy and reduce leakages. In the process, KOSKI recorded relevant information in its SCADA and linked it to its GIS system, which allowed officials to both improve current service quality and efficiency and allow for future preventative maintenance.

Konya has managed to use SCADA as a powerful management tool to improve the overall efficiency of KOSKI, not only in terms of NRW reduction, but also in terms of energy efficiency, staffing efficiency, customer management improvement, and preventive maintenance development. As a result, KOSKI generated significant efficiency gains that allowed them to recover the cost of the SCADA system within 6 months and make it a profitable tool for KOSKI thereafter. KOSKI exceeded the targeted savings achievements and efficient use of resources faster than anticipated and has thrived in maintaining this good performance over time, in spite of the demographic, economic, and perimeter extension evolution.

One of the most striking achievements is the reduction of Non-Revenue Water (NRW) from 66 percent in 2001 to 27 percent in 2015, despite the demographic increase and urban/economic development of Konya during that period. Supplied and billed amounts of water delivered to the city in 2015 were respectively 86 million m^3 and 63 million m^3, corresponding to 27 percent NRW.

Following the March 2014 reform, KOSKI is now responsible for service provision to a much larger service area. It expanded from the urban center (previously defined as the Metropolitan Municipality) to the scale of the entire Konya province. This means that KOSKI is expected to deliver the same quality of service to its extended service area. This represents an unprecedented challenge. As it consolidates the service provision at the scale of the entire province, KOSKI is rolling out the SCADA system to replicate the same approach to its enlarged service area, using its own funds.

Konya Treated Wastewater Reuse

Konya WWTP has been operating since 2009. The treated wastewater is discharged to an irrigation canal in the catchment area of the salt lake, a closed basin defined as a sensitive area. KOSKI therefore has to treat the wastewater to remove nutrients. The plant is designed for Carbon (C) and partial Nitrogen (N) removal. The WWTP is also equipped with a biogas system, which is used to generate energy. In its effort to optimize its operations, KOSKI created a subsidiary to manage its electricity generation (biogas digestion) and to explore avenues for more renewable energy development.

In the second stage, P removal is also targeted in addition to C and N removal, in compliance with EU standards. Konya WWTP discharge is introduced to tertiary treatment before irrigation of limited urban green areas (purple network project). Treated wastewater effluent is used in irrigation of urban green areas (parks, pavements, and so forth) after being tertiary treated in a pilot plant having 150 m3/h capacity. Tertiary treatment is composed of multimedia filtration (MMF), microfiltration (MF), Ultrafiltration (UF) and pre-chlorination-ultraviolet disinfection (UV). In addition, post chlorination systems are used as tertiary treatment. The system has a 24 km long drip irrigation system.

Before the project, commenced, KOSKI did not collect revenue from the downstream use of the treated wastewater in irrigation, and the municipality used to water its green areas using drinking water delivered by trucks. The project built a win-win situation: the municipality got its green and forested areas irrigated through modern water efficient drip irrigation systems, saving the cost of truck and staff who were watering ‘manually’; while KOSKI got revenue from the

treated wastewater reused by the municipality and could allocate the drinking water previously used for watering to supply more people. The treated wastewater reuse is overall very positive for the municipality, for KOSKI, and for the environment because it allows mitigating the pressure on already threatened resources.

The pilot plant with a capacity of 150 m^3/hour has been operated since 2012 and 3.2 million m^2 green area has been irrigated for four years. The amount of wastewater reused in irrigation is around 400.000 m^3/year, which corresponds to the monthly drinking water consumption of about 6,700 people (5m^3 /cap. /month).

Optimized Sludge Management and Disposal in Antalya

ASAT (Antalya) officials made a presentation on their experience in resource recovery through: (i) biogas generation from sludge and (ii) its pragmatic win-win dried sludge disposal arrangement. Antalya sludge management is an example of an integrated and optimized system. It combines sludge dewatering with a cogeneration installation that uses a combination of biogas, natural gas, and heating oil, and the innovative and pragmatic final reuse of the sludge as fuel in a cement factory located 360km away in Konya province.

Biogas generation using anaerobic sludge digestion is a very common method widely used in domestic WWTP's to use sludge as a resource not as a waste to be disposed of. What is not so common is the level of integration which ASAT has put in place and the win-win solution it developed for sludge disposal. Antalya WWTP (Hurma) is equipped with 4 anaerobic digesters (each 9.000 m^3) generating 12.000 m^3/day biogas. Electricity generation from biogas in the cogeneration plant is 45 MW/day. Due to high electricity tariffs, ASAT officials considered generating electricity with a cogeneration plant using biogas produced in anaerobic digesters. Electricity is generated in a cogeneration plant with a Natural-gas/Biogas gas engine having 1950 kW power together with 2 MW heat-energy produced from the hot water generated during engine cooling and the gas engine exhaust gas. 2MW energy is also produced from a thermal oil circuit. The cogeneration plant is operated in a way that optimizes the electricity production by adjusting the operation times according to the hours of the day, charging the cheapest electricity tariffs, and by using natural gas or biogas when electricity tariffs are high, based on the relative price of natural gas versus biogas, so as to seek maximum financial efficiency from the drying and cogeneration plant. As a result, ASAT supplies 40 percent of the WWTP's electricity requirement from its biogas generation.

Sustainable sludge management was a priority issue in the ASAT agenda because Antalya is one of the most attractive touristic cities, having 200 blue flag beaches out of the total of 436 blue flag beaches in Turkey. Before the sludge drying facility began operations, the treatment sludge disposal method was the open dump, which created a very unpleasant situation among the citizens. This solution was not sustainable and, in order to prevent health risks to people and livestock because of the contaminants, pathogens, and fecal origin of sludge, legislation was enacted to tighten procedures about land application of sludge. ASAT has looked for ways to dispose of the sludge generated in its WWTP in a more sustainable and environmentally friendly manner.

The most common disposal method for wastewater sludge in Turkey is storage in landfills, but there is no appropriate and socially acceptable site for sludge disposal around Antalya and the disposal costs related to disposing of the sludge in a landfill far from the city would have significantly increased the disposal costs. Therefore, ASAT decided to apply sludge drying as a sustainable and effective sludge management method. The sludge generated in WWTP is dried in a sludge drying plant with 150 ton/day drying capacity. The final product has 20 percent dry solids, which is transferred to a KONYA cement factory located in Konya over 360 km away free of charge with the trucks carrying several goods to Antalya harbor and then returning empty. It is this approach and the constant efforts to further optimize its system that makes ASAT one of the pioneering and leading water utility in terms of sludge management in Turkey.

International Case Studies: Feedback from French and Croatian experiences

Two international case studies were presented at the workshop dealing respectively with the Croatian and French experiences in implementing the EU Urban Waste Water Directive (UWWD) and Drinking Water Directive (DWD). De facto, the work was more focused on the UWWD, since compliance with DWD seems much less challenging for Turkey.

These two countries were selected for the following reasons:

- Croatia, which joined the EU in 2013, will have to comply fully with the 'acquis communautaire' in the field of water in 2023 for the UWWD, and in 2019 for the DWD. Croatia is therefore adopting regulatory and implementation support measures and is finalizing investments necessary for compliance, with the support of EU and IFIs funding, a situation similar with Turkey's situation.
- France is at a much more advanced stage of compliance with both directives, but the process to reach compliance proved challenging. Turkey could benefit from this experience and be interested or inspired by France's methods to move towards full compliance with the directives, and monitoring the progress, taking into account measures taken when the European Commission took France to the European Court of Justice.
- In addition, both Croatia and France are parties to the Barcelona Convention (and its Protocol on Pollution from Land Based Source), as well as Turkey

Croatia international case study:

The Croatia case study was structured in two presentations. First, a presentation of the Croatian Context was delivered by Dinko Polic and Vesna Grizelj Simic (respectively Deputy General Manager and Sector Head at Hrvatske Vode - HV). First, information was given on institutional aspects and on the main actors responsible for the implementation of the Water Management Strategy (2008/2038), the Implementation Plan for Water Utility Directives, and the River Basin Management Plan. Among a description of the main challenges for Croatia's good implementation of the two EU directives at stake, the presentation singled out several topics of potential relevance for Turkey:

- The delimitation of sensitive areas based on documented studies of existing or potential environmental degradation
- The preparation of planning documents giving a framework for investment projects
- The identification of priority investments
- The funding of a total initial investment in water utility projects of €3.8 billion (62 percent by EU operative programs from 2007 onwards; 13 percent by state budget; 13 percent by Hrvatske Vode, 9 percent by Water service providers and 3 percent by IFIs)
- The challenge of affordability since the water price in Croatia is currently of €2/m^3
- The need to adapt water utility management and to involve local authorities in the implementation effort
- The key issue of investments sustainability, which depends on technical capacities and the funding of operational costs and maintenance (O&M)

A second presentation, delivered by Robert Kartelo, Head of Sector at HV, described the involvement of HV in the preparation of projects from 2010 onwards for a total value of about €1.8 bn. He provided feedback on average duration of projects (23.7 months for networks, 32.7months for WWTPs) and respective cost (189 €/ m for networks and 221 €/ p.e. for treatment plants). Feedback from the Croatian experience showed that due attention has to be

paid to proper planning, to project quality, and to technical aspects, such as design, technology, and demand analysis. The presentation concluded that "knowledge and experience exchange was not sufficient to allow new member states to learn from those who had gone through the process before them, at least not in an institutionalized way."

France international case study:

The presentation on the implementation on the UWWD in France was delivered by Bruno Rakedjian, of the French Ministry of Environment, currently seconded to the European Commission (DG ENV). Bruno first discussed the 2007 situation of non-compliance of 20 percent of treatments plants, with a corresponding risk for France to be fined about €400 million.

Bruno explained the measures that were taken and implemented at the various administrative levels (Ministry of Environment, National Water Agency, and River Basin agencies and municipalities) to cope with the French implementation deficit regarding the UWWTD. He underlined the importance placed by French authorities to define sensitive areas, set clear priorities, and provide advice and guidance to local authorities / municipalities (for example, training support, advice on the best sanitation system, best location of UWWTP, and technological options) to support them in reaching compliance in an efficient way. He also outlined associated measures that were put in place to monitor progress and make the information available to all. These included: dashboards with priorities; transparency policy (website); implementation progress; and monitoring of treatments in line with the definition of sensitive areas.

Statistics were presented about the situation in 2014, showing inter alia that the volume of urban waste water in France was €5 billion m^3 a year, the total cost (investment + O&M) of compliance amounted to about €11 billion, and the average water price was €3.85/m^3 (€2/m^3 for water supply and €1.85/m^3 for wastewater. The sanitation assets in France corresponds to an investment of €2,600/ person/40 years, or €65/citizen/year). Results obtained thru the EU Directive implementation can be illustrated by a remarkable Biological Oxygen Demand (BOD) reduction in rivers in France, in the EU territory, but also in other Member States, such as for instance, Ireland or Scotland.

Some lessons from the French experience may be of relevance for Turkey:

- Reaching compliance takes a lot of time.
- Transparency (national database and website) contributes to good implementation as well as to dissemination of good practices.
- Implementation action plans, indicators, and clear priorities are critical to success.
- Appropriate funding is needed for investments (€4.3 billion) and even more for operation costs (€6.6 billion). Investment efficiency is warranted to optimize operations costs.
- National / local organizations must be in place, with strong political support being a strong catalyst;
- Cooperation between national and local authorities is important,
- A comprehensive capacity-building program is useful,
- Alternatives must be compared to single out cost efficient solutions.

At this point, the audience was invited to discuss how these case studies may be interesting for Turkey. The conversation focused on issues such as responsibility sharing between national and local authorities, the most accurate type of treatment depending on the size of settlements, the funding of investments, and the energy efficiency of UWWTP.

In the afternoon, World Bank experts made two presentations: one on the concept of integrated

urban water management, including examples of its application in Latin America and Korea; and the other on the new generation of public-private partnerships (PPP) in the water and wastewater sector, the opportunity that they may represent, and where using them makes sense. The PPP presentation underlined that BOT approaches have the advantage of considering the total cost of investment, which may not be the cheapest to construct, allowing them to implement optimized solutions and to hold the private sector accountable for operating efficiently.

A panel discussion followed, chaired and moderated by Dr. Yakup Karaaslan, Deputy General Director, GDWM. Discussants were Mr. Recep Şahin, Deputy General Secretary of Union of Municipalities in Turkey); Mr. Recep Akdeniz, Deputy General Director, General Directorate of Environmental Management, Ministry of Environment and Urbanization; and Mr. Taner Kimençe, Head of Department, Department of Basin Management, GDWM, MoFWA.

The main points raised by the panelists during the panel discussion session are summarized below:

- The establishment of new SKIs and the extension of the service area to the current ones under the Law No 6360 brought both technical and financial challenges, since SKIs also took over water- and wastewater-related liabilities of the new service area. This, however, could be an opportunity for the population served, since SKIs' expertise on urban areas would benefit to the new areas as well. This should be supported by both technical and financial assistance.
- The Law No 6360 also delegated to SKIs the responsibility of service provision and flood management in rural areas, but did not provide financial resources for these activities.
- Implementation of regulations on urban transformation and renewal should be integrated with water management planning.
- Implementation of the existing regulation on water loss management is of utmost importance for the sustainability of the services. Several trainings were carried out by the Ministry on the implementation of this regulation. Further workshops and trainings to SKI officials are needed on the subjects of monitoring, reporting, and minimizing water losses.
- Projects on efficient use of water as well as reuse of wastewater should be developed.
- Using PPPs with build-operate-transfer and performance-based contracts could present a good model to increase the efficiency of service provision. However, the contractual conditions should be defined very carefully to achieve the utmost benefit for the SKI and the population served. SKIs need assistance in this subject.
- The regulation on water losses in irrigation is under discussion at the prime minister level.
- SKIs serving populations where refugees are located face special technical and financial challenges to provide water and wastewater services, and that these SKIs need more assistance.
- SKIs established after 2014 have a period of 4-5 years to overcome their institutional, operational, and technical issues.
- Integrated urban water and wastewater planning should also take socioeconomic impact analysis into consideration. Although implementation of a "polluter-pays" principle and cost-recovery tariff is crucial for sustainability of the services, affordability of the population should also be taken into consideration. A staged approach could be implemented where investments are realized following a prioritized plan in stages, with gradual tariff adjustments made up to the cost-recovery level within affordability constraints. These plans should be monitored on an annual basis and be revised if necessary. Some SKIs would need assistance in this regard.

- Tariff-setting procedures of SKIs should be transparent to obtain public acceptance and willingness-to-pay. Especially in new metropolitan areas, SKIs should be engaged in awareness-raising activities to explain the need for water and wastewater tariffs and infrastructure investment contribution fees paid by customers for the sustainability of the services.
- A revision of the EU DWD is underway. It will cover reporting requirements on drinking water from source to tap. SKIs should anticipate and build necessary data management mechanisms.

During the discussion, officials of the SKIs stressed the new challenges related to the extension of their service areas from the densely populated urban areas to the boundaries of the province. They stressed that their increased responsibilities have not been matched with additional funding. They said that these unprecedented expectations of service extensions and improvements represent a direct risk on already challenged balance sheets and have not been matched by corresponding staffing and capacity strengthening policies.

The workshop concluded with a discussion on areas where the Bank could provide additional support to Turkey and how the new financial instrument “Program for Results” could be of interest.