Wastewater Treatment and Reuse in Iran: Situation Analysis

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Introduction

Iran covers a total area of about 165 million hectares. 52 percent of the country consists of mountains and deserts and some 16 percent of the country has an elevation of more than 2 000 m above sea level. The Central or Interior Plateau is located in between two mountain chains and covers over 50 percent of the country. It is partly covered by a remarkable salt swamp (kavir) and partly by areas of loose sand or stones with stretches of better land near the foothills of the surrounding mountains.

The climate is one of great extremes due to its geographic location and varied topography. The average annual rainfall is 230 mm, while rate of evaporation exceed 2000 mm annually. Approximately 90 percent of the country is arid or semi-arid and located in the interior and far south which is characterized by long, warm and dry periods, lasting sometimes over seven months. About 23 percent of the rain falls in spring, 4 percent in summer, 23 percent in autumn and 50 percent in winter as snow fall.

Of the average annual rainfall volume of 417 billion cubic meters (bcm) an estimated 70 percent evaporates before reaching the rivers. The total long-term total renewable water resources are estimated at 130 bcm of which about 13 bcm are external water resources. Internal renewable water resources are estimated at 117 bcm. Surface runoff represents a total of 92 bcm, of which 5.4 bcm come from drainage of the aquifers, and groundwater recharge is estimated at about 49.3 bcm, of which 12.7 bcm are obtained from infiltration in the river bed, giving an overlap of 18.1 bcm.

Dams have always played an important role in harnessing precious Iranian water reserves and the long-term objective of Iran's water resources development plan is based on the control and regulation of water resources through dams. In 2006, 94 large storage dams with a total capacity of 31.6 bcm were operating and 85 large dams with a capacity of 10 bcm were under construction. In 2002, the total installed gross desalination capacity (design capacity) was 590 521 m^3/day or almost 215.5 million m^3/year. The desalinated water produced was around 200 million m^3 in 2004.

In 2004, the total agricultural, municipal and industrial water withdrawal was estimated at about 93.3 bcm, of which 40.0 bcm from surface water, 53.1 bcm from groundwater (qanats and wells) and 0.2 bcm desalinated water. Groundwater depletion is estimated at 4.8 bcm/year. Most of the overexploitation happens in the central basins where less surface water is available. Land subsidence, salt intrusion, and lowering of the water table are among the most prominent effects. Estimates suggest the water levels in Iranian aquifers have declined by an average of nearly half a meter every year over the last 15 years.

Total surface water and groundwater withdrawal represents almost 70 percent of the total actual renewable water resources. Use of non-conventional sources of water is minimal. The treated wastewater is said to be indirectly used in agriculture. In some towns, although in a limited form, raw wastewater is used directly for irrigation resulting in some health-related problems.

Groundwater discharge (through wells, qanats and springs) varied from less than 20 bcm/year in the early 1970s to over 74 bcm/year at the beginning of the present millennium. The number of wells during that period increased fivefold, from just over 9,000 to almost 45,000.

The cultivable area is estimated at about 37 million ha, of which 20 million ha are irrigated and 17 million ha are dryland. Of this irrigated area, 6.5 million ha consisted of annual crops, 2 million ha are under horticultural crops and about 6.2 million ha are under annual dryland crops, while the remaining are fallow.

Agriculture is the main water withdrawal sector, with 86 bcm in 2004, whose part of the total water withdrawn remains identical compared to 1993 (around 92 percent). Municipal and industrial water withdrawal amount to 6.2 and 1.1 bcm respectively. About 54 percent of water utilization in this sector is from groundwater resources and the remaining amount is from surface waters. Agricultural land availability is not a major constraint. The major constraint is the availability of water for the development of these lands.

Crop yields on irrigated land, although generally 2–3 times higher than on rainfed land, are still on the low side by international standards. Water shortage and soil salinity are mentioned among the main causes of this yield gap. Out of all water used in agriculture, about 100 million tons of food materials are produced in 2008. Economic value per cubic meter is around 1 kg/m^3.

In 1995, the average price of water delivered to farmers by the government was $US0.2 to 0.8 per 1,000 m^3, while the cost of groundwater withdrawal was $US5 to 9 per 1,000 m^3 and the cost for regulating surface water in existing projects was $US 3 to 5 per

1000 m^3. This means that the government heavily subsidized delivered water, which is probably one of the main reasons for the low irrigation efficiency throughout the country.

Agriculture plays a significant role in the national economy; more than 33 percent of the labour force was engaged in the agricultural sector. The latter accounted for 25 percent of the GNP, and more than 25 percent of export (except oil) income is from agriculture in terms of value. The sector produces more than 80 percent of the food requirement of the country, and 90 percent of the raw material of agro industries is maintained by this sector. Iran ranks amongst the top 7 countries in producing 22 important agricultural products.

Total population is about 72 million (2010), of which less than 40 percent are living in rural areas. The annual demographic growth rate was estimated at 3.7 percent over the period 1980–1990 and decreased to 0.9 percent over the period 2000–2005. It is expected that 80 percent of the total population may live in urban areas and especially in big cities like Tehran, Mashhad, and Isfahan.

Organizational roles and responsibilities

According to national law all water bodies (rivers, lakes, etc.) are public property and the government is responsible for their management. The first water law after the revolution was approved in 1982. According to this water legislation, three ministries are directly in charge of water resources management and development.

Based on this law, allocating and issuing permits to use the water for domestic, agricultural and industrial purposes is the responsibility of the **Ministry of Energy** (MOE). This ministry has two responsibilities: energy supplies and water resources. As far as irrigation is concerned, it is in charge of the construction of large hydraulic works, including dams and primary and secondary irrigation and drainage canals for the distribution of water. Within the MOE, the **Water Affairs Department** (WAD) is responsible for overseeing and coordinating the planning, development, management and conservation of water resources. The WAD consists of the following sections: **Water Resources Management Company** (WRMC), eleven **Provincial Water Authorities** (PWA), Irrigation and Drainage Operation and Maintenance Companies (O&M) and Water and Wastewater Engineering Companies (WWEC).

WRMC is the mother company that manages all water sectors within the MOE except drinking water distribution for rural and urban areas. PWAs are responsible for the water sector in each province including irrigation and drainage development and operation. Drinking water distribution and wastewater collection is the responsibility of provincial water and wastewater engineering companies. The **National Water and Wastewater Engineering Company** (NWWEC) provides oversight and assistance to service providers in areas such as investment planning, human resources development, and in the establishment of standardized systems and procedures.

The **Ministry of Jahad-e-Agriculture** (MOA) is the result of merging ministries; the former ministries of Agriculture and of Jahad-e-Sazandagi (crusade for construction). It is appointed to distribute water for agriculture among farmers and is responsible for managing agricultural activities including fishery and forestry.

The “Farmers’ House” was established in order to protect the rights of the farmers. Its role is to streamline and coordinate the farmers’ activities, including their commitments in the fields of farming, fruit growing, animal husbandry, hunting, poultry production, supportive industries and so on.

The **Ministry of Health and Medical Education** (MHME) is responsible for setting drinking water quality standards, as well as monitoring and quality control of drinking water from physical, chemical, biological aspects from its source to consumption points and enforcing them. Also, these two ministries (MOE and MHME) by their well-trained and the experience personnel, laboratories and facilities could apply the existing national and international standards for water and wastewater effluents.

The **Environmental Protection Organization (EPO)** is in charge of water pollution control, preparation of the environmental protection policy and the laws, directives and systems necessary for evaluating the impacts of social and economic development projects, particularly irrigation and hydropower projects, on the environment and following up their implementation.

The **National Economic Council** sets tariff policy for the whole country, with some differentiation across regions.

Service provision for urban water

Up to 1990 the water and sanitation sector was highly decentralized. Most water and wastewater service provision was the responsibility of municipalities and provinces. This was changed through a fundamental sector reform in 1990 with the ratification of the Provincial Water and Wastewater Companies Law of September 1990.

In 2008 sixty companies were responsible for the provision of water and wastewater services. Evenly spread over Iran’s thirty provinces, each province has one urban and one rural water and wastewater company (WWC). The 60 companies had 38,000 employees. Only Tehran has two separate companies for water and sewerage. In all other provinces, water and sanitation services are provided together. The regional water boards provide bulk raw water through transmission pipelines to the water and wastewater companies, which treat and distribute it.

The state-owned WWCs are able to manage their day-to-day operations with a measure of autonomy where Managing Directors can make most decisions on operations and staffing within the limits of the centrally authorized staffing levels and with some flexibility to provide extra compensation to well performing employees. However, the WWCs do not control their own investment programs and, therefore, have limited scope to improve investment and operating efficiency and the level and quality of service. Moreover the WWCs have to follow an organizational model developed by the NWWEC and cannot select a model that would be more appropriate for their particular situation.

Water and wastewater companies are responsible for the distribution of water for domestic use in urban and rural areas and for collecting wastewater and also collecting fees. The current urban tariff system is based on a fixed fee that depends on the size of the connection pipe and on the type of customer (household or other types), and on a volumetric charge based on increasing block-tariffs. Regarding sewage bills they are currently levied and collected only in neighborhoods where a network exists and are a percentage of water bills (70%).

On average, the service providers do not recover operation and maintenance costs due to low tariffs and low bill collection. Many Provincial Water and Sewerage Companies are incurring significant net losses.

Now the government is implementing on a sector strategy with the targets for improved cost recovery and collection and increased efficiency and at the same time removing subsidies and encouraging financing by the private sector.

Water pollution is caused by industrial and municipal wastewater, as well as by agriculture. Concerning municipal wastewater, the bulk of collected sewage is discharged untreated and constitutes a major source of pollution to groundwater and a risk to public health. In a number of cities without sanitary sewerage, households discharge their sewage through open rainwater drains.

There are also many problems in dealing with industrial wastes. Major problems are lack of information about the true amount of these wastes, lack of treatment and disposal technologies, illegal dumping. Annual level of industrial wastewater is about 1.5 billion cubic meters and less than 30 percent of these wastewaters have efficient WWTP's. Except a few cases, there is no kind of mixed wastewater treatment plant in Iran to combine industrial wastewaters with domestic ones.

Less than 40% of the total populations have complete and efficient wastewater treatment plants (WWTP's). The population served by the management of these plants is about 30 million, less than 40% of the total domestic sludge is being treated completely. This means that; of more than 200,000 cubic meters of daily sludge (2000 tons/day dry solids) of total fecal, septic and waste excrements sledges, only about

80,000 cubic meters (800 tons) is being digested and/or stabilized daily by different treatment methods.

The most common method of treatment for these sludge is digestion (aerobically and an aerobically). Lagooning, composting and land-filling are the next methods of treatment. Mechanical dewatering is usually implemented as final treatment to reduce the volume of the stabilized sludge. In a few WWTP's these methods would be applied on the raw or untreated sludge. The stabilized sludge has been used in many agricultural activities from the past to present.

Usually the regional wastewater companies who are responsible for the operation of these WWTP's deliver these treated wastes to the local farmers. The risk assessment is undertaken by a research department in the Ministry of Agriculture

Since the 1980s access to urban water supply has increased from 75% to 99%. However, a number of challenges remain. According to the World Bank, the sector is affected by "low water use efficiency in urban and rural uses; limited participation by stakeholders in development planning and management; large needs for rehabilitation and development of hydraulic infrastructure for sustainable water usage; problems of pollution caused by the discharge of untreated wastewater into public waterways and aquifers; and weak institutions involved in the sector and limited coordination among stakeholders."– Still according to the World Bank it is also characterized by "poor performance of water supply and on-site wastewater disposal facilities, causing increasing risk for ground and surface water pollution and health and environmental risks resulting from the discharge and re-use of untreated effluent for irrigation; limited technical, institutional and financial capacity of water and wastewater companies; a lack of clarity of institutional responsibilities of sector entities; and non transparent and inadequate tariff structures and levels.

Wastewater Status and Trends

Before the Islamic revolution, wastewater treatment and reclamation was virtually inexistent in Iran. (Only city of Isfahan and small satellite and small systems existed) A strong effort was made only after 1990's. (Table 1) In 2001, there were 39 wastewater treatment plants (WWTP's) with a total capacity of 712 000 m^3/day, treating the wastewater produced by a population of 3.8 million. The wastewater actually treated was around 130 million m^3/year. Some 79 treatment plants with a total capacity of 1.917 million m^3/day were under construction and 112 treatment plants with a total capacity of 1.590 million m3/day were being studied for completion by the year 2010.

Now, Iran's 129 municipal wastewater treatment plants cover 13 million inhabitants and generates more than 2,425,000 cubic meters of treated wastewater per day.(Table 2)

Municipal wastewater is mainly domestic and goes through secondary biological treatment. No further treatment is provided due to cost. Out of 129 treatment plants, 51 are activated sludge, 41 facultative and 33 aerated ponds, 2 sequential batch reactor, 1 wetland, and 1 trickling filters.(Table 2)

Out of 3,547.8 MCM sewage produced in 2010, 1,162.3 MCM of wastewater was collected and only 820.7 MCM was treated. Out of this treated effluent, only 328.2 MCM was used for mainly irrigation.(Table 3) It is estimated that over 90% of the treated wastewater effluent from treatment plants across country is reused in some way; however, much of it is mixed with freshwater before use, particularly in the suburban areas.

The percentage of population served by drinking water systems, wastewater collection and wastewater treatment is now 99, 45 and 35 percent, respectively. For rural areas, the percentage of population served by drinking water system, wastewater collected and treated is 74 and 2 percent, respectively. These figures still have to improve dramatically before the end of the fifth Five Year Plans (FYP) which started in year 2011.

In the literature, there is no comprehensive national inventory of the extent of direct and indirect use of (un)treated urban wastewater, planned use of wastewater and even data regarding treated and non-treated wastewater used for irrigation. Table 2 represents the most recent compiled summary of government owned operating treatment plants in Iran. Table 4 shows the potential of publicly owned wastewater treatment plant's reclamation projects for agricultural and landscape irrigation and industrial reuse.

Farmers have worked to manage irrigation with wastewater for several decades. Since the early 1990s the general approach has been to treat the wastewater and either discharge it to the environment where it mixes with freshwater flows and is indirectly reused downstream, or by mixing it with qanat's water use to irrigate restricted, relatively low-value crops. A significant number of indirect users of wastewater are unregulated and withdraw treated wastewater from downstream points along a surface water source after discharge from the wastewater treatment plants. This volume is significant and will play an important role in meeting future demands for water in Iran.

Present wastewater reuse can be summarized as follows: (Table 5-7)

1. Indirect (intentional) potable reuse

   From 1000 cities in Iran, only 200 have wastewater collection network operational or under design and construction. In many cities, wastewaters from seepage pits, infiltrates through layers of the ground ultimately reaching and recharging underground aquifers. The average distance between the water table and the bottom of these seepage pits should be above 20m. Because of rapid industrialization and population increase, there are small communities and industries within city limits that draw their water from these underground strata.

2. Intentional Groundwater Recharge for Non Potable Reuse

   This is already practiced around the major city limits where underground aquifers are recharged with the seepage pits, WWTP effluent to recharge a brackish groundwater aquifer through streambeds and channels and are used downstream through springs and qanats by farmers to irrigate their fields and washing purposes.

3. Direct use

   Direct use of untreated wastewater from sewage outlet, directly disposed of on land where it is used for crop production is not a common scene in Iran. Treated or partially treated wastewater used directly for irrigation without being mixed or diluted is more common. This is practiced in many plants. There is no exact estimate about the amount used by this method to irrigate fodders, cereals, fruit trees, and vegetables eaten cooked or uncooked.

4. Indirect use

   Indirect use of untreated wastewater, where diluted wastewater is mixed with the storm water or small streams or tributaries of larger water bodies (polluted) are used for irrigation, is very common especially downstream of urban centers where treatment facilities are inadequate. In this way, a self purification process takes place in full scale while effluents are flowing in streams, mixing with the stream water or diluted with qanat waters. This water is quite suitable for unrestricted irrigation.

5. Planned direct use

   In this case when the reclaimed water has been transported from the point of treatment to the point of use without an intervening discharge to waters is becoming more common especially in places that drinking water for cities are not adequate (i.e. City of Mashhad during the recent drought). The planned direct use of reclaimed water is not administered by the authority responsible for managing wastewater treatment plants, i.e. WWCE, but is administered by special contract with the WCD and farmers either formalizing their rights to use reclaimed water directly or by substitution of their right.

In Iran farmers are actively engaged in urban and peri-urban agriculture. Many of these farmers are specialized in market and fresh product gardening depending on irrigation and they rely on raw or diluted wastewater when higher quality sources are unavailable. Lack of alternative water sources, the limited financial resources and capacities of cities to treat their wastewater, the socio-economic situation and the context of urbanization which needs food and market incentives favoring food production (especially vegetables) in the proximity of cities, creates the conditions for unplanned and uncontrolled wastewater use.

In many situations farmers rather use diluted sewage for its fertilizer value even though they might have an access to well or qanat water. This practice can also be seen in rural communities located downstream of where cities discharge. Experience has shown that once wastewater reuse is in place and its advantages (availability and fertilizer value of sewage) have been realized by the farmers, it is difficult to alter behavior especially if changes have an associated cost.

Policy aspects and national strategy

To cover 200 KCal per day per person, the overall annual amount of water per person can only be called sufficient when it exceeds 1700 m^3. The renewable water per capita in Iran was 1830 m^3/a in 1996, but in 2020 will be only 1200 m^3/a. Considering these figures it is likely that Iran might suffer from a lack of water in future and in fact, in some regions of the country, water scarcity is already a problem today.

The water resources management policy emphasizes an integrated approach in water resources development by incorporating natural elements of the total water cycle as part of principles of sustainable development. Based on the country's perspective on water resources, in order to control the overexploitation of groundwater resources, the surface water withdrawal percentage should change from 43 percent at the present to 55 percent. In addition, the country aims at decreasing the agricultural share from 92 percent to 87 percent by increasing water use efficiency. Water productivity is expected to increase to 1.4 kg/m^3 over the next 20 years. The country plans to develop irrigation for another 1.76 million ha in the next 20 years.

The increasing water shortage in the country has forced many decision-making bodies to consider the reuse of effluent as an appealing option. Among the recent decisions taken by the Expediency Council were the adoption and implementation of general plans for recycling water nationwide. The proposed policies and strategies are as follows:

- Fully satisfy the drinking water demand potential from freshwater, prior to any other use.
- Guarantee future urban water demands by replacing the agricultural water rights to using freshwater (from rivers, springs well, etc.) with using treated effluents.

- Improve environmental, hygiene and health conditions, as well as promoting reuse of treated effluents.
- Avoid the use of high quality urban water to create green spaces, and instead allow low quality water for this purpose.
- Cut off water supply to industries which have not taken practical measures for treating and reusing their wastewater.
- Expand research projects for the establishment of reasonable standards for the safe and reliable reuse of wastewater. Replacing freshwater with treated effluents in agriculture necessitates introducing farmers to the positive and economic advantages of using wastewater, and consequently convincing them to exchange freshwater with effluents. This in itself requires research and study on the sanitary, economic and environmental impacts of using wastewater for agriculture and the artificial recharging of groundwater resources.

Legislation for water reuse. In order to ascertain that the policies established for waste water reuse are followed properly, satisfactory legislative measures and proper management practices need to be introduced. The legislation should be so developed that it fits well into the overall legislative framework of the country, with adequate provisions for all aspects of activities related to waste water reuse. Legislation and regulations should also have provisions for all financing, planning, construction and operation aspects of wastewater reuse systems. Also, legislation should establish water quality standards for various uses and also provide regulations for discharges into the sewage collection systems.

Standards are set by Supreme Council for the Protection of Environment with coordination of other ministries. The Water Pollution Prevention Guideline was first drafted in 1984 and then in 1991 the wastewater effluent standard was ratified. The Amendment of wastewater effluent standard was published in 1994 and in 2007 the first guideline for use of reclaimed water was published.

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Table 1 - Cumulative wastewater collection network, number of WWTP's and population connected statistics

Year	Length (km)	No. of WWTP	Population Served
1997	9978	30	1,959,548
2000	15654	37	2,327,702
2005	23473	84	6,001,322
2010	35500	129	12,977,079

Table 2 - Summary of WWEC operating treatment plants characteristics (2010)

Row	Name of Water and Wastewater Company	No. Treatment Plants	Population Coverage by WWTP (Person)	Total Treatment Plant Capacity (m^3/day)			Processes
				Design Capacity	Constructed Capacity	Operating Capacity	
1	East Azarbaijan	7	1, 288, 627	239, 647	239, 647	198, 046	AS(6), AS+SBR(1)
2	West Azarbaijan	6	884,957	405,820	181,820	129,937	AL(5), SBA
3	Istahan	20	2,428,210	757,120	757,120	449,219	AS(4), AL(8), L(8)
4	Ardebil	3	178,913	48,300	48,300	27,933	AS(2), AL(1)
5	Alborz	1	80,000	168,000	42,000	15,000	L(1)
6	Ahvaz	1	194,000	52,000	52,000	36,000	AS(1)
7	Ilam	4	145,688	72,000	36,200	21,279	AL(1), L(3)
8	Bushehr	3	154,617	125,500	41,833	34,009	L(3)
9	Tehran	9	2,778,853	988,890	540,330	430,159	AS-TF(2), AS EA(6), AS(1)
10	Chahar Mahal	5	298,129	97,700	54,700	49,314	AS(4), AL
11	North Khorasan	2	125,748	15,600	13,600	14,100	AS, L
12	Razavi Khorasan	4	292,400	52,900	52,900	39,400	AS(1), L(3)
13	South Khorasan	1	45,741	10,500	10,500	7,010	L
14	Khozestan	5	94,956	59,100	47,511	24,711	L(4), AL(1)
15	Zanjan	2	123,708	73,353	39,916	6,505	AS, L
16	Semnan	3	74,400	76,943	76,943	11,200	AL(2), L(1)
17	Sistan & Baluchestan	2	156,000	175,148	68,600	18,400	AS, L
18	Shiraz	1	432,000	80,352	80,352	60,480	AS
19	Fars	2	68,800	60,440	18,100	4	AL(2)
20	Qom	2	189,100	69,000	69,000	47,000	AS, AL
21	Qazvin	3	209,842	168,468	46,996	31,353	L(3)
22	Lorestan	4	391,314	254,000	188,000	128,000	L, AS, AL, ANL
23	Kordestan	2	412,249	131,360	115,360	115,360	L, AS

Row	Name of Water and Wastewater Company	No. Treatment Plants	Population Coverage by WWTP (Person)	Total Treatment Plant Capacity (m^3/day)			Processes
24	Kerman	1	61,000	105,000	15,500	6,900	AS
25	Kermanshah	7	589,514	90,610	90,610	88,694	W(1), AS(4), L(2)
26	Kohgloyeh	1	60,983	44,000	44,000	13,000	AL
27	Golestan	3	29,380	29,200	15,900	9,920	L(2), AS
28	Gilan	2	15,830	31,600	21,600	3,353	AS(2)
29	Mazandaran	5	40,600	189,136	45,736	8,036	AS(4), L(1)
30	Markazi	9	383,441	78,734	78,734	83,160	L(5), AS(4)
31	Mashhad	3	525,000	100,200	100,200	102,000	AL(1), L(2)
32	Hormozgan	1	100,000	117,504	117,504	35,000	AS
33	Hamedan	3	36,087	39,636	39,636	12,624	AS, AL, L
34	Yazd	1	67,104	16,650	16,650	10,066	L
Total		**129**	**12,977,079**	**5,011,120**	**3,371,327**	**2,425,327**	

Notes:

ANL –	Anaerobic Lagoon
ASEA –	Activated Sludge (Extended Aeration)
TF –	Trickling Filter
AS –	Activated Sludge
AL –	Aerated Lagoon
L –	Lagoon (Oxidation Pond)
SBR –	Sequential Batch Reactor
WL –	Wetlands

Table 3- Summary of wastewater discharge, collected, treated and reused in Iran (2010)-(million cubic meter)

Wastewater Produced	3, 547
Wastewater Collected	1, 162
Wastewater Treated	820
Wastewater Reused	328

Table 4 - Summary of WWEC WWTP's handed over to WAD in 2010

No. of WWTP's	117
Wastewater treatment capacity (m^3/d)	2,248,522
No. of WWTP's handed over	54
Volume of treated effluent (m^3/d)	785,586
No. of WWTP's in negotiation	18

Table 5 - Potential Wastewater Reclamation Projects for Private Sector

Row	Province	No. of Treatment Plants	Mean Operating Flow, m^3/day	m^3/day	Total Operating Flow, m^3/day	Volume of Reuse (m^3/day)	Percent of Total	Type of Reuse	Potential of Reuse
1	West Azarbaijan	6	21,656	4465-32645	130,000	-	<1	-	?
2	Isfahan	14	19,631	446-146221	275,000	88,600	32	L	I, L
3	Alborz	1	14,800		14,800	10,640	72	A	-
4	Tehran	4	14,124	4523-32486	56,497	-	<1	-	L
5	Chahar Mahal	5	9,320	2600-27000	46,600	46,600	100	A, L	-
6	Korasan Razavi	4	9,859	600-24835	39,435	-	<1	-	A
7	North Khorasan	2	7,750	7000, 8500	15,500	-	<1	-	A, L
8	Zanjan	1	9,360	9360	9,360	-	<1	-	A
9	Sistan & Baluchestan	2	4,787	2574, 7000	9,574	5,000	152	A, L	I
10	Semnan	3	3,814	890-8920	11,442	1,143	10	A	A
11	Fars	3	25,060	5900-60480	75,180	-	<1	-	A
12	Qom	2	19,910	7995, 31824	39,819	26,000	65	A, L	A, L
13	Hormozgan	1	35,000	35000	35,000	-	<1	-	L, I

Notes:

L – Landscape Irrigation

A – Agricultural Irrigation

I – Industrial Reuse

Table 6 - Wastewater Treatment Plant Capacity in Iran (2010)

Category		
In Operation	- No. WWTP	129
	- Designed Capacity (MCM/yr)	1261
	- Operating Capacity (MCM/yr)	884
In Design Process	- No. WWTP	107
	- Designed Capacity (MCM/yr)	1177

Table 7 – Types of wastewater Disposal by WWEC's WWTP

Disposed to River	47
Disposed to River and Potential for Planned Irrigation Use	20
Potential for Planned Agricultural Reuse Only	63
Groundwater Recharge Potential	5

Annex 1. Questionnaire results of competences on the safe use of wastewater in irrigation. (*To be updated*)

1 - Assessment of Health Risk						
	How are the current knowledge and skills of the pertinent staff in your organization in relation to: ?			**What is the importance of this subject for your organization?**		
	DOE	**EPO**	**MOA**	**DOE**	**EPO**	**MOA**
Microbial and chemical laboratory analysis	*Good*	*Good*	*Poor*	*Very High*	*Very High*	*High*
Epidemiological studies	*Basic*	*Poor*	*Poor*	*High*	*High*	*High*
Quantitative microbial risk assessment - QMRA	*Basic*	*Poor*	*Poor*	*Very High*	*High*	*High*
Setting health based targets	*Excellent*	*poor*	*Basic*	*Very High*	*High*	*High*
2 - Health Protection Measures						
Wastewater treatment	*Good*	*Basic*	*Basic*	*Very High*	*Very High*	*Very High*
Non-treatment options	*Good*	*Basic*	*Basic*	*High*	*Low*	*Very High*
3 - Monitoring and System Assessment						
Monitoring of health protection measures	*Basic*	*Good*	*Poor*	*Very High*	*Very High*	*Very High*
Wastewater use system assessment	*Good*	*Poor*	*Poor*	*Very High*	*High*	*High*
4 - Crop Production Aspects						
Components of wastewater harmful to crop production	*Basic*	*Basic*	*Basic*	*Low*	*Low*	*Very High*
Agricultural effects of wastewater irrigation	*Good*	*Basic*	*Basic*	*High*	*High*	*Very High*
Management strategies for maximize crop production	*Poor*	*Poor*	*Good*	*Low*	*Very Low*	*Very High*

5 - Environmental Aspects						
Components of wastewater harmful to the environment	*Good*	*Good*	*Poor*	*Very High*	*Very High*	*Very High*
Environmental effects through the agricultural chain	*Good*	*Good*	*Poor*	*High*	*Very High*	*Very High*
Management strategies for reducing environmental impacts	*Good*	*Good*	*Basic*	*High*	*Very High*	*Very High*
6 - Sociocultural Aspects						
	How are the current knowledge and skills of the pertinent staff in your organization in relation to: ?			What is the importance of this subject for your organization?		
	DOE	EPO	MOA	DOE	EPO	MOA
Cultural and religious beliefs	*Good*	*Basic*	*Basic*	*High*	*High*	*High*
Public acceptance	*Good*	*Poor*	*Basic*	*Very High*	*High*	*Very High*
7- Economic and Financial Considerations						
Economic feasibility	*Good*	*Poor*	*Basic*	*Very High*	*Very Low*	*Very High*
Financial feasibility	*Good*	*Poor*	*Poor*	*Very High*	*Very Low*	*High*
Market feasibility	*Basic*	*Poor*	*Poor*	*Very High*	*Very Low*	*High*
8 - Policy Aspects						
Institutional roles and responsibilities	*Basic*	*Good*	*Basic*	*Very High*	*Very Low*	*Very High*
Laws and regulations	*Good*	*Good*	*Basic*	*High*	*Very High*	*Very High*
Plans and programs	*Basic*	*Poor*	*Poor*	*Very High*	*High*	*High*
Economic instruments	*Good*	*Poor*	*Poor*	*High*	*Very Low*	*Very High*
Education and social awareness	*Basic*	*Poor*	*Poor*	*High*	*High*	*Very High*