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Mitigation Enabling Energy Transition in the MEDiterranean region

Together We Switch to Clean Energy

State-of-the-art report on the water and water-related energy use in the building sector

Jordan

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Regional Center for Renewable Energy and Energy Efficiency

المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

Credits

Authors:

Mohammad Mosleh (RSS/NERC)
Ahmad Daraneh (RSS/NERC)

Coordination and Revision:

Sawsan Bawaresh (RSS/NERC)

Design Lead:

Asmaa Ahmed (RCREEE)

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About the project

The Mitigation Enabling Energy Transition in the Mediterranean region "meetMED" is an EU-funded project developed by the Mediterranean Association of the National Agencies for Energy Management (MEDENER) and the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE).

With the objective of contributing to energy and climate transition Southern Mediterranean Neighbourhood through a multi-scale, multi-partner inclusive approach, meetMED II activities aim at developing a more stable, efficient, competitive, and climate-resilient socioeconomic environment in Southern Mediterranean countries, by fostering regional cooperation for Energy Efficiency measures and implementing demo actions.

Chapter 1:
Water Management and Governance

Water sector in Jordan is witnessing a growing pressure due to two main challenges; a) water scarcity, and b) high water demand due to the increased population in recent years. Responsibilities of managing water sector including water resources, pumping stations and distribution are divided among number of entities. The Ministry of Water and Irrigation (MWI) is responsible for overall policies and related strategies in water sector. The Water Authority of Jordan is in charge of water supply and waste water services as well as water resource planning, monitoring, construction and operation. The Jordan Valley Authority is responsible for managing water resource in the Jordan Valley. There are three water distribution companies, which manage and operate water-pumping stations in the middle, southern and northern parts of Jordan. The following highlight the main actors in the water sector at the national level.

1.1 Ministry of Water and Irrigation (MWI)

MWI is the main public water institution in Jordan. The ministry is responsible for the following:

- Policy-making at the national level.
- Outlining the country's water strategy.
- Creating the national master plan for water use.
- Preparing water studies.
- Monitoring water resources.

1.2 Water Authority of Jordan (WAJ)

WAJ was established as an autonomous corporate body, with financial and administrative independence linked with Minister of Water and Irrigation. WAJ carries full responsibility for the public water supply, wastewater services and related projects as well as for the overall water resources planning and monitoring, construction, operations and maintenance. The responsibilities of WAJ are defined in the law and are briefly described hereafter:

- Survey the different water resources, conserve them, and determine ways, means and priorities for their implementation and use.
- Develop the potential water resources, increase their capacity and improve their quality, protect them from pollution, plans to meet future water needs by providing additional water resources.
- Regulate, and advise on, the construction of public and private wells.
- Study, design, construct, operate, maintain, and administer water and public sewerage projects.
- Draw terms, specifications and special requirements in relation to the preservation of water and water basins, and ascertain the safety of water and sewerage structures.
- Carry out theoretical and applied research and studies regarding water and public sewerage to achieve the Authority's objectives.
- Issue permits to engineers and licensed professionals to perform public water and sewerage works.
- Regulate the uses of water, prevent its waste, and conserve its consumption.

WAJ has developed a policy to allow private initiative in the water sector in the form of private water companies and public-private partnerships, MWI has also started implementing private-ownership principles in newly established government-owned companies, such as:

1.2.1 Miyahuna LLC Water Company

Considered the responsible party for the provision of water and sanitation services to the Capital governorate, the province of Madaba and Zarqa governorate, in addition to the operation and maintenance of water systems, operation and maintenance of sewage collection networks, and the operation of several small sewage treatment plants.

According to Jordan Water Utilities Monitoring Report – 2020, Miyahuna serves around 98% of the buildings in the three governorates; the quantity of water distributed is **313.671 million m^3.**

1.2.2 Yarmouk Water Company (YWC).

YWC is a national limited liability company wholly owned by WAJ. It is responsible for the operation and maintenance of drinking water production and distribution systems and purification of wastewater in northern governorates of Jordan Irbid, Jerash, Ajloun and Mafraq.

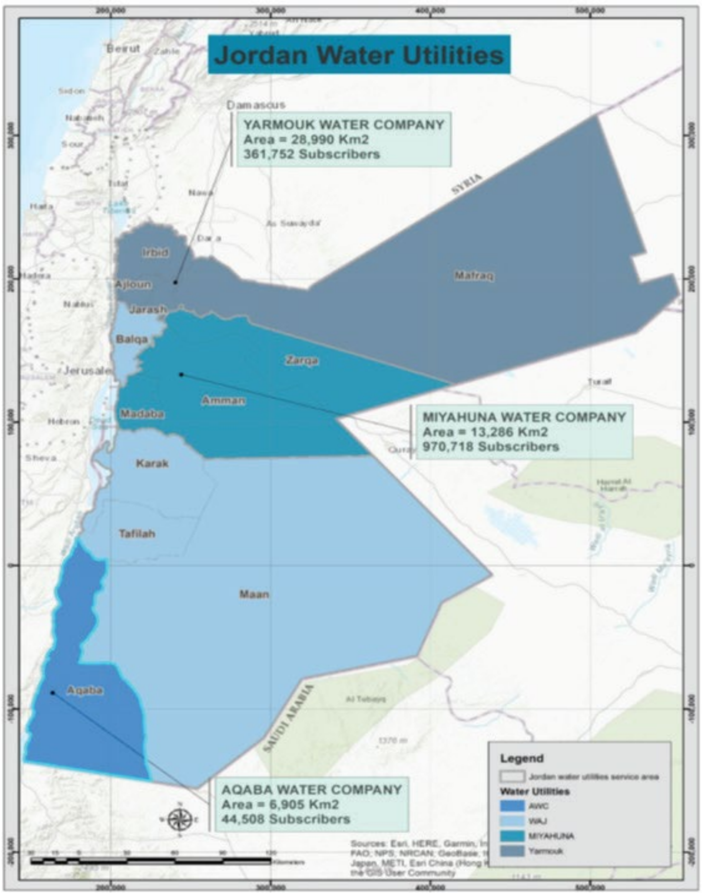
According to Jordan Water Utilities Monitoring Report – 2020, YWC serves around 96% in the northern governorates; the quantity of water distributed is **106.513 million m^3.**

1.2.3 Aqaba water company (AW)

The purpose of AW establishment was to increase the operational efficiency of the water and wastewater sectors in the Aqaba Special Economic Zone in particular and the Governorate of Aqaba in general, in order to cope with the increasing demand for water and sewerage services and to improve the services provided to the public. AW is a national limited liability company wholly owned by the Government of the Hashemite Kingdom of Jordan.

According to Jordan Water Utilities Monitoring Report – 2020, AW serves around 100% in the governorate of Aqaba, the quantity of water distributed is **28.697 million m^3.**

Figure 1 shows the service areas for the three water utilities in Jordan:



1.3 The Jordan Valley Authority (JVA)

JVA manages, and protects water and land resources and their supporting infrastructure in the Jordan Valley in an environmentally and economically sound manner, in the Jordanian national interest, through creating partnership with the private sector where appropriate.

Water resources were developed through the construction of dams, King Abdullah Canal and pressurized irrigation networks, six dams were constructed in the northern and middle Ghors with a storage capacity of **160 million m^3** , the six dams include:

- Wadi Arab.
- King Talal.
- Shuei.
- Ziglab.
- Karamah.
- Kafrein.

Three other dams: Tannour, Wala and Mujib were constructed in the southern Ghors with a total storage capacity of 57.3 million m^3. Wehda dam is being constructed at the Yarmouk river to store 110 million m^3 for domestic and irrigation purposes.

JVA mandate:

- The development of water resources of the Jordan Valley and their utilization for purposes of irrigated agriculture, domestic and municipal uses.
- Industry, hydropower generation and other beneficial uses.
- Conducting studies required for evaluation of water resources including hydrological, hydro geological and geological studies, drilling of explanatory wells and installation of observation wells.
- Planning, design, construction, operation and maintenance of irrigation projects and related structures and works of all types and purposes including dams and appurtenant works.
- Soil surveys and classification, and the identification and reclamation of lands for use in irrigated agriculture.
- Settlement of disputes arising from the use of water resources.
- Organize and direct the construction of private and public wells in coordination with WAJ.

1.4 Utilities Performance Monitoring Unit (UPMU)

UPMU was established in accordance to enhance the principles of transparency and good governance in the water sector and to improve the legal and contractual relationship between MWI, WAJ, and the Water Utilities, it is a part of the water sector in Jordan, and it offers an independent view on the performance of the water utilities owned by WAJ.

To meet these objectives, UPMU performs the following tasks:

- Monitoring the Utilities' performance and issuing performance reports.
- Setting and developing performance indicators, baselines, and mechanisms for calculating and using them as a basis for comparing and evaluating the utilities' performances.
- Developing and reviewing the necessary documentation for establishing the Utilities and developing their tasks/duties (i.e. Development and Delegation Agreements (Assignment Agreements)).
- Issuing the basis and general evidence which describe the frameworks for developing internal working guidelines and procedures, such as Business planning and Customer service guidelines as regulatory standards.
- Reviewing, approving, and accrediting company business plans and setting targets, in cooperation with the Utilities and in accordance with water policies.

1.4.1 Water utilities' performance in 2020

UPMU has prepared the Performance Monitoring report for the year 2020 that focuses on monitoring the quality of services provided by the water utilities (Miyahuna, YWC and AW) and their level of operational performance towards that end. The monitoring covers the key areas that are needed to assess and analyze the status quo of the utilities in four major sections: water and wastewater operations, customer services, finance, and human resources.

The table below shows key data for the three water utilities:

utilities	Served area (Km^2)	Water subscribers	Sewage subscribers	Water distributed (MCM)	Authorized consumption (MCM)	Estimated water service coverage (%)	Estimated Wastewater coverage (%)
Miyahuna	13,286	970,718	765,449	313.671	170.697	98	77.5
YWC	28,990	361,752	174,355	106.513	54.077	96	46.3
AW	6,905	44,508	38,098	28.697	18.092	100	90.5

Table 1 Utilities key data 2020

The following table shows the energy efficiency performance indicators for water utilities:

Performance indicator	Unit	Miyahuna	YWC	AW
Average unit energy consumption	Kwh/ m^3	3	3.2	1
Renewable energy utilization	%	0	0	0
Power consumption monitoring	%	43.1	95	100

Table 2 Energy efficiency performance indicators

Some of the financial challenges facing the water utilities is the high electricity cost. Because of Jordan topography water pumping is a large consumer of electricity, around 42% of the drinking water for Amman stems from water sources situated 20 to 76 km away, as these sources are elevated up to about 1,200 m, they consume around 14% of the total electricity generated in Jordan, which amounts to 1,685 GWh. In addition to the inability to cover O&M costs due to low water tariffs, table 3 shows the utilities' O&M and electricity expenses for the period 2018-2020:

Description	Miyahuna			YWC			AW		
	Amount JOD '000								
Year	**2018**	**2019**	**2020**	**2018**	**2019**	**2020**	**2018**	**2019**	**2020**
Electricity Expenses	80,518	85,329	77,063	39,649	42,624	36,304	3,915	4,345	3,874
O&M Expenses	134,922	144,514	145,995	71,553	76,899	70,445	17,392	17,685	19,956
% of Electricity from O&M	60%	59%	52%	55%	55%	51.5%	23%	25%	19.4%

Table 3 Utilities' O&M and electricity expenses for the period 2018-2020

Chapter 2: The mainstream water equipment installed in residential and public administration buildings

The water utilities' in Jordan are responsible of delivering water to the end user by water pumping stations for each territory, the percentage of time that subscribers receive water varies according to the governorate needs, for AW (as expected with continuous supply) the system is pressured 168 Hrs. / week, Miyahuna almost 36 Hrs. /week and YWC 9 Hrs. /week. The water is pumped to the buildings by underground water network, which consists of High Density Polyethylene (HDPE) pipelines and its fittings. Therefore, all buildings must have a storage water tanks (usually installed on the buildings' roof) to meet the occupants' water weekly needs in addition to water wells or spare tanks in case of water shortage, where a small pump is used to pump water to the main storage water tanks.

Then the water flow by gravity from the storage water tanks to the internal cold-water network in the building, it is worth mentioning that some buildings' owners install a small pump to increase the water pressure in the internal network. The table below shows a brief description of the common standard water equipment used in the residential and public administration buildings:

Description	Standard equipment	Notes
Water deposits	Cylindrical polyethylene tanks /	The polyethylene tanks are more common because they cannot be affected by rust or corrosion.
Irrigation equipment	Sprinklers / Manual irrigation.	-
Pools, with the associated treatment equipment	In-ground pools, centrifugal pump (circulation), sand filter, and diesel / gas boiler for heated pools.	Pools are usually installed in villas and most of them are not heated.
Taps and showers	Mixer and Monobloc tabs. Mounting: wall / basin	Usually made of chrome plated steel.

Elevation or recirculation pumps	Centrifugal pumps.	Mostly with easy-press to control the pumps' operation.
Water treatment equipment	Cartridge filter.	Installed on the drinking water tabs in buildings.
Toilet flushes	Dual flushes.	The standard capacity of the flushing box is 6 Lit.
Sinks and bathtubs	Ceramic.	-
Water network	PVC / PEX / galvanized steel pipes	-
Hot water production equipment	Electric heater (1.5 – 2.0 Kw) / diesel or gas boiler / solar thermal heater	-
Clothe washers	Front loading machine – fully automatic	The minimum energy labeling grade allowed is A+

Both efficient and inefficient water using products are found in the Jordanian market therefore, the low-income customer homes are likely to be equipped with the least protection against water wasting products.

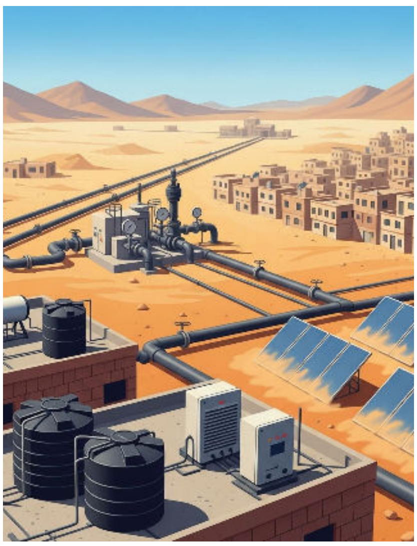
Chapter 3: Installation and operational conditions that affect the water-energy nexus of buildings

The water–energy nexus is mainly regulated by the Energy Efficiency and Renewable Energy Policy for the Jordanian Water Sector which was published in 2015 by MWI. This policy puts into effect the mandate of MWI to improve the performance of the water sector through:

1. Improving the energy efficiency in water facilities in order to decrease the specific power consumption for water supply, and
2. Introducing renewable energy technologies to protect the environment and reduce energy price volatilities in the water sector.

The energy targets of MWI for the year 2025 are specifically:

1. The reduction of energy consumption billed water by 15%.
2. Increase of the share of renewable energy sources in the power generation for the water sector by 10%.



Water supply in Jordan relies mainly on resources, which are located at a considerable distance to agglomerations. Consequently, the water sector involves an energy extensive operation by deploying large water pumping, boosting and treatment and distribution facilities. Due to Jordan's topography, pumping stations face an extra challenge to provide buildings at the entry point with a pressure between **4-6 bars,** which is the required value to allow water to reach the rooftop storage tanks that are often 4 to 5 stories above ground level.

Another challenge arises from the occupants' behavior towards the use of heated water, as they usually use values that are above the needed set points **(55 - 60 ˚C),** which increase the consumption of energy.

Additionally there is a general preference to use electric water heaters instead of solar thermal systems, which are a very good substitute especially in Jordan because of the availability of solar radiation around the year.

3.1 Water-Use Efficiency (WUE)

Jordan Plumbing Code is based on the model code developed by the International Association of Plumbing and Mechanical Officials (IAPMO); the Uniform Plumbing Code (UPC) – 2009. It is worth noting that the UPC is developed under American National Standards Institute (ANSI) guidelines, requiring an open vetting process involving all stakeholders. The current enforcement of code in Jordan consists of a building design drawings review by Jordan Engineers Association (JEA), and on-site monitoring of construction by an engineer employed by builder/owner.

The majority of the water efficiency requirements in the Plumbing Code are contained in Chapter 4, "Plumbing Fixtures and Fixture Fittings" which sets a standard water use values for specific products as shown in table 5:

Fixture	Recommended water use
Lavatory faucet	4.5 liters/min
Showerhead	7.6 liters/min
Toilet	4 liters/flush
Urinal	1.9 liter /cycle
Kitchen faucet	8.3 liters/min
RO water treatment	1 liter rejected for 1 liter produced

Table 5 Recommended water-use specifications for plumbing fixtures.

However, the following are some challenges in terms of applying WUE in Jordan:

1. Insufficient enforcement of plumbing codes.
2. Insufficient enforcement of product standards that allows water-wasting products into Jordan.
3. Products manufactured or assembled in Jordan are not subject to testing.
4. Water use labeling is non-existent for most devices.


Chapter 4:
Cold and hot water uses in residential and public administration buildings

According to the "Jordan water sector facts and figures" report published by MWI in year 2017, the total amount of domestic water uses in 2017 was 470 MCM from total water use in Jordan which is more than 50% of total water use in Jordan.

Water Uses in Jordan for year 2017, MWI

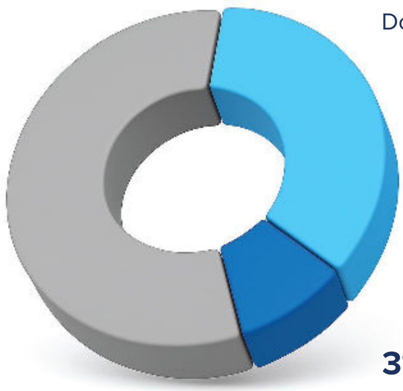


Figure 2 Water uses in Jordan for 2017

Plumbing fixtures (faucets, Toilet, Showerhead, etc.) are the major water consumer of the domestic sector in buildings, as for the rest it is consumed by clothe washers, landscape irrigation, and water leaks which occurs due to the poor maintenance for internal water network and plumbing fixtures in the buildings.

Only **5%** of domestic water is used for drinking and cooking purposes, according to study conducted by WAJ in 2015, which said that **45%** of the water is used in bathrooms and for the irrigation of gardens. Showers account for **30%** of the supplied domestic water used in bathrooms, while **20%** is used for washing clothes and cleaning houses.

As for the hot water in the targeted buildings, it is generally used for showers, bathing and washing, the water is heated either by electrical heaters, gas fueled heater, boiler heating system or solar thermal heaters. Based on our experience the average hot water need is **25 Lit. / Person / day.**

Chapter 5: Water and energy tariffs

5.1 Energy tariffs

The following tables below shows the electrical tariffs (according to Energy & Minerals Regulatory Commission (EMRC)) for residential and public administration buildings respectively:

Electrical Tariff	kWh/ Month	Fills/ kWh
First category	1-160	33
Second category	161-300	72
Third category	301-500	86
Fourth category	501-600	114
Fifth category	601-750	158
Sixth category	751-1000	188
Seventh category	More than 1000	265

Table 6 Electrical Tariff for residential buildings

Electrical Tariff	kWh/ Month	Fills/ kWh
First category	1-160	42
Second category	161-300	92
Third category	301-500	109
Fourth category	501-600	145
Fifth category	601-750	169
Sixth category	751-1000	190
Seventh category	More than 1000	256

Table 7 Electrical tariff for public administration buildings

As for the fuel prices it is shown in table 8 below:

Fuel	Unit	Price (JoD)
Diesel / Kerosene	Lit.	0.615
LPG cylinder	12.5 kg	7.00

Table 8 Fuel prices

5.2 Water tariff

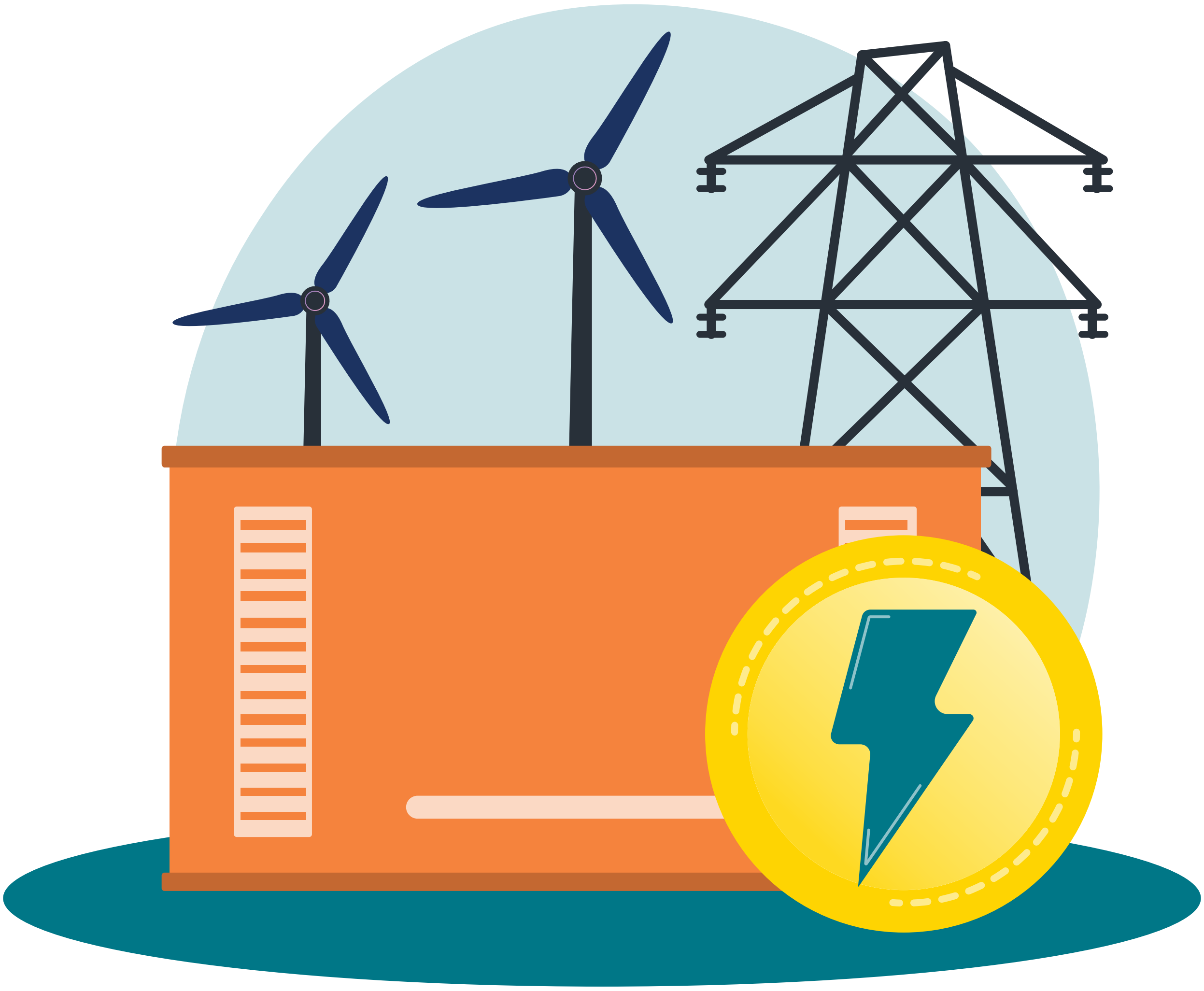
The following tables below shows the water and sanitation tariffs (according to MWI) for residential and public administration buildings respectively:

Category	m^3 / Month	Fills/ kWh	Sanitation tariff
		JoD/ m^3	JoD/ m^3
First category	0 – 18	0.361	**0.04**
Second category	19 – 36	0.45	**0.06**
Third category	37 – 54	0.55	**0.29**
Fourth category	55 – 72	1.00	**0.57**
Fifth category	73 – 90	1.20	**0.80**
Sixth category	91 – 126	1.62	**0.93**
Seventh category	127 – 147	1.92	**1.1**

Table 9 Water tariff for residential and commercial buildings

Category	m3 / Month	Fills/ kWh	Sanitation tariff
		JoD/ m^3	JoD/ m^3
First category	0 – 6	2.30	**0.805**
Second category	More than 6	1.43	**0.95**

Table 10 Water tariff for public administration buildings



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