



Ministry of Water & Irrigation



Wastewater Treatment National Plan for Operation and Maintenance

September 2015

This document constitutes an integral part with the following set of strategies, policies and Action plans and should be read with them:

1. National Water Strategy 2016-2025.
2. Water Sector Capital Investment Program (2016-2025).
3. Action Plan to Reduce Water Sector Losses (Structural Benchmark).
4. Energy Efficiency and Renewable Energy in the water sector Policy.
5. Water Substitution and Re-Use Policy.
6. Water Reallocation Policy.
7. Surface Water Utilization policy.
8. Groundwater Sustainability Policy.
9. Climate Policy for a Resilient Water Sector.
10. Water Demand Management Policy.
11. National Framework for Decentralized Wastewater Management in Jordan.
- 12. National Plan for Operation and Maintenance of Wastewater Treatment.**

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List of Abbreviations

AS	Activated Sludge
BEP	Break Even Point
BOD	Biological Oxygen Demand
BoQ	Bill of Quantity
COD	Chemical Oxygen Demand
CP	Condition Precedent
CW	Central Workshop
DPP	Development partnership with the private sector
DS	Dry Solids Content
EPC	Engineering, Procurement, Construction
EU	European Union
GIS	Geographic Information System
GIZ	Gesellschaft für Internationale Zusammenarbeit (German Agency for International Co-operation)
GoJ	Government of Jordan
ISSP	Institutional Support and Strengthening Program
JICA	Japan International Cooperation Agency
JOD	Jordanian Dinar
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
MF	Maintenance Fund
Mill.	Million
MMS	Maintenance Management System
M&V	Measurement and Verification
O & M	Operation and Maintenance
PE	Population Equivalent
PI	Performance Indicator
PK	Primary Key
PPP	Public Private Partnership
PSP	Private Sector Participation
P&L	Profit and Loss
ROI	Return on Investment
SG	Secretary General
SS	Suspended Solids
SSTDP	Sewage Sludge Treatment and Disposal
ToR	Terms of Reference
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan

WC Water Companies
WP Working Paper
WWTP Wastewater Treatment Plant

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1 Introduction

The water scarcity in Jordan forced MWI to embark on a policy to introduce the re-use of treated wastewater as an additional resource cycle to improve the efficient use of water. Over the past 10 years, massive investments took place to construct wastewater treatment plants (WWTP) as a key facility to implement the re-use strategy.

The development in the wastewater sector is comprehensively governed by defined strategies, policy papers and Jordanian standards/ WAJ regulations:

- Water for Life - Jordan's Water Strategy 2008 - 2022 (currently under revision)
- Jordan's National Water Strategy 2016 – 2030 (Zero Draft)
- Waste Water Policy (currently under revision)
- National Strategic Wastewater Masterplan (February 2014)
- YWC Masterplan Sewerage (January 2015)
- Jordan standards JS 893/95, JS 202/91 and JS1145/96
- WAJ Specifications for sewerage works

WAJ is at present supervising 33 WWTP's all over Jordan. Except As Samra WWTP, which is successfully operated under a BOT contract, and the Za'atary Refugee Camp WWTP all other plants are operated and maintained by WAJ (11) or the three utility companies (17). Out of the countrywide 33 existing WWTP's 10 or almost one third are located in the YWC service area (Fig. 1).

Most of the WWTP are applying the activated sludge stabilization as standard treatment process. The introduction of a more advanced technology through anaerobic sludge stabilization will increase operational efficiency and contribute to the reduction of CO2 emissions.

Although successfully applied in the largest WWTP of Jordan, Khirbet As Samra, this advanced technology requires higher level of process control and professional expertise. Within the service area of Yarmouk Water Company (YWC), another WWTP using this technology has been commissioned about a year ago, but still faces operational problems. Another two WWTP's in the YWC service area will be introducing anaerobic sludge stabilization, necessitating support measures to enable YWC running these plants in a sustainable way.

On top of the encountered problems is the lack of professional expertise in WWTP process control, followed by inadequate O&M budgets, a lack of performance based bonus-malus regulations and at the end an effective monitoring system to control and steer the WWTP operations in real time mode.

Any sizeable improvement in WWTP O&M needs external support involving funding agencies and the private sector.

Under the WAJ/ KfW funded "Climate Change Mitigation Measures in the Wastewater Sector in Jordan" (SSTDP), proposals for sewage sludge treatment and disposal are favouring the anaerobic sludge stabilization, a technology so far successfully used only in the As Samra WWTP. The Wadi Shalala plant is designed and constructed to apply this technology, but the YWC staff is not able to operate the digesters yet, resulting in an one year O&M contract extending the contractor's responsibility for the plant.

As the anaerobic sludge stabilization will considerably improve the energy balance in several WWTP's, and will be introduced in at least another two plants within the coming years, the capacity building or outsourcing operation and maintenance of these plants are special options to be studied and incorporated in a new O&M concept.

The "National Strategic Wastewater Masterplan", prepared within the USAID-ISSP project of February 2014 outlines the investment priorities in wastewater services across Jordan through 2035. The plan to cover all major cities and small towns (> 5,000 inhabitants) is quite ambitious and requires 173 locations to be covered.

Unfortunately the Plan does not consider the Syrian refugee impact, energy efficiency and keeps silent about professional operation and maintenance of WWTP's.

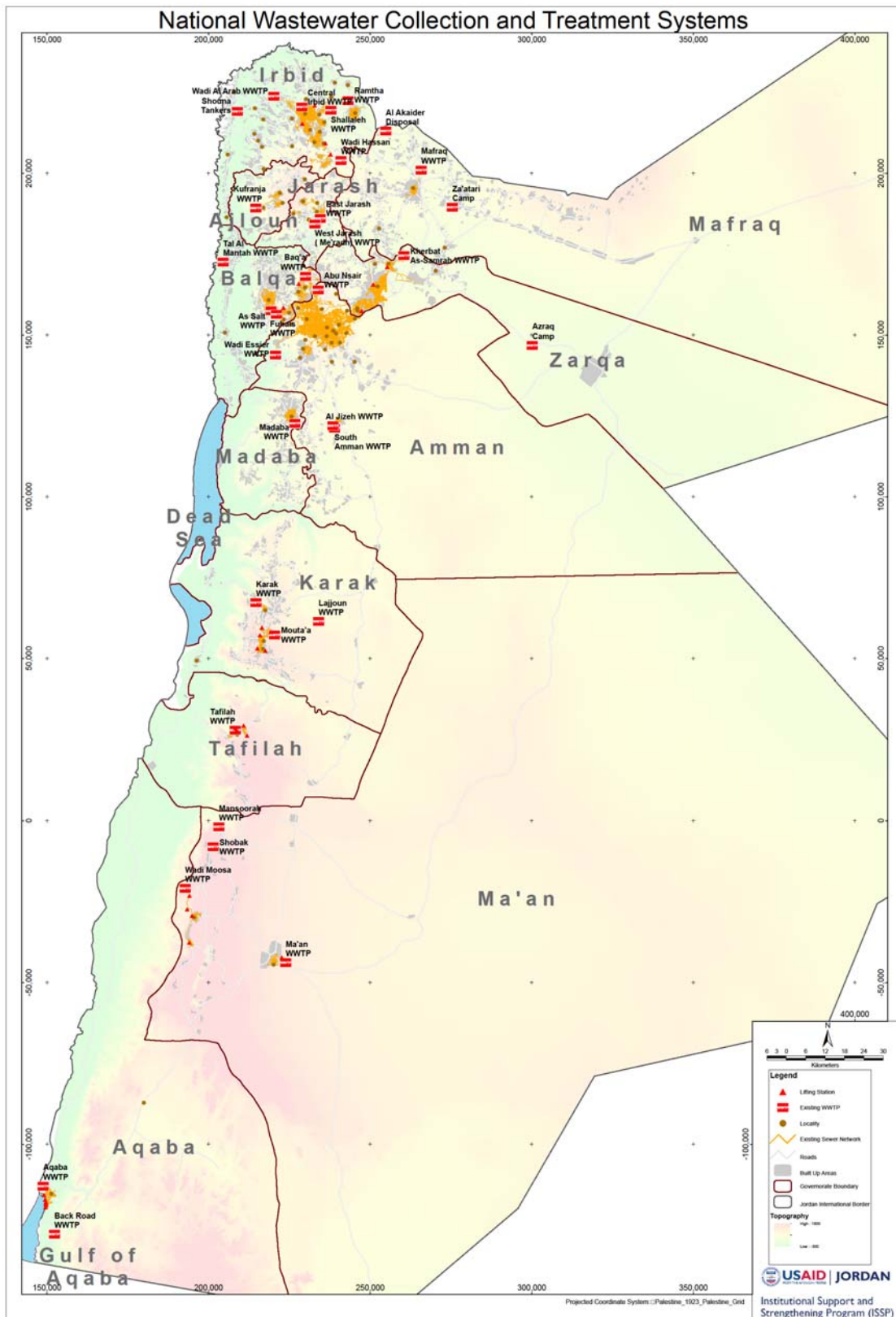
Under the JICA funded project for the "Study on Water Sector for the Host Communities of Syrian Refugees in Northern Governorates in the Hashemite Kingdom of Jordan" a Masterplan Sewage has been published in January 2015 and covering the period up to 2035. Although only covering six so called sewerage districts (SD) and the related WWTP's in the YWC service area, it provides valuable information on the required expansion under consideration of the Syrian refugee development.

The Plan is as well covering a traditional institutional and capacity development plan, including the O&M staff plan for the proposed sewerage facilities. However, it does not envisage the engagement of the private sector in investment and O&M, nor energy efficiency measures, nor does it refer to the objective to cover small towns and as such cannot be regarded as a comprehensive master plan for the development of the sewerage sector in YWC.

In both Master Plans, there is no indication on the re-use of the treated effluent, although the required tertiary treatment is part of the treatment process and the re-use projects after completion will be transferred to the respective utility companies and should be part of the O&M responsibility, for example hydro power plants.

About 30% of the O&M cost of a typical WWTP are energy costs. Optimized plants could produce a large portion of their energy needs using anaerobic digestion for the sludge treatment. The modernization of a number of plants is envisaged under the SSTDP, but will at the same time requiring much higher inputs in operations and adequately qualified staff.

The private sector should participate not only in construction, but as well in operation and maintenance of WWTP's. The water strategy, wastewater policy and WAJ regulations provide the legal and institutional framework for PSP and allow for such involvement in the wastewater treatment, the successful example of the BOT As Samra should be studied and possibly replicated after adjustment to the specific operating conditions like YWC.



(source: National Strategic Wastewater Masterplan, - April 2014)

Figure 1 : National Wastewater Collection & Treatment Systems

2 Options for sustainable WWTP operation

Several options are outlined below . Obviously the operating cost/ efficiency relationship as shown in Fig. 2 plays an important role in developing a concept for improved and sustainable operation of WWTP's in Jordan.

Efficiency is defined as running the WWTP according to defined standards, maintaining the structures and equipment as per established SOP's, avoid the mining of assets, minimise emissions and negative impacts on the environment and population and using/ developing the human resources available in Jordan to minimise dependency on expensive external expertise.

Operating costs are defined as all expenditures on personnel, electricity, material, maintenance and replacement of worn-out equipment and include the cost of sludge transport to defined disposal sites.

At present, a comparison between present operating practises and the required optimum O&M fulfilling all performance criteria is difficult and not useful for deciding on a future concept, as the compliance with the required standards and SOP's is not reflected in the present operating practises & costs. When further considering the costs occurring due to improper operation and violation of environmental standards, a distorted picture is created.

Depending on the period to be considered in an economic analysis, it may be even more economical to operate the plants by private sector companies. Option 4, for example, could be moving to the lower right box in Fig.2, if a period of 30 years is considered.

Not to be forgotten is the introduction of new technologies and treatment processes like anaerobic sludge stabilization through digesters, which reduces the electricity consumption in a plant and contributes to the reduction of CO2 emissions. Such technology requires a higher degree of professional expertise and additional short to medium term inputs in capacity development of personnel.

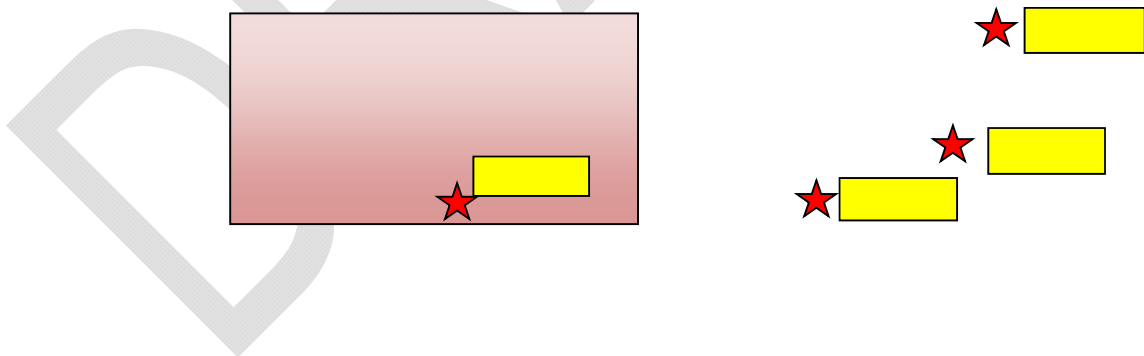


Figure 2 : Operating cost/ Efficiency relationship

The inefficiencies and constraints observed in the present WWTP operations by WAJ lead to some conclusions to be considered for the future O&M concept:

1. WAJ in its present condition cannot provide trained and experienced staff to operate the WWTP's under their control acc. to the required standards and in addition suffers from limited financial resources and a rigid framework of rules & regulations prohibiting it from change and decisive action. Limited budgets and low salaries demotivate the staff, placing WAJ in Fig. 2 in the lower left corner (low operating cost and low efficiency of services).
2. Public companies (AWC, YWC and Miyahuna) are performing comparatively better, but depending on their financial situation face similar constraints like WAJ. In particular YWC is in a delicate financial situation and presently cannot cover its obligations.
3. The private sector is successfully operating the biggest WWTP in Jordan and should be involved to improve the O&M of WWTP's and provide the needed professional expertise.
4. Funding constraints limiting the private sector engagement are to be solved prior to any tendering process.

2.1.1 Key management practises for efficient WWTP operation

Guiding principles for selection of an appropriate management option are if important parameters in the operating environment are applied like

- Involvement of operations in planning & design to incorporate the practical experience of staff working in WWTP's;
- Availability of qualified Jordanian professionals for process control and operation;
- Developing key staff below the engineering level in the construction and commissioning phase by temporarily seconding them to the contractor;
- Adjustment of the organizational set-up by introducing a process engineering & control function and making it the "heart" of the plant operation;
- Introduction of a performance based incentive system to reward and motivate staff.
- Pro-active monitoring, control and intervention to avoid non compliance
- Provision of adequate funds for WWTP O&M and/or safeguarding payments to private sector companies supplying goods and services.

The options described below are all applicable within the existing legal and regulatory framework, the selection of the most appropriate one depends on the specific situation in a region or governorate.

Keeping in mind the refugee situation in the YWC service area, it is almost compulsory to involve the private sector as an additional population of around 30% is stretching the available capacities in YWC beyond the limits.

On the other hand the southern region is much more stable, AWC due to favourable operating conditions and customer composition is able to attract qualified professionals and can take over WAJ operated WWTP and improve performance.

2.1.2 OPTION 1 - WWTP operations by WAJ/ Water Company staff plus traditional Capacity building through TA (RTSC)

This approach is the traditional way of trying to cover the operational deficiencies, but has not been very successful in the past, as the institutional framework and rigid civil service rules and regulations in combination with limited financial resources on one hand limit the impact of TA, and on the other hand the agencies providing TA cannot be forced into performance based operations.

A typical outline of such assistance and institutional modifications are described in the JICA Masterplan Sewerage for host communities of Syrian refugees in YWC, but will be difficult to implement as pre-conditions like employment of additional staff, logistical support, funding of spare parts and revision of the organizational structure are difficult to fulfil.

This option may only be attractive if a long term TA arrangement (6-10years) can be agreed upon with one of the agencies typically supporting such activities (GIZ, USAID, JICA), but will not guarantee a sustainable and sound O&M of the WWTP's.

2.1.3 OPTION 2 - WWTP standard operations by water companies , Process Control, Performance Monitoring & Management by private sector run Regional Technical Support Unit (RTSC)

At present, the vast majority of WWTP are already under the control of the three water companies. AWC, for example, is actively engaging in forming a kind of RTSC by establishing a separate organizational unit for the O&M of other WWTP in the southern region, and have been charged by WAJ to run WWTP Ma'an, Wadi Mousa, Mouta and Shobak Tankers. This will be the nucleus of a first RTSC.

In the long run, WAJ will be completely dis-engaging from WWTP O&M, which requires the water companies to build the needed professional expertise in-house, and as they are more flexible in attracting professionals (except YWC at the moment), the logic to establish the RTSC in the water companies and concentrating specialist expertise in such operating environment and develop the required expertise in process engineering & control, digester operation, health & safety and monitoring there is striking. Furthermore the concentration of really qualified professionals in such centre will cover more than 10 plants in each region and at a later stage would support the further development in smaller communities as outlined in the National Wastewater Masterplan.

As the public sector cannot provide the expertise, it is almost compulsory to involve experienced WWTP operating companies to build up the expertise in the RTSC water companies. It has to be understood, however, that this private sector input is not short term, but should cover a period of not less than 5 years to build up the capacity and experience and a kind of O&M philosophy which is oriented towards performance and quality of services. Depending on the treatment technology used, each RTSC may require different expertise, but in general required are

- Process engineering & control
- QHSE (Quality, health, safety and environment)
- Operations management
- Maintenance management
- Laboratory
- Mechanical & Electrical engineering

Potential bottlenecks are the availability of adequate O&M budgets and interference by managers not qualified to assess the needs and performance of such centre. It may be necessary to ring fence the activities of the RTSC and minimise external influence.

2.1.4 OPTION 3 - WWTP plants using anaerobic sludge stabilization outsourced to private sector, all other plants run by water companies with the support of RTSC

This option in the short term would apply to three plants in YWC (see chapter 4), as the operation & maintenance of digesters is new to WAJ/ water companies and needs a tight process control and a good QHSE system. The needed expertise, apart from As Samra

Operating Company, is not available within the existing water sector institutions and companies. Keeping in mind that this technology is significantly reducing the greenhouse gas emissions and reduces the energy consumption in the WWTP's, it's as well improving the overall performance of the wastewater sector institutions and companies.

The disadvantage of higher operating costs when involving the private sector is only visible if short term horizons of 5-10 years are considered in the economic analysis. When considering a lifespan between 20 – 30 years, the long term advantage of lower investments will appear.

For Jordan it's further important to develop and demonstrate a technological lead in the wastewater treatment in the region, as the knowledge based export of services can best be maintained if the expertise is practically developed and introduced in the education on all levels. As Samra WWTP is an excellent example how to develop the Jordanian expertise on large scale plants, but as the majority of WWTP are more of a medium size like the WWTP Wadi Al Arab and Wadi Shalala it's logical to develop the professional expertise for such plant size.

2.1.5 OPTION 4 - Performance based operation of all WWTP's in a region by Jordanian private sector

The private sector in Jordan still needs to grow and take over a larger part of the water sector operations. Limiting factor are the financial constraints of WAJ and some of the water companies. The wastewater activities are not generating revenues and the present, subsidized water tariff structure is not enabling the full cost recovery of the water and wastewater services.

This limitation is as well limiting the private sector activities, unless performance based contracting models are introduced and applied on the basis of financial and economic models showing the advantages of private sector participation over a period of time.

First priority shall be the reduction of internal inefficiencies in the wastewater O&M, caused by the constraints of operating the WWTP's in the public sector environment.

The treatment cost per m³ of wastewater in As Samra is only 0.2 JOD, whereas the average cost in WAJ operated plants is 1-2 JOD.

3 Future WWTP Plan for O&M/ The Way Forward

Out of the options described above, a selection of one or combination of several are possible, depending on the specific situation in a region or water company, but key conditions to be fulfilled are

- Provision of experienced professional expertise and capacity building of existing O&M personnel through the private sector;
- Development and application of performance based indicators in WWTP operation;
- Introduction of SOP's and treatment process oriented training;
- Provision of adequate budgets for O&M of WWTP's;
- Introduction of an incentive system working on bonus-malus basis, covering personnel and companies.

3.1 General Approach

The plan requires embarking on three parallel tracks in order to cover short to medium term needs within the coming 5 years:

TRACK 1: Short term, investment driven track with the objective to avoid operational problems when constructing new or rehabilitating existing WWTP and

introducing advanced technologies by including a minimum 2-year O&M period in the construction contracts;

TRACK 2: Medium term (min. 5 years), capacity development & knowledge driven track with the objective to improve professional knowledge of existing WWTP personnel, introducing performance criteria & -standards and developing transparent incentive schemes through the establishment of three Regional Technical Support Centres (RTSC North, Middle, South), located in each of the three water companies.

TRACK 3: WWTP Clustering and Private Sector Operation in selected areas (YWC) to accommodate and facilitate the introduction advanced treatment technologies (anaerobic) sludge stabilization in medium sized WWTP's.

Fig. 2 shows the expected effect in the cost/ efficiency relationship. Obviously Track 3 is the most costly one in the short run, but as well the most efficient solution and cannot be applied on all plants. Track 1 and 2 are less costly and may be less effective, but possibly a more appropriate solution for small and medium sized plants.

Track 1 is anyway only a short term solution to avoid operational problems immediately after start-up and guarantees that the extension and enlargement of existing plants are properly integrated. As shown in Table 2 below, 16 out of the 33 WWTP need to be expanded over the coming 15 – 20 years, out of which already

As shown in Table 2, WAJ is not really a major player in the O&M any more, only 8 out of 33 WWTP are within their operational responsibility, and AWC is in the process to take over the O&M from WAJ in the other plants in the southern region. In a way AWC is already establishing the nucleus of the RTSC South, as the WWTP O&M to other governorates outside their service area is recognized by creation of a separate organizational unit in AWC. After the proposed establishment of the other two RTSC under Track 2, the O&M responsibility for all WWTP except As Samra, 2 plants in the refugee camps of Za'atary and Azraq and three plants in YWC shall be completely taken over by the water companies, which generally have more flexibility in acquiring the needed professional expertise and resources.

RTSC	No.	WWTP name	Population		Actual load	Hydraulic capacity		Required expansion	O & M responsibility	
			present	2035	2015	2015	2035		present	proposed
					[m³/d]	[m³/d]	[m³/d]	[%]		
North (YWC)	1	Wadi Al Arab	159000	328000	10700	21000	28400	35	WC	PS
	2	Central Irbid	110000	118000	8600	11000	10900	-1	WC	PS
	3	Wadi Shallala	159000	307000	5000	13700	22500	64	WC	PS
	4	Ramtha	80000	201000	4050	5400	17300	220	WC	WC
	5	Wadi Hassan	24000	35000	1200	1600	2500	56	WC	WC
	6	Al Keder Tankers							WC	WC
	7	North Shouna Tankers							WC	WC
	8	Kufranjah	65800	101000	2800	9000	9000	0	WC	WC
	9	East Jerash	72000	113000	3300	3800	10800	184	WC	WC
	10	West Jerash (Merad)	69000	106000	2300	9600	9600	0	WC	WC
	11	Mafraq	41000	156000	3100	6100	14400	136	WC	WC
	12	Za'atary Refugee Camp	80000	40000	2800	3700	3700	0	PS	WC
Middle (Miyahuna)	13	Khirbet As Samra	2270000	3500000	241000	267000	365000	37	PS	PS
	14	Tal Al Mantah Tankers							WAJ	WC
	15	Baqa'a	173000	275000	11700	14900	27700	86	WAJ	WC
	16	Abu Nseir	27000	45000	2300	4000	4000	0	WC	WC
	17	As Salt	40000	85000	6500	7700	9900	29	WAJ	WC
	18	Fuheis	40000	40000	2300	2400	3500	46	WAJ	WC
	19	Wadi As Seer	45000	46000	3800	4000	5900	48	WC	WC
	20	South Amman		600000		52000	52000	0	WC	WC
	21	Al Jiza	60000	To be abandoned					WC	WC
	22	Madaba	91000	131000	5300	7600	10500	38	WC	WC
	23	Azraq Refugee Camp	22000	11000		800	800	0	PS	WC
South (AWC)	24	Aqaba	105000	150000	15700	21000	85000	305	WC	WC
	25	Back Road Aqaba				100	100	0	WC	WC
	26	Ma'an	41000	73000	2400	3900	5800	49	WC	WC
	27	Wadi Mousa	31000	55000	2500	3400	5100	50	WC	WC
	28	Shobak Tankers							WC	WC
	29	Mansourah Tankers							WAJ	WC
	30	Tafilah	37500	59000	1600	7500	7500	0	WAJ	WC
	31	Karak	61000	82000	1800	5500	8000	45	WAJ	WC
	32	Mouta'a	46000	68000	5000	7100	7100	0	WC	WC
	33	Lajoun Tankers	121000	112000					WAJ	WC
Operational responsibility:			WAJ	WAJ						
			WC	Water companies (WC)						
			PS	Private Sector (PS)						
Heavy impact Syrian Refugees				Refugee population > 10% of total population						

Table 2 – Present/ Future O & M responsibilities

A special case are the three WWTP of Wadi Al Arab, Irbid Central and Wadi Shalala, all applying the anaerobic sludge stabilization with digesters, a treatment process so far only applied in As Samra WWTP. For these plants, the engagement of an experienced operating company from the private sector is essential, as YWC is suffering from the heavy Syrian Refugee impact and does not have the resources to guarantee a smooth and reliable O&M in these plants. A more detailed approach to overcome the operational problems in these plants is highlighted in chapter 6.

3.2 Track 1 – Short term investment driven track

TRACK 1 in a way is based on the present system, with the traditional project cycle of planning, design, tendering and construction, and the completed WWTP handed over to either WAJ or one of the water companies for operation. Usually the contractor is formally training the O&M personnel over a short period, extending to max. three months. Experience shows that such short training periods are not useful and generally based on the operation of the installed equipment. Process oriented training is not really carried out.

The future projects shall include a 2 year O&M period for each plant, with the objective to demonstrate the adequacy of design and construction and to train the operating staff on-the-job over an extended period of time.

Contrary to the previous approach, it will be mandatory for the contractor to propose and engage a qualified, experienced operating company as part of the consortium. The tender

document has to include a separate schedule for the O&M services and the evaluation criteria to include O&M and assign appropriate points in the technical evaluation. Special emphasis shall be given to treatment process oriented training, the development of SOP, and maintenance plans.

3.3 Track 2 – Medium term capacity development through RTSC

TRACK 2 with the establishment of RTSC's is to fill the void on professional expertise and knowledge in WAJ and the water companies, to provide assistance, technical support and capacity building to the O&M staff of all WWTP's in a specific region and to establish a performance based monitoring system covering all WWTP's in Jordan.

Besides the technical orientation the tasks should cover as well financial aspects. Needed is the determination of specific O&M costs for each WWTP as basis for preparation of realistic O&M budgets and the financial planning to cover future rehabilitation measures for existing plants.

Besides the above mentioned tasks, an emphasis has to be placed on the treatment process control as heart of all operations. This is by and large neglected in the present operations, partly due to the lack of professional expertise and partly due to the low level of attention on the side of the higher management.

Depending on the entity operating each plant, performance based incentive schemes should be developed to motivate the staff and to raise their identification with the tasks to be covered. An additional effect could be the attraction of interested staff from other sections of the utilities or WAJ.

The provision of experienced professional expertise should be coming from the private sector. Possible arrangements vary from TA through agencies like GIZ to twinning agreements or service contracts with private operators, depending on the funding source. The range of expertise could vary, as some RTSC have to build up expertise on anaerobic sludge stabilization, whereas others cover only the existing treatment methods like the activated sludge process.

3.4 Private sector participation in WWTP operations

TRACK 3 is envisaging the complete O&M and possibly part of the investment by private sector companies. This track proved to be successful for large plants like Khirbet As Samra, and may need to be extended to medium sized WWTP's operating digesters or other facilities generating electricity, and covering areas where WAJ or the water companies do not have adequate expertise nor resources to run the plants in accordance with established standards.

The PSP is usually more costly, but the long term benefits and positive environmental impacts will result in a positive balance at the end and relief WAJ from running WWTP's in an institutional environment not supportive to flexible and performance based operations.

For each project a realistic business case will be built, covering a period of 30 years and including a comprehensive analysis of benefits and costs, an EIA and determination of the scope of services.

4 Example for Clustering of WWTP operations in YWC

4.1 *Status quo*

The service area of YWC covers the governorates of Irbid, Mafraq, Jerash and Ajloun. Out of the 12 existing WWTP, 11 are operated by YWC, 1 by UNICEF (Za'atary Camp). Planned and ongoing extensions/ modifications within the coming 2 years will be in 5 plants (Mafraq, Irbid Central, Wadi al Arab, Jerash East and Kufranja).

YWC is facing severe problems in operating the newly constructed Wadi Shalala WWTP and refused to take over responsibility of the plant. WAJ as a short term measure engaged Messrs. Passavant, the contractor erecting the plant on a one year O&M contract. However, the performance of Passavant on the O&M is not according to expectations, limited input of professionals and resources is endangering operations, and the effluent quality is above permissible standards. Part of the problem is that Passavant is a manufacturer and contractor, not an operator. With the one year contract expiring in June 2016, WAJ and YWC have to explore options for a sustainable medium term operation of the WWTP.

In parallel the WAJ/ KfW funded project "Climate Change Mitigation Measures in the Wastewater Sector in Jordan" (SSTDP) is embarking on introducing in Wadi al Arab and Irbid Central WWTP the anaerobic sludge stabilization with the objective to reduce electricity consumption and greenhouse gas emissions.

That means digesters will be used in three plants, and a hydropower plant to be constructed to utilize the treated effluent from the three plants for power generation before dispatching the effluent for re-use in the Jordan valley.

4.2 *Proposed O&M plan implementation in YWC*

The impact of Syrian refugees is putting unexpected additional loads on some of the existing plants, i.e. Mafraq, Wadi Al Arab, Irbid Central, Wadi Shalala, Ramtha and Wadi Hassan. Ongoing projects to extend the wastewater collection systems are located in Beit Ras, Manshiet Bani Hassan and Mafraq city.

With three plants out of the above mentioned six undergoing major changes within the coming 2 years and shifting to anaerobic sludge stabilization, altogether 3 plants, i.e. Wadi Shalala, Irbid Central and Wadi al Arab will be applying this treatment process and can absorb the additional wastewater load. Considering the erection of a hydro power plant near Wadi Al Arab dam within the ongoing wastewater re-use project, a cluster of 3 WWTP's and the HPP could form the nucleus for the Greater Irbid wastewater treatment system. The plants are about 10 km apart from each other and it would be logical to share resources in operating them (see Figure 3).

Within the coming 5 years the Irbid implementation will be as follows:

1. **Track 1** - WWTP Wadi al Arab, Irbid Central, Shalala, Kufranjah, Jerash East, Mafraq from 2016 – 2017
2. **Track 2** – Establishment of RTSC North for WWTP Ramtha, Wadi Hassan, Jerash West (Merad), Al Keder Tankers and North Shouna Tankers from 2016 – 2021
3. **Track 3** – WWTP Wadi Al Arab, Irbid Central, Wadi Shalala and HPP from 2018 - 2028

However, YWC is facing serious financial constraints due to the Syrian refugee arrivals on the operational side and will have difficulties to provide the required O&M budgets to run the plants in compliance with the relevant Jordanian standards.

Operation of digesters and hydropower plants is another bottleneck for YWC, building up professional expertise and experience will require a minimum input of three years and cannot be covered out of the present resources.

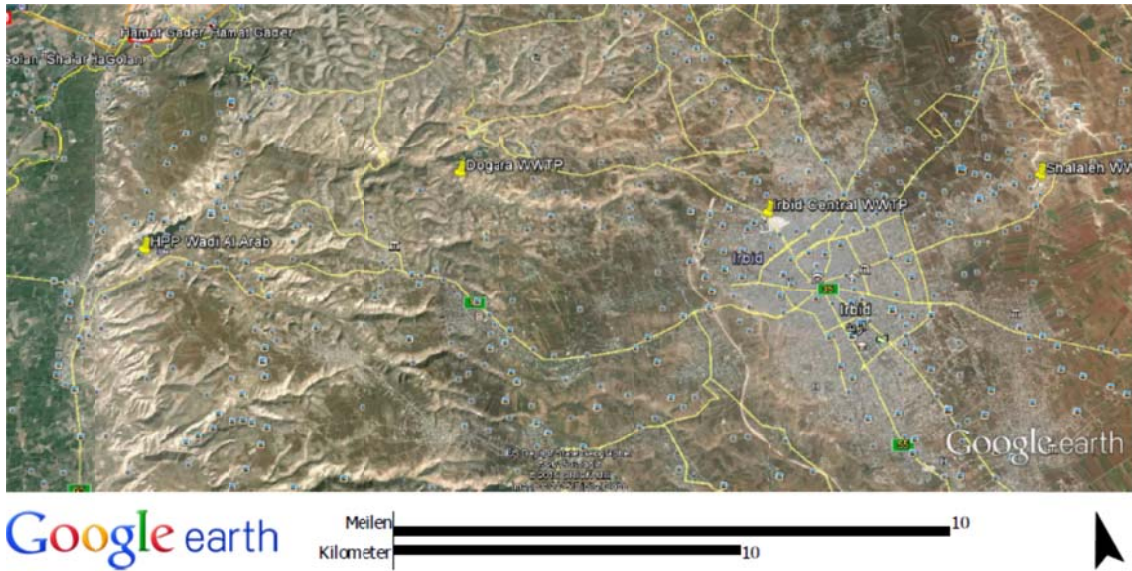


Figure 3 : Greater Irbid wastewater treatment plants

A combination of Track 1 and Track 2 covers the short- and medium term needs for an efficient WWTP operation, and possibly enable support to the other plants in the service area.

All Tracks need additional financial and human resources, for which external donor support seems to be the only available option. Assistance has been requested within the framework of the Jordan Response Plan (JRP).

5 Investments required to solve compliance issues

The ongoing or planned investment projects will ensure compliance with Jordanian standards and cover expansion of operations.

Table 3 shows the present status in each WWTP, the total investment required until 2025 amount to JOD 144 million, out of which JOD 75 million are already funded through different projects.

It is assumed that each expansion or extension of a WWTP will include rehabilitation measures to resolve any compliance issue.

The planning horizon for the investments is the year 2025, further projections are difficult to develop at this stage, as the geo-political situation in the region and the high refugee impact on Jordan may change on short notice.

RTSC	No.	WWTP name	Population		Actual load 2015 [m³/d]	Hydraulic capacity		Required expansion [%]	O & M responsibility		Investment Needs			Funding		
			present	2035		2015	2035		present	future	ongoing & funded	planned	Target Year	ongoing [1,000 JOD]	until 2025 [1,000 JOD]	
North (YWC)	1	Wadi Al Arab	159000	328000	10700	21000	28400	35	WC	PS	★		2018	5505		
	2	Central Irbid	110000	118000	8600	11000	10900	-1	WC	PS	★		2018	5396		
	3	Wadi Shalala	159000	307000	5000	13700	22500	64	WC	PS		★	2018		4757	
	4	Ramtha	80000	201000	4050	5400	17300	220	WC	WC		★	2020		4860	
	5	Wadi Hassan	24000	35000	1200	1600	2500	56	WC	WC		★	2025		2787	
	6	Al Keder Tankers								WC	WC		★	2018		
	7	North Shouna Tankers								WC	WC					
	8	Kufranjah	65800	101000	2800	9000	9000	0	WC	WC	★		2018	11540	92	
	9	East Jerash	72000	113000	3300	3800	10800	184	WC	WC	★	★	2020	18600	1131	
	10	West Jerash (Merad)	69000	106000	2300	9600	9600	0	WC	WC		★	2025		4043	
	11	Mafraq	41000	156000	3100	6100	14400	136	WC	WC	★	★	2020	16500	2375	
	12	Za'atary Refugee Camp	80000	40000	2800	3700	3700	0	PS	WC	★		2018	7500		
Middle (Miyahuna)	13	Khirbet As Samra	2270000	3500000	241000	267000	365000	37	PS	PS	★	★				
	14	Tal Al Mantah Tankers								WAJ	WC					
	15	Baqa'a	173000	275000	11700	14900	27700	86	WAJ	WC		★	2025		25257	
	16	Abu Nseir	27000	45000	2300	4000	4000	0	WC	WC		★	2025		4097	
	17	As Salt	40000	85000	6500	7700	9900	29	WAJ	WC		★	2020		6393	
	18	Fuheis	40000	40000	2300	2400	3500	46	WAJ	WC		★	2020		2571	
	19	Wadi As Seer	45000	46000	3800	4000	5900	48	WC	WC		★				
	20	South Amman		600000		52000	52000	0	WC	WC						
	21	Al Jiza	60000	To be abandoned						WC	WC					
	22	Madaba	91000	131000	5300	7600	10500	38				★	2025		5434	
	23	Azraq Refugee Camp	22000	11000		800	800	0	PS	WC	★					
South (AWC)	24	Aqaba	105000	150000	15700	21000	85000	305	WC	WC		★	2025		369	
	25	Back Road Aqaba								WC	WC					
	26	Ma'an	41000	73000	2400	3900	5800	49	WAJ	WC		★	2025		123	
	27	Wadi Mousa	31000	55000	2500	3400	5100	50	WAJ	WC		★	2025		1517	
	28	Shobak Tankers								WAJ	WC					
	29	Mansourah Tankers								WAJ	WC					
	30	Tafilah	37500	59000	1600	7500	7500	0	WAJ	WC		★	2025		2832	
	31	Karak	61000	82000	1800	5500	8000	45	WAJ	WC	★	★	2018	9800	77	
	32	Mouta'a	46000	68000	5000	7100	7100	0	WAJ	WC						
	33	Lajoun Tankers	121000	112000						WAJ	WC					
													Total	74841	68715	
Operational responsibility:			WAJ	WAJ												
			WC	Water companies (WC)												
			PS	Private Sector (PS)												
Heavy impact Syrian Refugees				Refugee population > 10% of total population												

Table 3 – Investments required to resolve compliance issues

6 O&M Budget requirements

Table 4 provides an overview about past, present and expected development of treatment costs.

For 2016, a budget of JOD 19.4 million is to be provided to run all of the WWTP in accordance with established standards and to achieve the effluent quality as set out in the relevant Jordanian standards.

Recurrent costs of operating and maintaining the WWTP will include, among others

- Electricity required for the operation of equipment
- Chemicals (e.g. flocculating agents)
- Personnel
- Replacement cost of worn out equipment
- Other O&M requirements (consumables, spare parts)
- Transport of treated sludge
- General administration and transport

For comparison purposes the unit cost for treatment of 1 m³ influent as paid by WAJ for the BOT project As Samra has been added to Table 4, which includes capital cost and depreciation.

Surprisingly the cost of 0.2 JOD/m³ is much lower than the expected unit cost of 0.54 JOD/m³ for the plants operated by WAJ and the water companies.

The 2012 unit cost of 0,24 JOD/m³ is not necessarily representative, as the difficult financial situation in WAJ and YWC resulted in the mining of assets, i.e. cannibalizing parts of equipment (Wadi Al Arab), cutting preventive maintenance activities and reducing energy inputs for aeration.

Furthermore, new WWTP's like Wadi Shalala and South Amman have been commissioned and the rise in electricity tariffs are driving operational costs up.

Not to be forgotten is the impact of the refugee arrivals, resulting in partial overloading of WWTP's and higher cost in sludge transport out of the plants.

Important is the provision of budgets for the establishment of the three RTSC, with AWC already implementing part of it.

The figures in Table 4 indicate as well the impact of introducing anaerobic sludge stabilization, besides the positive environmental aspects the operating costs are reduced considerably. This will be very much visible in the three YWC plants of Wadi Al Arab, Irbid Central and Wadi Shalala. With the construction of an HPP on the pipeline transporting treated wastewater to the Jordan valley, an even higher reduction in operating costs will be materializing.

However, the O&M for such plants is more demanding and may require the involvement of the private sector soon after commissioning the digesters and HPP.

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RTSC	No.	WWTP name	Actual load 2015	Hydraulic capacity		O & M responsibility		Operational costs 2012	Required O&M Budget per annum			WAJ O&M cost 2012	O&M cost per m³ (2015)	O&M cost per m³ (2020)	Remarks	
			[m³/d]	2015 [m³/d]	2035 [m³/d]	present	future	[1,000 JOD]	2016 [1,000 JOD]	2020 [1,000 JOD]	2025 [1,000 JOD]	[JOD]	[JOD]	[JOD]		
North (YWC)	1	Wadi Al Arab	10700	21000	28400	WC	PS	566	1542	952	995	0,15	0,39	0,12	anaerobic sludge st.	
	2	Central Irbid	8600	11000	10900	WC	PS	348	527	485	540	0,11	0,17	0,12	anaerobic sludge st.	
	3	Wadi Shallala	5000	13700	22500	WC	PS	0	517	664	729	0,00	0,28	0,13		
	4	Ramtha	4050	5400	17300	WC	WC	262	766	1320	1665	0,18	0,52	0,67		
	5	Wadi Hassan	1200	1600	2500	WC	WC	235	389	672	770	0,52	0,89	1,15		
	6	Al Keder Tankers				WC	WC	55								
	7	North Shouna Tankers				WC	WC									
	8	Kufranjah	2800	9000	9000	WC	WC	147	960	1030	1260	0,15	0,94	0,31		
	9	East Jerash	3300	3800	10800	WC	WC	88	1080	1071	1243	0,07	0,90	0,77		
	10	West Jerash (Merad)	2300	9600	9600	WC	WC	146	926	1318	1568	0,17	1,10	0,38		
	11	Mafraq	3100	6100	14400	WC	WC	106	850	950	1100	0,18	0,75	0,43		
	12	Za'atary Refugee Camp	2800	3700	3700	PS	PS	0					0,00	0,00		Covered by UNICEF
Middle (Miyahuna)	13	Khirbet As Samra	241000	300000	365000	PS	PS	19490	21900	29300		0,18	0,20	0,22	BOT includes capital cost & depreciation	
	14	Tal Al Mantah Tankers				WAJ	WC									
	15	Baqa'a	11700	14900	27700	WAJ	WC	425	242	2918	3447	0,01	0,06	0,54		
	16	Abu Nseir	2300	4000	4000	WC	WC	205	284	710	820	0,23	0,34	0,49		
	17	As Salt	6500	7700	9900	WAJ	WC	338	1820	837	944	0,14	0,77	0,30	anaerobic sludge st.	
	18	Fuheis	2300	2400	3500	WAJ	WC	191	344	719	834	0,23	0,41	0,82		
	19	Wadi As Seer	3800	4000	5900	WC	WC	139	650	700	750	0,09	0,47	0,48		
	20	South Amman	10000	52000	52000	WC	WC	0	1000	2500	3500	0,00	0,27	0,13		
	21	Al Jiza				WC	WC	166								
	22	Madaba	5300	7600	10500			330	1201	492	521	0,17	0,62	0,18	anaerobic sludge st.	
	South (AWC)	23	Azraq Refugee Camp		800	800	PS	PS	0					0,00	0,00	Covered by UNICEF
24		Aqaba	15700	21000	85000	WC	WC	1561	1589	1418	1600	0,51	0,28	0,18		
25		Back Road Aqaba				WC	WC									
26		Ma'an	2400	3900	5800	WAJ	WC	515	813	1085	1251	0,60	0,93	0,76		
27		Wadi Mousa	2500	3400	5100	WAJ	WC	725	676	545	569	0,78	0,74	0,44	anaerobic sludge st.	
28		Shobak Tankers				WAJ	WC									
29		Mansourah Tankers				WAJ	WC									
30		Tafilah	1600	7500	7500	WAJ	WC	100	181	943	1158	0,18	0,31	0,34		
31		Karak	1800	5500	8000	WAJ	WC	86	242	974	1115	0,13	0,37	0,49		
32		Mouta'a	5000	7100	7100	WAJ	WC	0	1100	1500	1700	0,00	0,60	0,58		
Regional Technical Support Centres		North								575	625	690				
	Middle								575	625	690					
	South								575	625	690					
TOTAL all WWTP			355750	526700	726900			26224	41324	54978	30149	0,24	0,54	0,44		
TOTAL without As Samra and Refugee camps			114750	222200	357400			6734	19424	25678	30149					
												Average Unit Cost per m³				
Operational responsibility:			WAJ	WAJ												
			WC	Water companies (WC)												
			PS	Private Sector (PS)												
Heavy impact Syrian Refugees			Refugee population > 10% of total population													

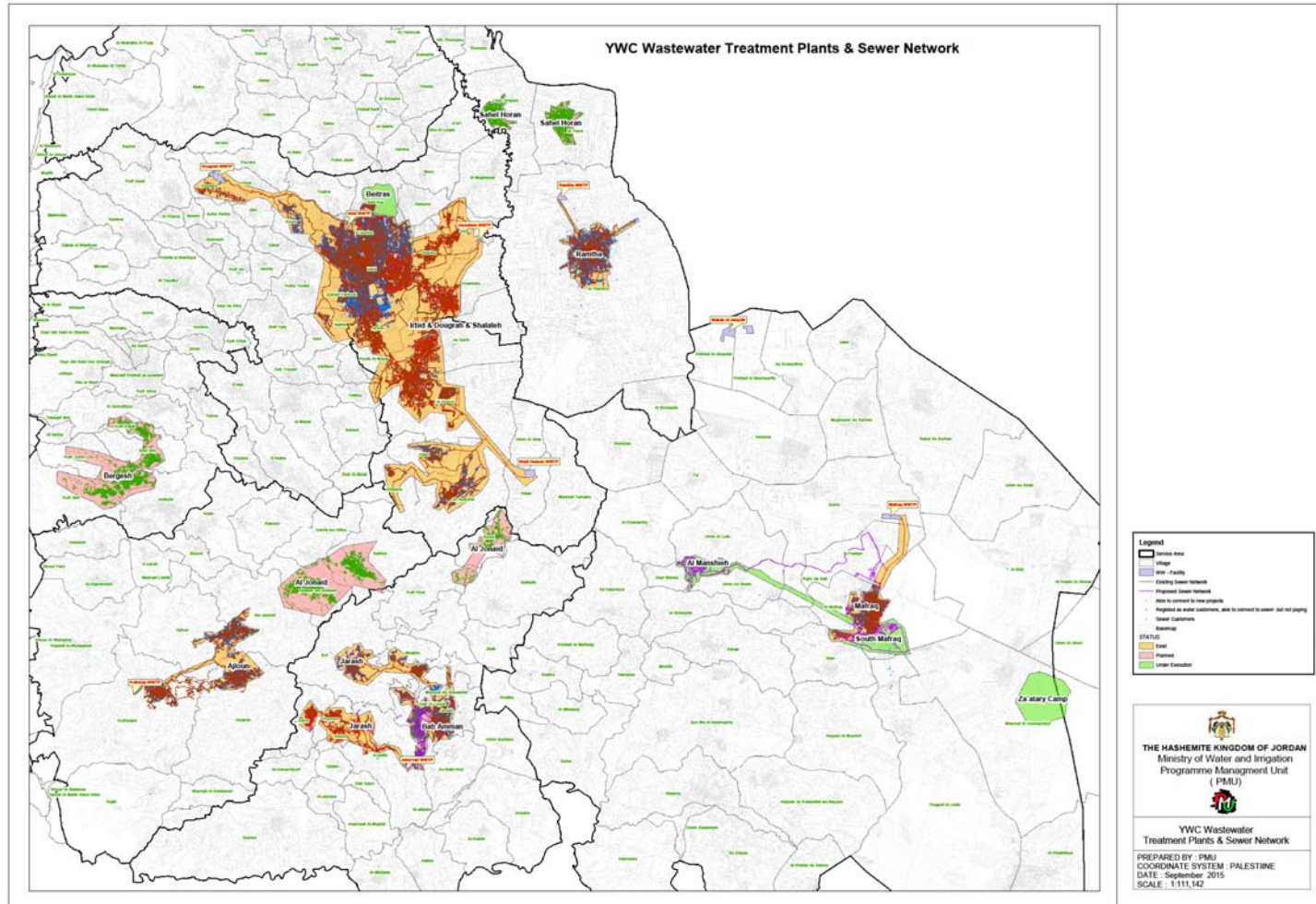
Table 4 – O&M Budget requirements

7 Prioritized Action Plan

Task ID	Action / Decision	Responsible	Target Date	Priority
1	PMU to review and update draft of National Plan WWTP O&M	PMU	15/09/2015	1
2	O&M National Plan to be introduced to MWI/ WAJ and water companies	PMU	20/09/2015	1
3	O&M National Plan to be introduced & discussed with USAID	MWI	25/09/2015	1
4	O&M National Plan to be approved by MWI and WAJ	Minister MWI & Sec Gen WAJ	30/09/2015	1
5	Development of WWTP O&M budget proposal 2016	WAJ, AWC, YWC, Miyahuna	30/10/2015	1
6	Approval of WWTP O&M budget 2016	MoF	31/03/2016	1
7	Establishment of RTSC South	WAJ & AWC	ongoing	1
8	Transfer of operational responsibility of all WWTP in the southern region from WAJ to AWC	WAJ & AWC	31/12/2016	2
9	Establishment of RTSC North	WAJ & YWC	30/06/2016	
10	Transfer of operational responsibility for WWTP under expansion (Kufranjah, Mafraq, East Jerash) from YWC to RTSC North	YWC	31/12/2016	1
11	Establishment of RTSC Middle	WAJ & Miyahuna	30/09/2016	2
12	Track 1 tendering for YWC WWTP's Wad Al Arab, Irbid Central and Wadi Shalala	PMU, YWC, KfW consultant	30/06/2016	2
13	Development of performance based bonus/ malus system for WWTP O&M	PMU	30/06/2016	2
14	Track 3 Development of proposal for Greater Irbid WWTP O&M organisation	PMU/ RTSC North	31/10/2017	3
15	Preparation of RFP for outsourcing O&M of Greater Irbid Wastewater systems to private sector	PMU	31/12/2016	3
16	Tendering O&M of Greater Irbid WWTP	PMU	31/03/2017	3
17	Contract award O&M of Greater Irbid WWTP	YWC	30/06/2017	3

Annex 1 - YWC Sewerage Systems & WWTP's

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Annex 2 - National Wastewater Collection & Treatment Schematic

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