long term technical assistance

EU-AFD TECHNICAL ASSISTANCE PROGRAMME TO SUPPORT REFORMS IN THE WATER AND WASTEWATER SECTORS IN LEBANON

Funded by the European Union

Implemented by AFD

A9 : INITIAL DIAGNOSIS OF THE WATER ESTABLISHMENTS

DATA COLLECTION AND DIAGNOSIS REPORT

Beirut Mount Lebanon Water Establishment

REVISED EDITION

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CONTENTS

ACRONYMS

AFD	Agence Française de Développement
ALI	Apparent Loss Index
AWWA	American Water Works Association
BMLWE	Beirut and Mount Lebanon Water Establishment
BWE	Beqaa Water Establishment
Capex	Capital Expenditures
CEO	Chief Executive Officer
CMS	Client Management System
DG	Director General
DMA	District metering area
DMAs	District metering areas
EDK	Electricité De Kadisha
EDL	Electricité Du Liban
EDZ	Electricité De Zahleh
ERP	Enterprise Resource Planning
EU	European Union
GAAP	Generally Accepted Accounting Principles
GIS	Geographic Information System
HR	Human Resources
ILI	Infrastructure Leakage Index
IT	Information Technology
IWA	International Water Association
KPI	Key Performance Indicator
KPIs	Key Performance Indicators
KVA	Kilo Volt Ampere
LBP	Lebanese Pound
LWP	Lebanese Water Project
M LBP	Million Lebanese Pound
MCM	Million Cubic Meters
MoEW	Ministry of Energy and Water
NGOs	Non-Governmental Organisations
NLWE	North Lebanon Water Establishment
NRW	Non-Revenue Water
NWSS	National Water Sector Strategy 2020
O&M	Operation and Maintenance
Opex	Operation Expenditures
P&L	Profit and Loss
PI	Performance Indicator

PIs	Performance Indicators
PS	Pumping Station
RWE	Regional Water Establishment
SCADA	Supervisory Control And Data Acquisition
SLWE	South Lebanon Water Establishment
TA	Technical Assistance
UARL	Unavoidable Annual Real Loss
UNICEF	United Nations International Children Emergency Fund
USAID	United States Agency for International Development
VAT	value Added Tax
WE	Water Establishment
WEs	Water Establishments
WTP	Water Treatment Plant
WW	Waste Water
WWTP	Waste Water Treatment Plant
WWTPs	Waste Water Treatment Plants

1 INTRODUCTION

Within the framework of the project "*Technical Assistance Programme to support Reforms in the Water and Wastewater sector*", funded by the European Union and implemented by AFD, Activity A9 stipulates to "*Carry out an initial diagnosis at the WEs*".

The purpose is to carry out a diagnosis performance study for the four WEs, aiming to assess their actual situation through the identification of strengths and weaknesses and critical issues along with possible actions/takeaways for the water establishment to implement service management to international standards, in line with the requirements of the NWSS.

The end goal is to eventually define strategic well-tailored orientations for each WEs, and to identify and implement pertinent KPIs for performance monitoring.

The activity was carried out in two-steps: Data collection, then preliminary diagnosis, covering:

- Technical matters:

  The assessment of the actual situation of human resources (quantitatively and qualitatively, job description, adequacy of the positions with the current profiles, description of the reference frame of the professions and in particular of the new professions that the RWE will need in the coming years, organization structure, etc.).

  The NRW: analysis of the major ratios of production, loss and sales actually collected and cleansed

  Energy related issues: Analysis of energy consumption, source of power, power optimisation and else.

  O&M issues : O&M procedures, O&M system components, existing water systems and planned new infrastructures, Information system, Quality of service in terms of complaints system and service coverage.

  And in general all administrative and technical aspects of the WEs activity.

- Financial matters:

  Revenues analysis covering tariffs, budgets, cash flows, profit and loss, billing system and collection rates, accounting system, water sales, subscription rates.

  Expenditures analysis covering Opex analysis and cost recovery.

  Expenditures related to Capex are not addressed in these preliminary diagnosis reports, due to the lack of relevant data in all four WEs. These will be tackled later on in the final diagnosis reports to be prepared subsequently to this report.

Four separate *Preliminary Diagnosis* reports are produced, one for each WE, structured as follows :

1. Introduction – Legal framework
2. Section A: Executive summary - Findings and recommendations
3. Section B: Technical Performance Diagnosis
4. Section C: Financial Performance Diagnosis
5. Section D: Collected Data

In addition, a brief historical background and legal framework of the establishment of the four WEs is given herein under. More details and key figures and services provided by each WE are given at the beginning the relevant Executive Summary, in order to provide the reader with a full but concise picture on the WE before focusing on diagnosis's results and recommendations.

The present report covers the preliminary diagnosis of BMLWE.

2 HISTORICAL BACKGROUND – LEGAL FRAMEWORK

Until 2000, 21 water authorities were in charge of the supply of potable water throughout the Lebanese territory: eight in the North, six in Beirut and Mount Lebanon, four in the South, and 3 in the Beqaa. Of these, only the Beirut Water Authority (today BMLWE) was an independent authority with its own budget and board, under the tutelage of the Ministry of Electric and Hydraulic Resources (today Ministry of Energy and Water - MoEW). The others were under the direct authority of the ministry.

The result of this fragmentation in service provision was a lack of strategic planning and implementation across the regional service areas, which needed to be managed in a more effective, reliable and sustainable manner

Law № 221/2000 of May 29, 2000, rectified by law № 241/2000 of 7 August 2000 and amended by law № 377 of 14 Dec 2001, re-organizes the water sector in Lebanon, introduces the principles of Integrated Water Resources Management (IWRM), and improves efficiency in service provision.

Under this new regulation, the former 21 water authorities were consolidated into four Water Establishments as follows :

- NLWE, based in Tripoli, merges the former water authorities of Batroun, Bcharreh, Minieh-Dannieh, Halba, Koura, Qbaiyyat, Tripoli and Zgharta.
- BMLWE, based in Beirut, merges the former water authorities of Beirut, Metn, kesrouane, Jbeil, Chouf, and Ain el Delbeh.
- SLWE, based in Saida, merges the former water authorities of Saida, Nabeh el Taseh, Sour and Jabal Amel.
- BWE, based in Zahleh, merges the former water authorities of Baalbeck-Hermel, Zahleh, and Chamsine.

On July 3, 2002, Bylaw 8122 set out the merger of all the former water authorities (as well as all communities, local committees and else, operating and managing drinking water, sanitation, and/or irrigation facilities) under the jurisdiction of the above four WEs.

On the administrative level, Article 5 of Law 221/2000 and its amendments states that the four WEs are independent public bodies, governed by a Board of Directors of six members and a CEO, all appointed by decree. The Board is entrusted with establishing all the internal regulations of the WE. The WEs works under special regulations, under the tutelage of the Oversight Department of MoEW.

The adoption of the Law 221 in 2000 led to the promulgation of a number of by-laws in 2005 as follows:

- Decree 14598 of 14/6/2005 – Rules of procedure
- Decree 14599 of 14/6/2005 – Operating rules amended by Decree 1756 of 16/4/2009
- Decree 14636 of 16/6/2005 – Financial regulations
- Decree 14875 of 1/7/2005 – Staff rules and regulations
- Decree 14916 of 5/7/2005 – Administrative organization

The operating rules are the same for all four WEs, except for SLWE where Articles 56 through 86, which govern matters related to irrigation, are not relevant as irrigation in South Lebanon falls under the Litani River Authority (LRA) and not SLWE as is the case for the three others.

The tasks of the WEs can be summarized as follows:

- Study, implement, invest, maintain and renovate water projects to distribute drinking water.
- Collect, and treat wastewater and dispose of effluents and sludge
- Propose tariffs for drinking water and wastewater disposal services.
- Monitor the quality of distributed drinking water and treated effluents.

In 2005, a number of related by-laws were promulgated:

- Decree 14602 of 14/6/2005 – Rules of procedure
- Decree 14603 of 14/6/2005 – Operating rules amended by Decree 1757 of 16/4/2009
- Decree 14639 of 16/6/2005 – Financial regulations
- Decree 14874 of 1/7/2005 – Staff rules and regulations
- Decree 14913 of 5/7/2005 – Administrative organization

3 DATA COLLECTED

The range period of the data collected was mainly the past five years from 2017-2020. However, when available, data ranges from 2015 were provided by the WE.

The data collected covers all what is available to date on:

- Human resources and organization structure
- Technical data in relation with system information (GIS, ERP, etc.), water systems and infrastructures, Water resources and production, Energy use and consumption, O&M approach and system (SCADA system), Water quality.
- Customer service (Subscribers, quality of service, service coverage, etc.).
- Economic and financial data covers the revenues, expenses, tariff and subscriptions, collection, billing, budgets, trial Balance, Administrative and Commercial accounts, cash flow, ERP system, etc.
- Audit and monitoring system.

SECTION A
EXECUTIVE SUMMARY - RECOMMENDATIONS

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A.1 INTRODUCTION

The structural degradation of the past two decades has transformed the WEs into poorly efficient utility vehicles on different functional levels. In addition, the present environment prevailing since 2017 has added to the complexity of the development process. This present crisis, especially the resulting high increase in transportation cost, has crippled all activities that demand human intervention, human presence, or human governance. It has also exposed the fragility of power supply to the production facilities. The non-efficient production and distribution means, poor governance tools, and data scarcity have also reflected heavily on the situation.

It became now integral to adopt new perspectives to overcome the aftermath of the economic and financial meltdown in the country.

Any remedial and development endeavour surely requires, as a prerequisite, the fortification of the Establishment in the following – but not only – fields:

- Strategic vision

  The WE should define and implement a clear development strategy setting out the objectives to be achieved and the way to achieve them within a scheduled time frame.

  The utility provider has to be able to sustain water supply; and at the same time, it has to undergo a rigorous development program that abides to this strategy.

  BMLWE has to develop its own strategy for the upcoming years, based on the following pillars and strategic goals:

  - Securing consistent water supply:
    By securing resources/demand balance in each distribution district, increasing storage capacity, developing and rehabilitating water networks, and generalising the use of automation. Moreover, due to the present crisis, securing sustainable energy sources has become a real challenge.

  - Assuring drinking water quality in compliance with standards and norms:
    By upgrading the labs and quality management program, and enforcement of law to control pollution

  - Cost optimization:
    By decreasing production cost (energy reduction by reliance on solar and surface water), increasing the use of technology and automation, decreasing NRW, favouring in-house O&M over outsourcing by acting to increase in-house maintenance capabilities and management system

  - Customer satisfaction:
    By improving customer service, call centre, customer interface (interactive platforms and social media), mobile application and the like

- Establishment's structure

  The first step is to revise the structure of the WE and set up a new organizational structure in order that it supports both functional and development processes.

- Human resources

  Due to the current crisis and the dramatic fall in wages, the employees of the establishments (essentially the most qualified and most experienced) are leaving. Additionally, WEs are not allowed to employ; and if so, the official wage scale has become too low to attract applicants. Therefore, the human resources of WEs are slowly depleting.

  The WEs must be able to renew and/or retain their human resources by being authorized to employ and raise salaries to an attractive level. However, the employment ban is a general policy of the Lebanese government which applies to all public institutions, and therefore derogating from it only the WEs is a real political issue.

- Data acquisition and management

  Considering the present great difficulties to retain the human resources, the experience and the knowledge base of the establishment have to be preserved at least. The system has to overcome the challenges of the high turnover rate especially the time required by newcomers to merge into the workplace. The turbulent environment the establishment has been passing through requires rigorous and continuous change management activities that consumes lots of time and energy of the management team.

  Therefore, data has to be properly collected and preserved. No development program can work effectively if it is not based on real and accurate data. This includes credible data collection means, archiving, and processing. The digital transformation of the WE is an essential and necessary milestone in the route towards sustainability.

- Governance

  Another challenge to be realized is the proper governance of the all functional, commercial, and quality processes. The establishment is sustainable if it is commercially viable. Commercial viability implies a turnover with a positive profit to loss ratio and positive cash flow. Added to this, a growing establishment implies an increasing annual asset valuation. Quality governance is an integral part of the establishment’s ethical and professional mission. Functional governance is a necessity for an adequately performing establishment. Another reason for a necessary digital transformation.

- IT and Communication infrastructure

  Proper and credible data collection activities, in addition to the digital transformation, require a concrete and reliable IT and Communication infrastructure. This includes integrated software that can work together and with the central ERP software. The communication means have to be reliable and commercially feasible.

- Billing and collection

  At the bottom of commercial viability and turnover growth are billing and collection. Customer segmentation, tariffs, payment portals, among others, can be included in a comprehensive billing solution. The collection process reflects the performance of a number of processes within the establishment. Collection can always be increased by keeping a comprehensive and up-to-date customer database.

- Production cost

  For a utility provider that depends solely on its collection, a positive cash flow can only be guaranteed by a profitable enterprise. Increasing profit can be realized by decreasing production cost, which mainly consists of energy cost.

  Energy cost can be optimized by choosing adequate energy source and by decreasing the energy demand of production facilities. Production facilities require less energy if they produce less water as well. Automation is a necessary requirement for a well-governed process.

- Automation

  Less water production implies optimized distribution. This means that supply adequately meets demand. The quantity of water produced has to be as close as possible to the quantity in demand. Non-revenue water (NRW) has to be kept minimal, whether technical or due to free riders. Pressure in the network has to be compatible with the customer demand curve to control the technical losses.

  Human interference to control distribution valves proved detrimental and incompatible with this endeavour and has to be eliminated.

  Therefore, Automation is a necessary requirement for optimized distribution.

- Water quality

  Distributed water quality is an essential parameter that has to be compatible to national water standards. The community’s ability to purchase drinkable water or to access health facilities in case of illness has been greatly compromised. Enhancing and guarantying water quality can also increase the subscribers’ base and their willingness to pay a higher tariff.

- Wastewater

  Sewage is a pollution hazard that poses great risk on water quality at its source.

  Management of the sewage sector is by law the duty of the WEs. Ideally, it should be designed, implemented, and operated to complement water systems in the supply of water for irrigation and possibly industry. This is not the case presently.

The legal and structural framework allows the intervention of other stakeholders (such as the Ministry of environment (MoE), the MoEW, the CDR, and the municipalities) in the sector. This, of course, hinders the direct operation of the sector by the WEs.

The sewage sector ought to be monitored and managed by the WEs, while operation could be done by others (i.e. municipalities and/or private sector). The other stakeholders should all participate, within their duties, to make the management of the sector possible. For example, the quality of the sewerage, the standards of the effluent, rain water, among others should be attended to by the concerned stakeholders as they fall beyond the mandate of the establishments.

- Irrigation

Scarcity of the water resources and the high interaction with the supply of water for drinking entails high focus on irrigation

Irrigation is by law part of the core missions of BMLWE. Ideally, it should be designed, implemented, and operated to optimize the use of water for irrigation by adopting new irrigation methods and by re-using the treated wastewater.

A great need to modernize irrigation laws in a view to facilitate and organize the use of water for irrigation through the setting up of an irrigation department in the organizational structure of the WE for monitoring and management and the creation of farmers' associations for operation.

- Water Establishments sustainability

Before the crisis, in 2019, BMLWE was sustainable, at least concerning the Opex cost recovery. But today this is not the case anymore.

All efforts should be invested to transform the establishments into sustainable enterprise within a midrange period. From what has been studied until to date, BMLWE can surely be transformed into a sustainable enterprise if the right decisions are made.

One way would be to realize the core activities of the establishments as to outsource some or all of the non-core activities to private or other public entities that may be able to guarantee operating these non-core activities.

However, for the water utility providers to achieve their sustainable full capacity interference is required on the functional, structural, and legal levels in order to develop production, distribution, and quality activities in a governed manner.

A.2 BMLWE GENERAL OVERVIEW

BMLWE serves a geographic area of approximately 2 000 Km² divided, for service and management purposes, into three potable water distribution departments as shown on Figure A 2-1 and Figure A 3-1 below. Irrigation services are limited.

The supplied population is around 2 900 000 (2020) with approximately 500 000 housing units, out of which approximately 76% are subscribed to the water supply service.

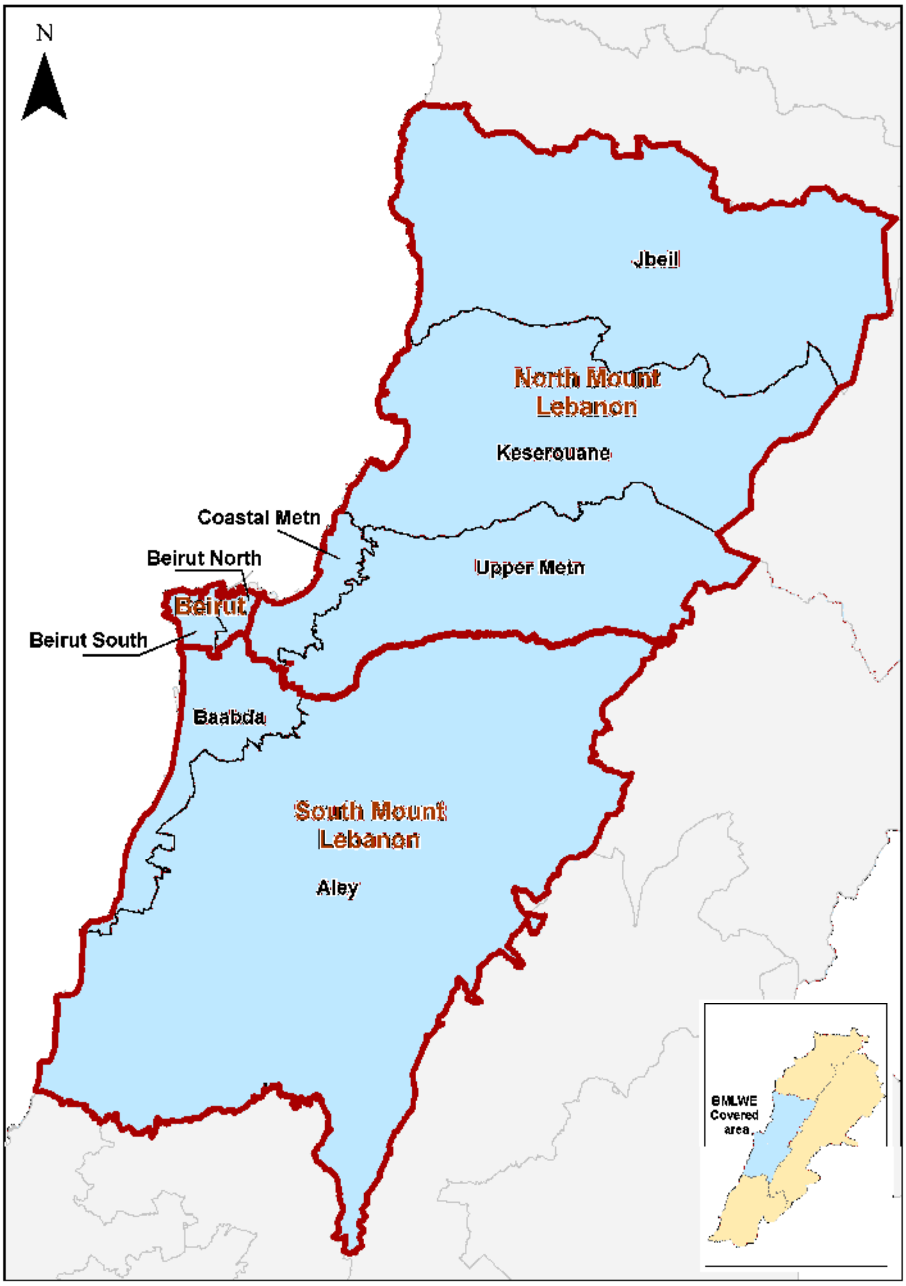


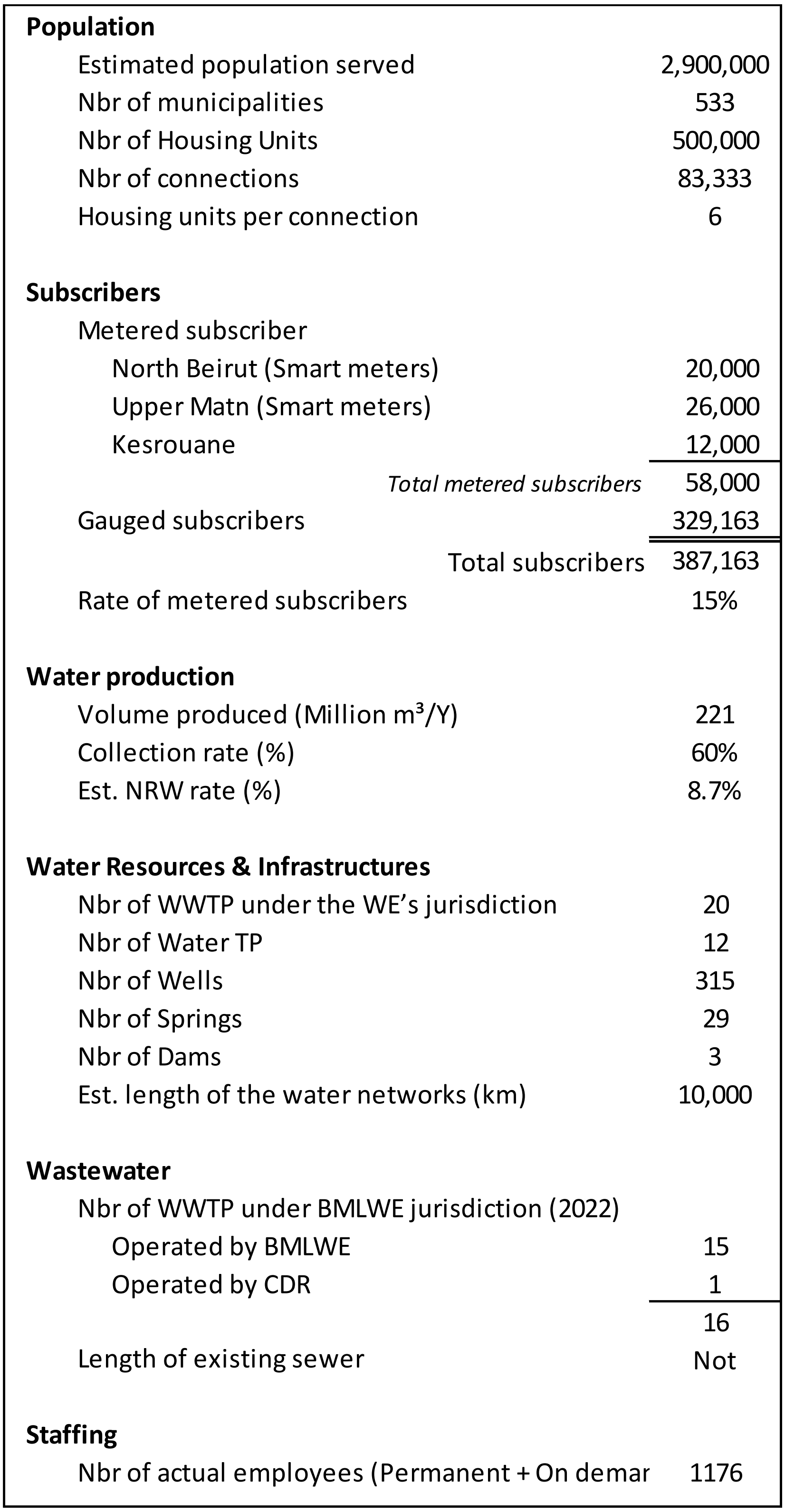
Figure A 2-1 BMLWE service area

BMLWE has the authority and responsibility to provide sewage collection and treatment services. This has traditionally been a service provided by CDR, at the starting period of the operation, and municipalities, and to date, BMLWE is operating 15 WWTP and 11 pumping station and is acting to take over the existing wastewater assets and receive direct ownership of newly constructed wastewater assets (5 WWTPs operated by others).

The water supply sources of BMLWE consist of a combination of 315 wells, 12 treatment plants, 29 springs and 3 dams. The length of the network pipelines in BMLWE is 10,000 km and the service connections is 83,333 connections. Water treatment to drinking water standards consists largely of chlorine disinfection, conferential treatment and advanced treatment to protect from any possible sources of pollution. A key figure is the losses which is about 6% as technical losses.

Table A 4-1 provides a general overview of BMLWE's key figures.

Table A 2-1 BMLWE overview (2020)



Population	
Estimated population served	2,900,000
Nbr of municipalities	533
Nbr of Housing Units	500,000
Nbr of connections	83,333
Housing units per connection	6
Subscribers	
Metered subscriber	
North Beirut (Smart meters)	20,000
Upper Matn (Smart meters)	26,000
Kesrouane	12,000
Total metered subscribers	58,000
Gauged subscribers	329,163
Total subscribers	387,163
Rate of metered subscribers	15%
Water production	
Volume produced (Million m³/Y)	221
Collection rate (%)	60%
Est. NRW rate (%)	8.7%
Water Resources & Infrastructures	
Nbr of WWTP under the WE's jurisdiction	20
Nbr of Water TP	12
Nbr of Wells	315
Nbr of Springs	29
Nbr of Dams	3
Est. length of the water networks (km)	10,000
Wastewater	
Nbr of WWTP under BMLWE jurisdiction (2022)	
Operated by BMLWE	15
Operated by CDR	1
	16
Length of existing sewer	Not
Staffing	
Nbr of actual employees (Permanent + On demar	1176

A.3 PERFORMANCE DIAGNOSIS SUMMARY

A.3.1 HUMAN RESOURCES

Figure A 3-1 below shows BMLWE's organization chart as specified by Bylaw 14915/5 of July 2005 (*The Organisation of Beirut&Mount Lebanon Water Establishment and the Specification of its employees, grades, salary scale, and hiring conditions*)

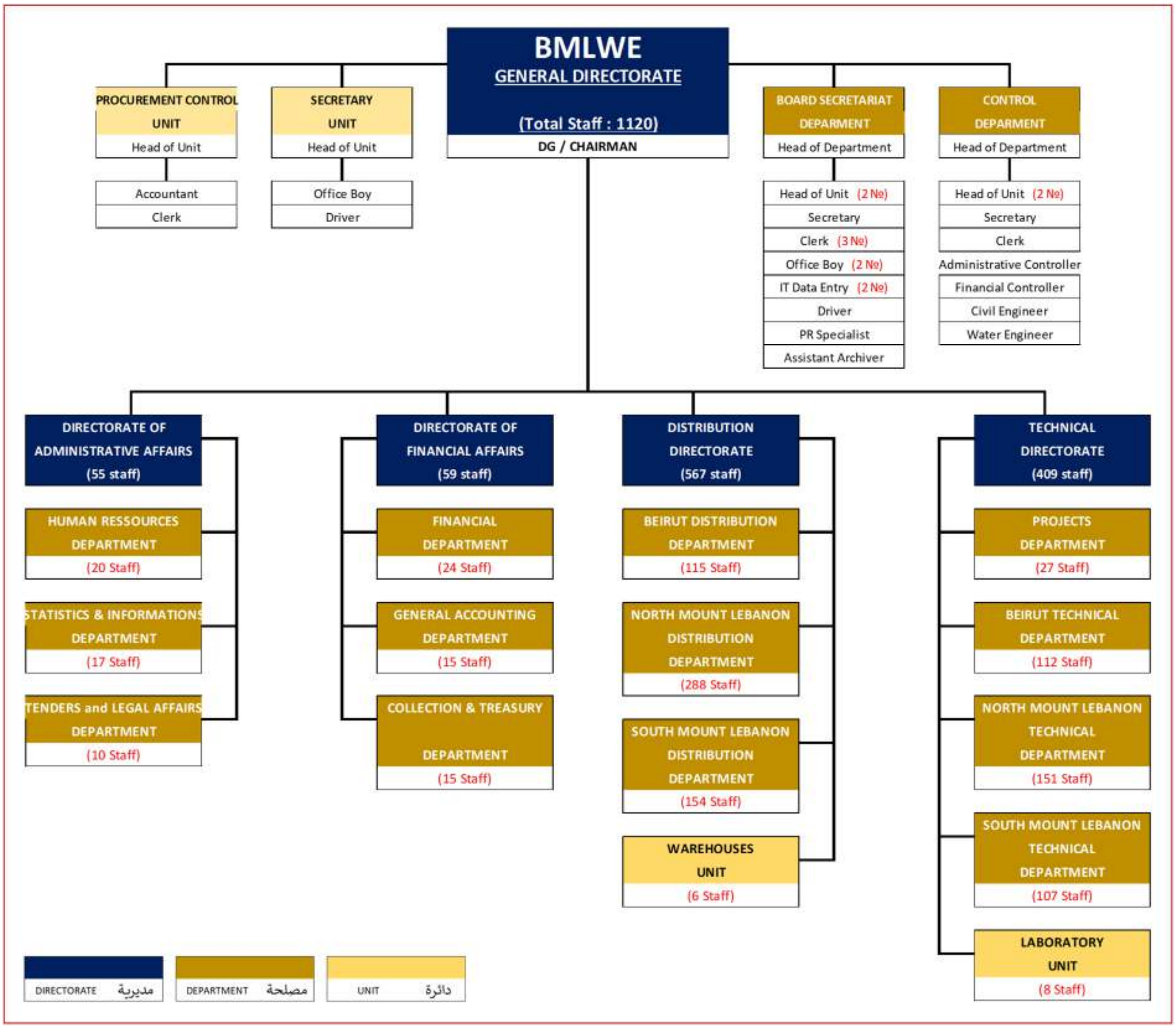


Figure A 3-1 BMLWE General Organigram as per By-Law № 14915/5 of July 2005

Detailed Organisation charts by department are provided under *Section D*

Total employees number should be 1120, of which only 206 positions are presently (2020) filled, which amounts to 76% vacancy.

Article 21 of law 46/2017 has provided for a ban of employment in all public institutions and establishments. To circumvent this ban, BMLWE (like all other WEs) hires on-demand staff to fill vacant positions, ending up with 734 (2020) on-demand personnel representing 67% of the total 1176 (386+ 790) present staff.

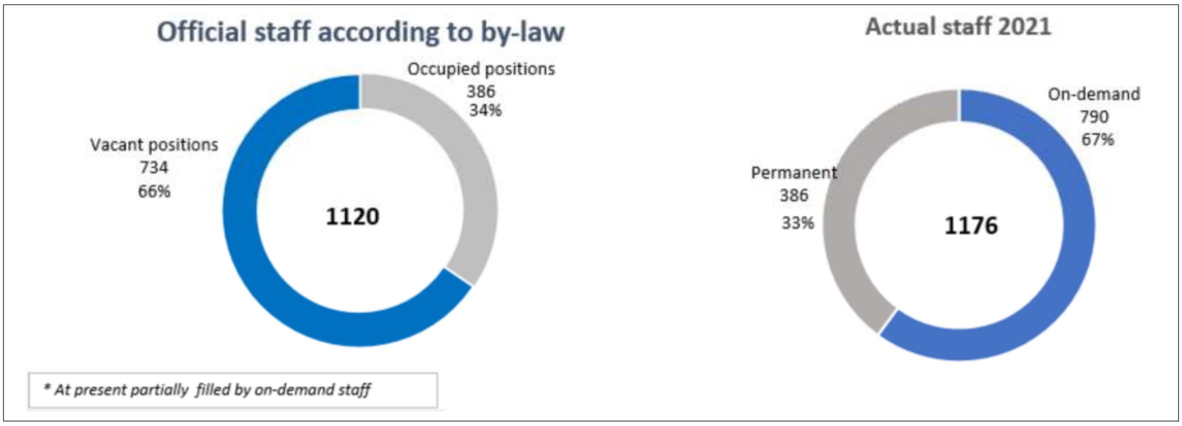


Figure A 3-2 Staff allocation (2020)

The assessment of staff productivity as measured by the number of staff members per 1000 connections was not possible due to the large uncertainty of the number of connections; therefore, the number of subscribers and the number of potential customers were used as alternative methods. The analysis shows that BMLWE is not understaffed, thanks to temporary on-demand staffing. However, there is a sharp lack of qualified personnel, which is the key factor behind the WE lack of operational capacity and the low levels of service. The gap between the number of staff specified in the WEs' organizational decrees and the number of positions occupied is a key indicator.

Due to the deterioration of the economic situation and the devaluation of the national currency, a number of employees have left, not in significant numbers to date (unlike the other WEs), but the risk of departures in large numbers is very real in the coming period.

A.3.2 WATER PRODUCTION

Presently, the water production is not adequately monitored due to the lack of flow measurement equipment in some of the water sources and the absence of telemetry solution for a simple monitoring system or SCADA system for a fully automated monitoring water management system at the wells, springs and pumping stations. Production figures given by BMLWE are known by region from 2016 to 2020 yet, it is based on operators' best estimate.

In 2021, the electricity outage and the rise in fuel prices triggered by exchange rate fluctuations would adversely impact the water volumes pumped; a decrease in water production and a decline in the number of hours of supply are to be expected.

A.3.3 WATER DISTRIBUTION - NRW

In order to examine the nonrevenue water at BMLWE, the analysis adopted a well-known procedure of top-down assessment and bottom-up assessment. However, the accuracy of production quantities, actual water consumption and the absence of DMAs are recognized as the main areas of concern.

Almost all production quantities are based on estimates of production and approximate working hours, while the actual water consumed by the customers cannot be known due to the absence of metering practices. On the flip side, the bottom-up estimate of real losses is ideally conducted on the level of a district-metered area, but the distribution networks are not organized into DMAs and there is no flow measurement at the level of the local reservoirs except for some very limited distribution zones.

The lack of data coupled with absence of DMAs compromised the accuracy of the results. The nonrevenue water has shown little progress between 2019 and 2020 and it is estimated by 47%. The vicious circle of NRW is one of the key reasons for poor utility performance and results in both physical and commercial losses. The analysis of the available data shows that the high NRW levels are mainly caused by commercial losses resulting from inefficiencies in billing, illegal connections and theft. The real (physical) losses are estimated to be 5%. While it is hard to draw any stroke conclusions from the current data, it is worth noting as an area for further research.

A.3.4 WATER QUALITY

As for the quality of water, the data show that BMLWE is not yet developed its own water quality management program to consolidate the water quality results in an accurate, reliable and comparable database, to reduce human error and to ensure the compliance with the national standards and international goals of water safety. The system shall enable the laboratories and departments to improve their processes and services by accessing and analyzing water quality information and make data-driven decisions. The system has to be coupled with GIS-based dashboard to visualize the data in a timely manner and to monitor the water supply chain by locating pollution incidents without carrying intensive sanitary surveys.

A.3.5 WASTEWATER

Legally, the wastewater sector in full (collection networks and treatment facilities) is under the responsibility of the WEs. BMLWE is operating 15 WWTPs and has taken over the ownership of 11 PS.

However, BMLWE is reluctant to take over any new wastewater facility, mainly for (i) the lack of funds to operate it and (ii) the lack of adequate expertise among the present WE's staff. Before providing necessary financial and human resources, BMLWE cannot take over and operate any new wastewater facility. This would be achieved when (i) a new organization chart is implemented and authorization to hire is given to the WEs and (ii) when a new tariff allowing the WE to cover the Opex is enforced.

Table A 3-1 Water production and wastewater facilities (2020).

WWTP' Name	Operated by	Design Capacity (m3/d)	Remarks
El Ghadir	BMLWE	138,000	Preliminary treatment only
Ras Nabi Younes	CDR	11,900	
Jbeil	CDR	-	Not operating yet, waiting for network's completion
Gharifeh	BMLWE	1,125	
Safa	BMLWE	3,000	
Barouk	BMLWE	1,200	
El Khraibe	BMLWE	450	
Jbaa	BMLWE	225	
El Moukhtara-Boutme	BMLWE	450	
Aammatour	BMLWE	900	
Niha-Bater	BMLWE	900	
Maaser El Chouf	BMLWE	450	
Mrousti	BMLWE	250	
Jdaideh	BMLWE	1,600	
Baadarane	BMLWE	450	
Ainbal	BMLWE	2,200	
Kfarqatra	BMLWE	250	
Hemlaya	MoEW	-	Under construction
Khenchara	CDR	8,432	Waiting for commissioning
Remhala/Aley	Municipality	-	Not operating

A.4 FINANCIAL DIAGNOSIS SUMMARY

A.4.1 KEY FIGURES

Table A 4-1 below summarises the financial key figures of BMLWE. Financial data for 2020 was not available.

Table A 4-1 Financial Key figures

``		2016	2017	2018	2019	2020
		(year ends December 31)				
Subscribers, production, NRW						
Total number of customers		367,233	373,749	373,504	381,306	387,163
of whom water meters (but not read)		19,163	19,700	20,544	21,143	21,756
Volume produced entering into the system	m³/year	190,369,035	204,864,280	201,959,245	223,936,990	221,818,895
Volume billed/subscribed	m³ /year	189,493,400	193,512,050	194,995,410	199,197,290	202,483,385
Estimated NRW rate		0.5%	5.5%	3.4%	11.0%	8.7%
Revenues; Collection rate; Operating cost						
Accrued revenues	LBP	118,998,030,576	124,364,329,686	125,264,738,399	152,068,346,850	154,637,983,383
Actual revenues	LBP	97,219,855,593	98,156,480,595	100,358,216,184	107,921,029,053	93,876,910,081
Annual collection rate		82%	79%	80%	71%	61%
Operating cost	LBP	85,344,091,570	78,545,364,198	83,848,850,921	89,145,964,363	79,488,693,571
Operating result, EBITDA						
EBITDA in case 100% collection rate	LBP	33,653,939,006 (28%)	45,818,965,488 (37%)	41,415,887,478 (33%)	62,922,382,487 (41%)	75,149,289,812 (49%)
Actual EBITDA considering actual collection rate	LBP	11,875,764,023 (12%)	19,611,116,397	16,509,365,263 (16%)	18,775,064,690 (17%)	14,388,216,510 (15%)
Cash situation						
Cash situation	LBP					
Account Receivables	LBP	117,786,949,907	124,837,023,844	118,706,484,875	149,317,860,308	191,971,918,895
Estimated Amortization						
Rates for 1 m³						
Nominal selling price (based on accrued revenues)	LBP/m³	628	643	788	744	764
Actual selling price (based on actual collection)	LBP/m³	513	507	481	364	464
Nominal operating cost (based on volume produced)	LBP/m³	448	383	835	853	358
Actual operating cost (based on volume billed)	LBP/m³	450	406	835	853	393

A.4.2 PROFITABILITY, SUSTAINABILITY

On the financial side, the analysis concentrated on profitability, liquidity and solvency of the WE. A particular attention is paid to the EBITDA, which reflects the profitability of the business together with the capacity to produce sufficient cash-flow.

Generally speaking, before the crisis BMLWE was in a good financial situation as revenues exceed O&M costs, giving the WE the capacity to replace worn-outs.

Operating result in 2019 is a profit amounting 17% of the accrued revenues with a positive EBITDA (assuming 100% collection rate, the operating result would be 41%).

Until 2018, the collection rate was around 80%, which is quite acceptable, but since it decreased down to 60%in 2020

We are in a situation where the official tariff level is higher than the O&M cost. The price of water service while taking into account the collection rate, is meeting the O & M costs although the trend is a matter of concern since the EBITDA trend is declining slowly.

On the financial performance, the Earnings Before Interest, Depreciation and Amortization (EBITDA) while taking into consideration effective payments is still in the green territory with an anticipated concern for year 2020 and probably for 2021. Due to the decline of the collection rate, cash problems are to be anticipated and most likely an increase of accounts receivable.

A.4.3 OPEX COST RECOVERY

The analysis reveals the impact of the cost of energy on operational expenditures.

In 2019, energy costs were 30% of the total Opex, against 51% for labour, and 14% for maintenance cost. With a total of 95%, energy and staff costs have the greatest impact on Opex (indirectly confirming the *pareto Principle* 80/20!). However, in 2022, the cost of energy became preponderant with nearly 60% of the Opex (Figure A 4-1 below).

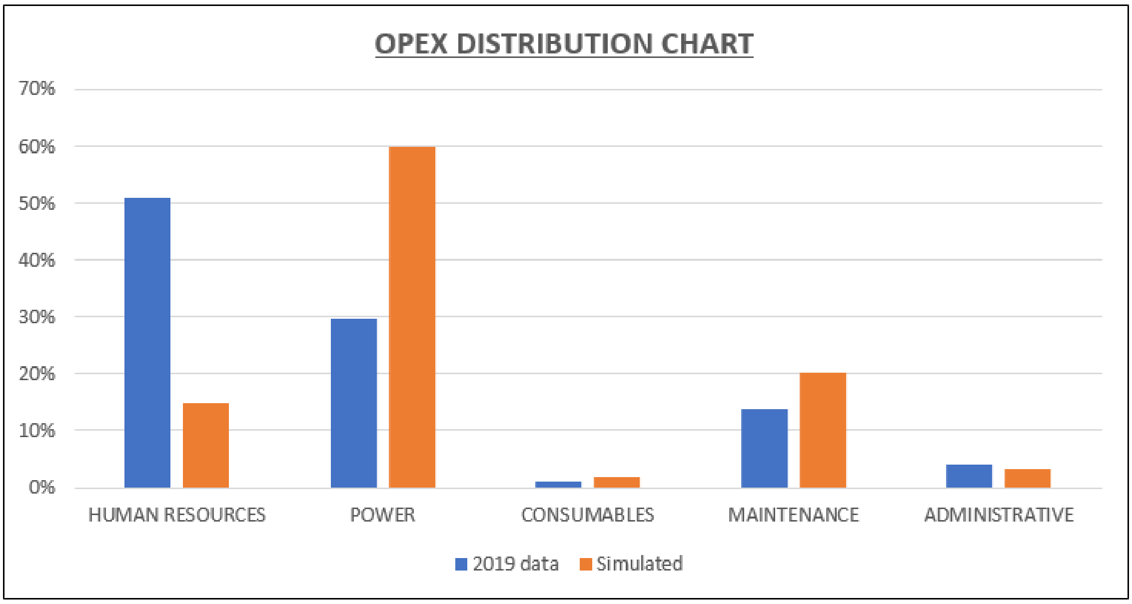


Figure A 4-1 Opex distribution : 2019 v/s 2022

Presently, the situation has worsened with the rising inflationary pressures, the devaluation of the Lebanese Pound and the rise in energy prices. BMLWE now covers 14% of the operational costs compared to 112% prior to economic meltdown (with the tariff in force in 2021).

The required tariff to balance the estimated 2022 Opex is around 2.6 Million LBP, which is simply not applicable from the socio-economic point of view.

Table A 4-2 Compared Opex Cost Recovery 2019 - 2022

Operational Revenues : 145 305 M LBP			Cash Flow : 100 261 M LBP			Total OPEX : 89 425 M LBP		
Financial Indicators (Base value)			**Collection rate assessment**			**OPEX Breakdown**		
Exchange Rate :	1 500	LBP/USD	Invoiced :	145 305	M LBP	HR	45 715	M LBP
Fuel :	850	LBP/l	Collected :	100 261	M LBP	Power	26 632	M LBP
Gazoline :	25 000	LBP/20 l	Collection Rate	69%		EDL	19 039	M LBP
Transportation :	8 000	LBP/day	Cost recovery	112%		Generators	7 447	M LBP
EDL/Gen. % :	78%	EDL				Donations	146.25	M LBP
EDL increase factor :	1.00		**Subscriptions rate assessment**			Consumables	984	M LBP
CPI :	115		Volume Produced	224 000	K m^3	Paid by WE	984	M LBP
Salaries increase factor :	1.00		Volume Billed	199 000	K m^3	Donations	0	M LBP
Including new WWTPs :	No		Technical losses	6%	(ILI = 8)	O&M	12 429	M LBP
			Subscriptions Rate	94.54%		Paid by WE	12 298	M LBP
Tariff increase factor :	1.00		Potential invoicing	153 698	M LBP	Donations	131	M LBP
(Avg. bill amount : 405 000 LBP)						Administrative	3 665	M LBP

Operational Revenues : 145 305 M LBP			Cash Flow : 100 261 M LBP			Total OPEX : 739 999 M LBP		
Financial Indicators (Typical 2022)			**Collection rate assessment**			**OPEX Breakdown**		
Exchange Rate (base = 1 500) :	20 000	LBP/USD	Invoiced :	145 305	M LBP	HR	106 675	M LBP
Fuel (base = 850) :	19 700	LBP/l	Collected :	100 261	M LBP	Power	438 678	M LBP
Gazoline (base = 25 000) :	375 000	LBP/20 l	Collection Rate	69%		EDL	256 286	M LBP
Transportation (base = 8 000) :	64 000	LBP/day	Cost recovery	14%		Generators	178 981	M LBP
EDL/Gen. % (base = 78%) :	78%	EDL				Donations	3411.029	M LBP
EDL increase factor :	13.00		**Subscriptions rate assessment**			Consumables	16 952	M LBP
CPI (base = 115) :	700		Volume Produced	224 000	K m^3	Paid by WE	16 952	M LBP
Salaries increase factor :	2.00		Volume Billed	199 000	K m^3	Donations	0	M LBP
Including new WWTPs :	Yes		Technical losses	6%	(ILI = 8)	O&M	155 385	M LBP
			Subscriptions Rate	94.54%		Paid by WE	153 877	M LBP
Tariff increase factor :	1.00		Potential invoicing	153 698	M LBP	Donations	1 508	M LBP
(Avg. bill amount : 405 000 LBP)						Administrative	22 309	M LBP

A.4.4 BILLING, COLLECTION, SUBSCRIBERS

The financial situation is not sustainable and must be addressed urgently. Increasing billing and collection rates is one of the key tools for enhancing the revenue base of the WE to achieve financial viability, and sustainability; in fact, the benefits of efficient billing and collection practices are almost instant and can improve the revenue accounts almost immediately.

The data show a constant slight increase in the overall water subscriptions before slowing down in 2020 due to the economic downturn. The number of subscribers increased at a 5% compound annual rate during 5 years, from 367,233 in 2016 to 387,163 at the end of 2020. This progress reflects the success of BMLWE's in rapidly expanding its customer base.

The annual collection efficiency improved to 80% in 2018 driven by a new momentum created by the management change before getting hit and slowed by the turbulence and the deteriorating economic conditions that started in 2019. The analysis shows that different regions have different trends and wide variance in the collection rate: In South and North Beirut, the collection rate for 2019 was 79% compared to 57% in Aley and Chouf raising questions about willingness of customers to pay and/or the inadequate customer records. In fact, the lack of official collectors and incentives and the reliance on contractual collectors are critical issues that prevent BMLWE from recovering sufficient costs to properly operate and maintain the facilities.

A.5 KEY RECOMMENDATIONS

The outcome of the Performance Diagnosis is the basis for identifying required action to gradually improve the WE's performance in order to bring the services provided and the financial sustainability up to acceptable standards.

Strategic goals to be achieved are :

- Improve the organization structure and staffing of the water establishment.
- Reduce the non-revenue water and water losses
- Promote the efficient use of energy to reduce the consumption and improve cost recovery
- Establish a comprehensive O&M system to maintain the existing water infrastructures and their associated equipment's and construct new water systems, where needed, to improve the quality of service, reduce the O&M cost and increase the service coverage
- Set up a monitoring and audit system to improve the quality of service.

Under Section A.5, *Main findings and recommendations*, key recommendations are given for each topic separately.

In this Section A.5, key recommendations are grouped and sorted by priority.

A.5.1 MASTER PLAN / STRATEGY

BMLWE has master plans prepared for Jbeil, Kesrouane, and Metn districts. However, there is not a general master plan covering the whole jurisdiction, in particular the Chouf

On the other hand, in 2018 BMLWE set a five-year plan for the implementation of a number of infrastructure projects. It is necessary to re-assess the relevance of these projects in line with the prevailing economic crisis, in particular :

- Conduct a cost benefit analysis for the capital investment projects needed in the near term for improved decision making
- Prioritize infrastructure projects based on a standard analysis grid

A.5.2 ORGANIZATION STRUCTURE AND STAFFING

To improve the organization structure and staff's performance, it is recommended to:

- Assess the pertinence of the present Organisation Chart in light of today's challenges the WE is facing, mainly but not only in the fields of wastewater, data acquisition and processing, water quality, and else; in addition to the fields of management and development
  Propose a new Organization Chart in line with the above, including job description and qualification requirements for each staff member down to the level of first line supervisors

- Set up a staff's performance monitoring body/system based on specific targets to achieve and performance indicators.
- Initiate necessary legal steps in order to implement this new organisation chart, and to allow the WE to fill in the vacant positions.
- Identify staff capacity building needs and set up an adequate training program to bring staff's performance to a satisfactory level in terms of the services to provide.

A.5.3 DIGITALISATION

The various data whether financial or technical should be centralized in one data centre or digital platform, therefore it is necessary to:

- Carry out an assessment of all data acquisition/processing systems in use at the WE and design a new data centre, to be implemented by steps, in the view of a central digitalization system for the whole WE. Based on the outcome of this assessment, the below steps would be carried out, in all or partially.
- Carry out studies for the improvement/replacement - if deemed necessary - of the existing ERP system, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.
- Carry out studies for the improvement and extension - if deemed necessary - of the existing GIS system to cover the acquisition of all technical data, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.
- Carry out studies for the design of a data acquisition and processing system to cover the monitoring and management of the production and distribution flows; with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building. Supply and installation of the required remote sensors for the operation of the systems shall not be part of these Tender Documents.
- Implementation of the digitalization system.

A.5.4 WATER PRODUCTION – AVAILABLE WATER RESOURCES

Presently, the water production is not adequately monitored; the production figures provided by BMLWE are based on operators' *best estimate*.

Therefore, it is necessary to:

- Carry out a general survey of all water sources presently in service; assess the status of the existing flow measurement equipment if any;

- Prepare Tender Documents for the implementation of flow/yield measurement equipment on all water sources, linked to the central production data center.
  Because the cost for installing measurement equipment on all the water sources presently in service is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

A.5.5 WATER DISTRIBUTION

Here again, the distributed flow provided by the WE is an operator's *best estimate*, due to the lack flow measurement at the level of the distribution centres or reservoirs.

Therefore, it is necessary to:

- Carry out a general survey of all distribution zones and identify the feeding point(s) of each, and assess the status of the existing flow measurement equipment at each feeding point, if any
- Prepare Tender Documents for the implementation of flow/consumption measurement equipment on each feeding point of each distribution zone, linked to the central production data center.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.
- Identify existing DMAs and/or areas that could possibly be turned into DMAs, and identify possible locations for the installation of bulk flow/consumption meters on the distribution network, linked to the central production data center; and prepare Tender Documents for the supply and installation of such equipment.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

A.5.6 PILOT DMA

Identify, in close coordination with the WE, one pilot area to convert into DMA and carry out within this area detailed studies for:

- Detailed customers census in order to assess the consumption needs and its geographic repartition.
- Detailed distribution network survey followed by a hydraulic modelling.
- Installation of bulk flow meters on strategic locations, and water meters on a number of house connections (if not all).
- Assessing the water losses.

A.5.7 NON REVENUE WATER

The lack of data coupled with absence of DMAs impacted the accuracy and quality of the NRW results. Given this finding, the following actions are recommended:

- Implement low cost high impact intervention, the so-called “quick wins” typically the commercial/apparent loss reduction measures instead of the more capital-intensive reduction measures targeting the physical/real loss. The activities consist of customer database update through door-to-door surveys to identify illegal practices, leaks on the service connections, and improved meter management, …
- Implement DMAs for demonstration and trial purposes. The DMAs are used as a diagnostic tool in quantifying physical losses (through bottom-up assessment), and to validate the results of the NRW assessment (top-down assessment).
- Prepare a NRW Reduction Strategy/Plan based on pilot projects outcome and set the NRW targets with the required budget.
- Promote the NRW problem ownership and introduce organizational measures such as working groups, NRW units to boost the implementation capacity.

A.5.8 BILLING AND COLLECTION

The benefits of efficient billing and collection practices are instant and can improve the revenue accounts almost immediately.

Based on the outcome of the present assessment, the below actions are recommended:

- Conduct a study to assess the weak collection efficiency and the inadequate customer records with focus on the reliance on contractual collectors (contract terms, remuneration, number of collectors and performance targets)
- Carry out studies for the assessment of the existing billing and payment processing system and the possibility of the introduction of improved billing technologies, with the view of future integration within a central digitalization system.
- Strengthen the geographic information system mapping to cover the subscribers’ data and the records of properties showing all potential water customers.

A.5.9 TARIFF STUDIES

Tariffs in force are deemed to cover WE's costs including Opex, Capex, and asset depreciation. With the present tariff in force, this is far out of reach.

Therefore, it is recommended to:

- Undertake an economic analysis of production and cost taking into consideration the short-run and long-run to allow for a comprehensive pricing strategy that would allow to gradually recover the operational costs and eventually any future capacity expansion.

- Establish a tariff setting scheme and tariff reforms with mechanisms for obtaining the information on present and future costs of operation and mechanisms of indexation to adjust tariffs by inflation, energy prices and other items that are part of the cost schedule of BMLWE.

A.5.10 O&M MANAGEMENT SYSTEM

In order to enhance efficiency and reduce the cost of O&M, it is necessary to design a modern preventive/corrective maintenance system, and implement it in the view of central digitalization system for the whole WE.

A.5.11 PRODUCTION COST OPTIMISATION

With the present financial situation, energy has become the major component of production cost, nearing 90 % (Figure A 4-1 above). BMLWE's strategy is to implement renewable energy sources such as hydroelectric or solar, in addition to shifting from underground to surface water sources, where possible. However, there is no comprehensive view of the subject.

Therefore, it is necessary to carry out a general *Cost Optimisation Master Plan* covering in details all the available options over the WE's jurisdiction, and setting up the upper threshold of what could be possibly achieved in this field.

A.5.12 TAKING OVER THE WASTEWATER SECTOR

BMLWE is reluctant to take over the wastewater sector for reasons detailed under Sub-section 0 above.

In the meantime, financing must be provided from sources other than BMLWE own funds (GoL or donors) to:

- Outsource the operation and maintenance of each treatment plant and related network to private operators via performance-based contracts.
- Hire a sewage treatment expert seconded to the WE in order to oversee the execution of these contracts

A.5.13 SHIFTING TO METERED CONSUMPTION POLICY

Metered consumption is the end key for reducing NRW, Opex, and overall water consumption. In fact BMLWE applies water metering in parts of Beirut and elsewhere.

However, based on lessons learned from past experiences in BMLWE and the other WE, it appears that this is not a top priority, where water resources are not sufficient, and a number of prerequisites are to be implemented before systematically installing water meters, out of which:

- Setting up a team to operate and manage meters’ maintenance and reading.
- Selecting the most adequate meter type based on the adopted reading policy.

- Securing continuous supply in the areas where the meters shall be installed, in order to encourage the consumers to subscribe and accept the idea of water metering.

Water metering projects may be systematically implemented over the whole jurisdiction once the above is implemented and running smooth.

SECTION B
TECHNICAL PERFORMANCE DIAGNOSIS

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B.1 HUMAN RESOURCES

The assessment of personnel investigates the quantitative sufficiency of different criteria of education and specialisations within the establishment. This assessment considers the current case of Lebanon where hiring and firing have been severely restricted and external contracts have been made to cover not only daily labour but vital positions.

Moreover, it is important to assess the validity of the imposed organisational regulations that specify the number and type of employee for each region and area of business and show irregularities in that design that currently limits the WE even if hiring was within their ability.

B.1.1 Total personnel

The main reference for the preferred number of staff comes from Tynan and Kingdom where the best performing quartile of water utilities measured 5 employees per 1000 service connection or fewer. The figure cannot be generalised easily given issues such as:

- The number of connections is not an applicable basis for assessing performance since some activities such as water distribution may be related to the number of connections, but others such has customer service, meter reading, and door-step collection may not. That and with the case of Lebanon a connection often serves an apartment or office building with multiple units.
- The figure does not consider the method of billing and collection where in some countries the process is done over the mail or using the internet while in others, such as the case of Lebanon and much of the region, billing and collection is primarily done in the field with company staff personally interacting with most customers.
- Moreover, the number needed to operate and manage the processes related to customer billing and metering would be different depending on the length of a billing cycle, where a monthly cycle would require more than an annual cycle.
- Also of great relevance is the relative number and distribution of resources, where in some utilities production and transmission facilities are few and centralised, while in others, such as in Lebanese WEs, the resources are many and often localised.

Those and more objections can be drawn, and therefore it was our attempt to focus on the sufficiency of staff for each business area and job type instead, as will be shown next. To assess the total number of staff we took the following:

- The total number as per the WE organisation by-laws.
- The number of employees.
- The number of contracted staff.
- The total number of staff whether contracted or employed.

First, we look at a faithful demonstration based on an estimate of the number of connections done for the WE. The exact or even approximate number of connections is not known. The number of connections here refer to the total number of supposed tapping points on the network, or approximately the total number of buildings connected to the network. That number does not correspond to either legal tapping points or the number of official subscribers that is estimated for the WE.

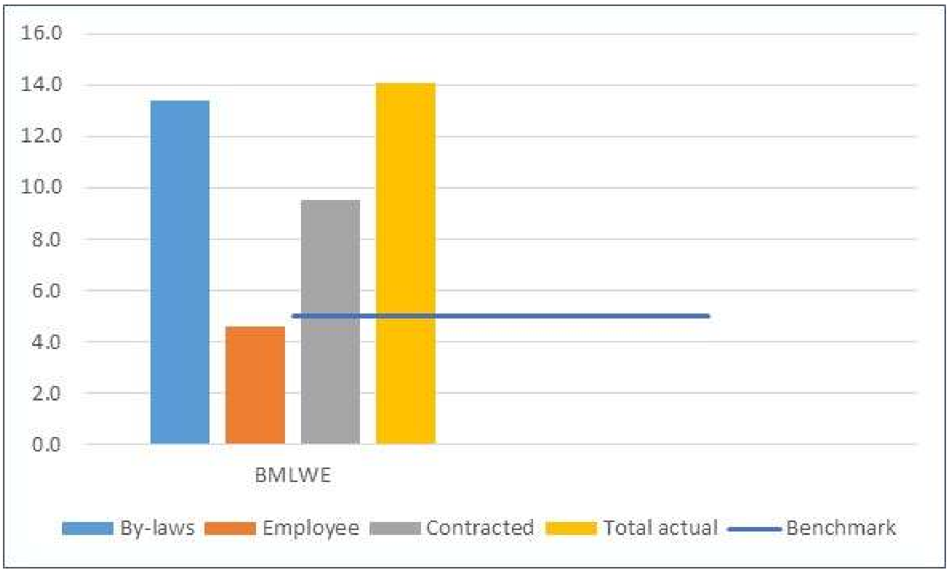

Figure B 1-1 Personnel per 1000 connections.

Acknowledging that the estimated number of connections is prone to a large uncertainty, it can clearly be seen that using the number of connections as a base indicator may not be the best in the cases of Lebanon and using the number of subscribers therefore would be more representative of the idea behind such indicator.

Using the number of subscribed customers instead, we can interestingly find that for the case of BMLWE the results are close or lower than the benchmark, yet the number assigned by the by-laws exceeds and is about double that of the benchmark. That would indicate that the number of decreed staff in this WE has been exaggerated.

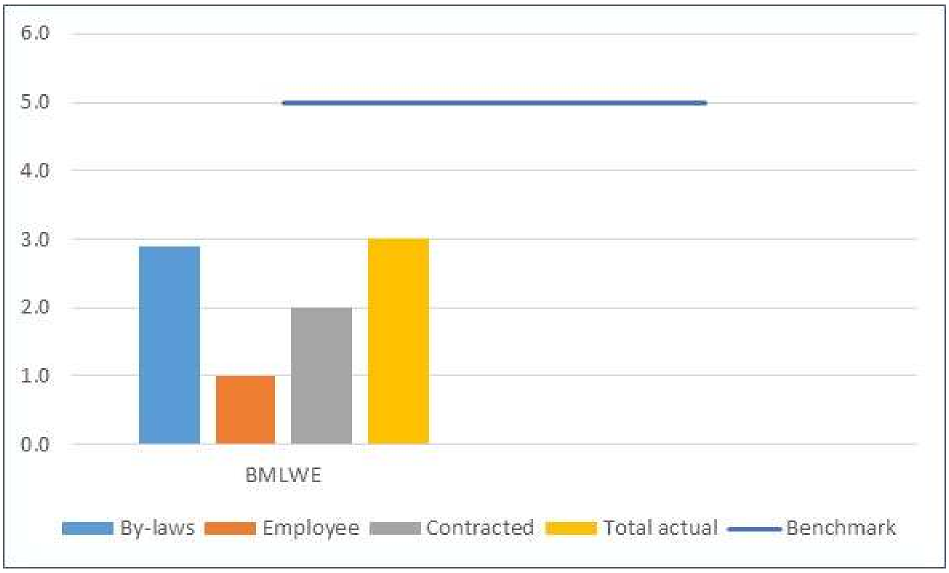

Figure B 1-2 Personnel per 1000 subscribers.

Acknowledging that the number of subscribers does not represent the service area, and accounting for the number of illegal users, the previous conclusion could therefore be misleading. For assessing the total number of potential subscribers, we would use the number of units within the service area as demonstrated below. Working out better estimates would be a priority in many areas of analysis and planning.

Table B 1-1 Approximate system size assumptions used.

Variable	Unit	BMLWE
Connections	1000 No.	83
Subscribers	1001 No.	387
Units	1002 No.	500
% Subscribed	%	77%
Implied population	M No.	2.5

Using the number of units instead of the number of current customers a clearer picture is formed and the decreed number of staff for BMLWE would fall well within the benchmark.

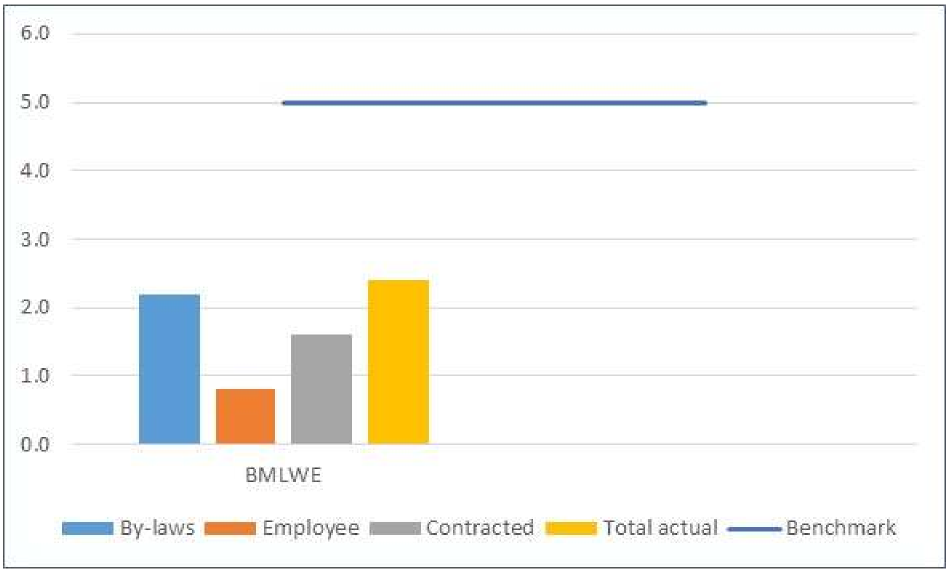

Figure B 1-3 Personnel per 1000 units or potential subscriber.

Another indicator used for sizing the total utility staff is related to the quantity produced

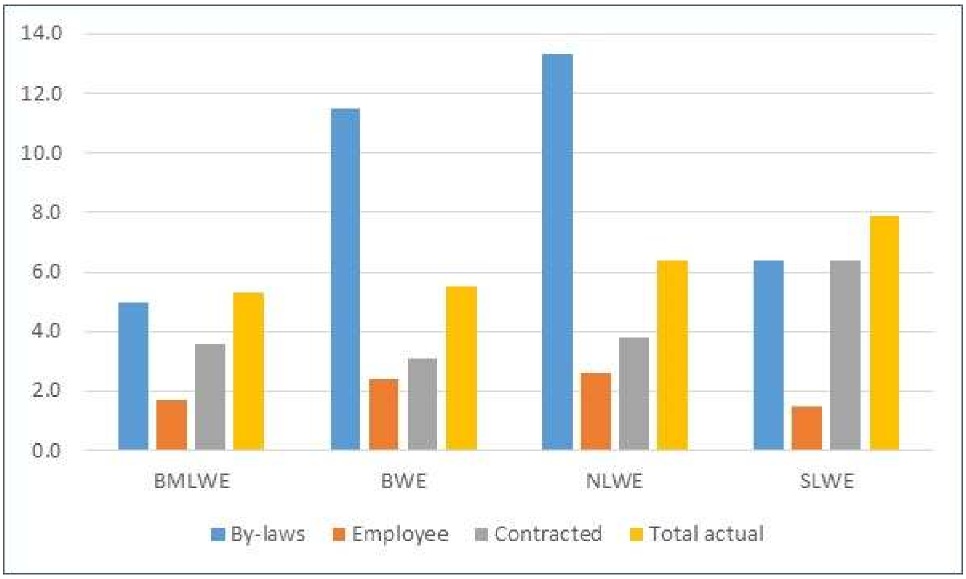

Figure B 1-4 Compared Personnel per 1,000,000 cubic meters produced.

The comparison with other WEs shows a similar trend where the decreed staff of BWE and NLWE according to the by-laws relatively exceed those of BMLWE and SLWE. However, and according to this indicator, the actual total number of staff is proportionate in all WEs.

Table B 1-2 Total personnel performance indicators.

Performance indicator	Unit	BMLWE		Benchmark
Employees per connection	No./1000 Connections	By-laws	13.4	5 (Tynan and kingdom 2002)
		Employee	4.6	
		Contracted	9.5	
		Total actual	14.1	
Employees per customer	No./1000 Customer	By-laws	2.9	5 drawing from Y&K 2002
		Employee	1.0	
		Contracted	2.0	
		Total actual	3.0	
Employees per units	No./1000 Units	By-laws	2.2	5 drawing from Y&K 2002
		Employee	0.8	
		Contracted	1.6	
		Total actual	2.4	
Employees per water produced	No./(10^6 m^3)	By-laws	5.0	Comparative
		Employee	1.7	
		Contracted	3.6	
		Total actual	5.3	

B.1.2 Personnel business area

Looking at the distribution of personnel by department, and using the concept of business areas, we find that the organisation by-laws has the following features:

- Customer services is completely being part of distribution in BMLWE.
- No wastewater management units in BMLWE.
- Structure is vertical and complex in BMLWE.
- Stores units does not have a financial counterpart in in BMLWE.

And so on. Also looking at the number of staff under units of each business area we can see the large discrepancy.

Table B 1-3 Personnel according to the by-laws under units of different business areas.

Variable	Unit	BMLWE
Customer service units	No.	0
Distribution units	No.	561
Engineering units	No.	27
Facility units	No.	370
Finance units	No.	69
General units	No.	65
HR units	No.	20
Water quality units	No.	8

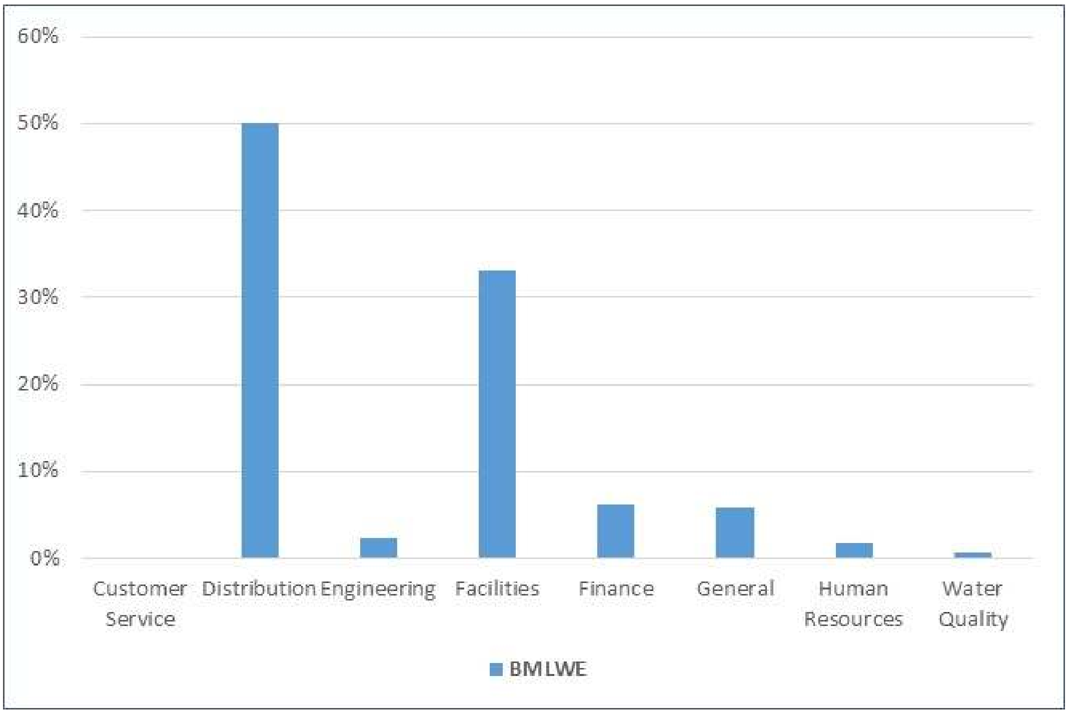

Figure B 1-5 Personnel according to the by-laws under units of different business areas.

To better be able to judge the efficacy of the distribution, we look at the distribution business which usually includes most of the following:

- Operation of water distribution.
- Maintenance of distribution networks and service connections.
- Implementation or overseeing new connections.
- Water loss management.
- Local customer services, metering, and collection.
- Local store management.

And the facilities business, usually includes production, treatment, and transmission operation and maintenance. In most cases also includes water quality labs.

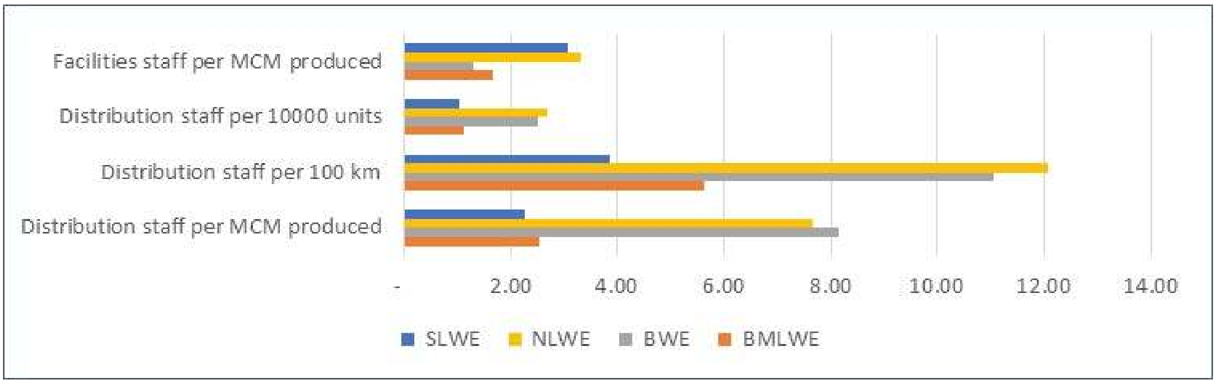

Figure B 1-6 Facilities and distribution personnel performance according to the by-laws under units of different business areas.

The comparison of the four WEs according to facilities and distribution personnel performance shows disparities in the number of staff of the four WEs, which promotes the need to revise the organization structure by specialists.

B.1.3 Personnel job type

We attempted to look at the distribution of current employees and contracted staff by job type, especially since it shows where the WEs are being challenged the most and which positions are the most critical. This is limited by the freedom of the WE to choose adequately and therefore should only be seen in terms of general patterns. Moreover,the analysis is also limited by the availability of information, as detailed information of permanent staff and their current jobs was made available by BWE, information for contracted staff was incomplete . Therefore, we shall concentrate the effort on the available information found in the by-laws as follows:

Table B 1-4 Personnel by job type according to the by-laws.

Variable	Unit	BMLWE
Auxiliary - Clerical	No.	73
Auxiliary - Driver	No.	38
Auxiliary - Guard	No.	24
Auxiliary - Office boy	No.	37
Collector/Reader	No.	50
Customer service	No.	91
Financial/Administrative	No.	83
Management	No.	42
Management (Eng.)	No.	62
Technical - Driver	No.	26
Technical - Engineer	No.	13
Technical - Labourer	No.	121
Technical - Other	No.	437
Technical - Water quality	No.	23

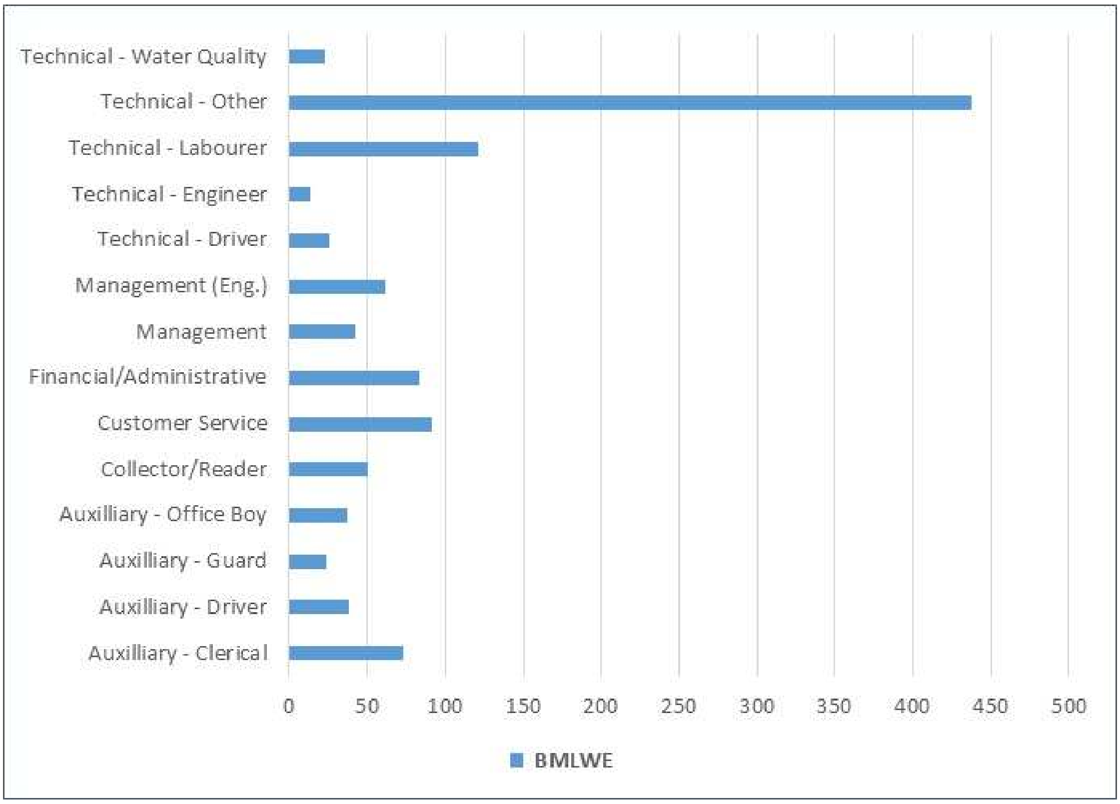

Figure B 1-7 Personnel by job type according to the by-laws.

Table B 1-5 Relative number of each job type according to the by-laws.

Relative size	Unit	BMLWE
Auxiliary - Clerical	%	7%
Auxiliary - Driver	%	3%
Auxiliary - Guard	%	2%
Auxiliary - Office boy	%	3%
Collector/Reader	%	4%
Customer service	%	8%
Financial/Administrative	%	7%
Management	%	4%
Management (Eng.)	%	6%
Technical - Driver	%	2%
Technical - Engineer	%	1%
Technical - Labourer	%	11%
Technical - Other	%	39%
Technical - Water quality	%	2%

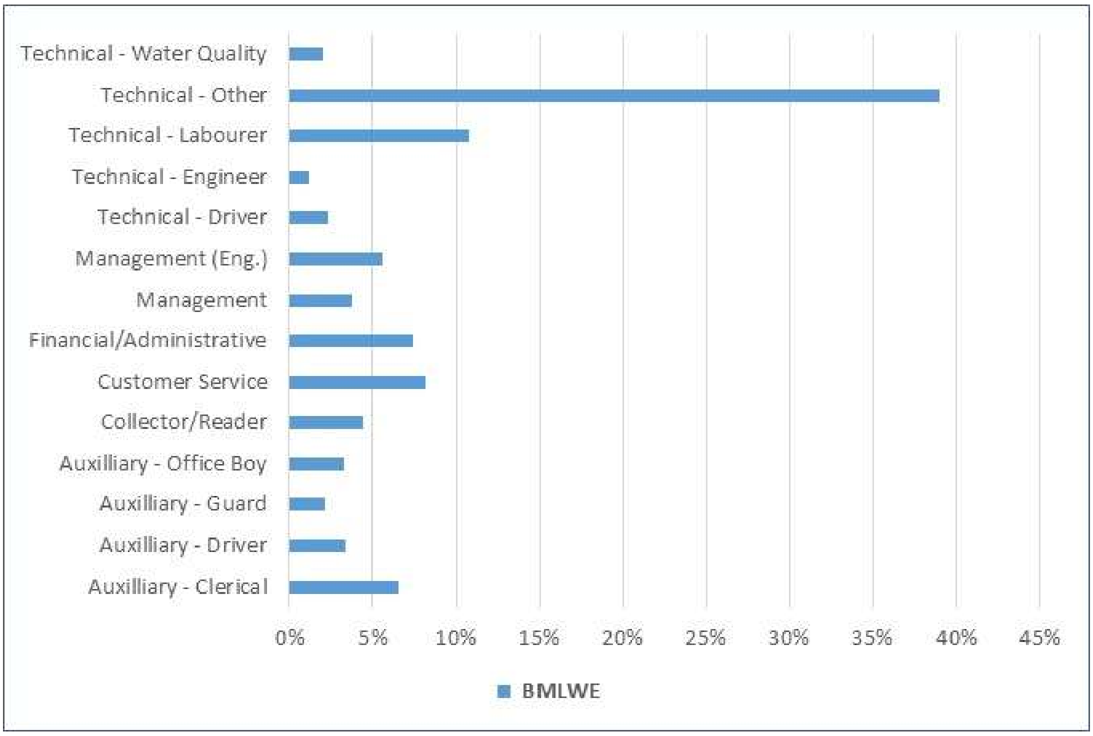

Figure B 1-8 Relative number of each job type according to the by-laws.

It can be clearly seen in the case of BMLWE that the technical needs of the establishment in terms of technicians and labourers have outweighed those of hiring clerks and drivers. The apparent discrepancy in the number of management personnel is due to engineering management roles being assigned to non-engineers.

Looking back at the by-laws, we can look at specific areas of interest for improved water supply service performance for the four WEs. Looking at the customer service staff, here including clerical staff or otherwise involved in customer service office work, as well as the number of collectors and meter readers, we can see the discrepancy between the number of staff expected to perform these duties and the number of customers.

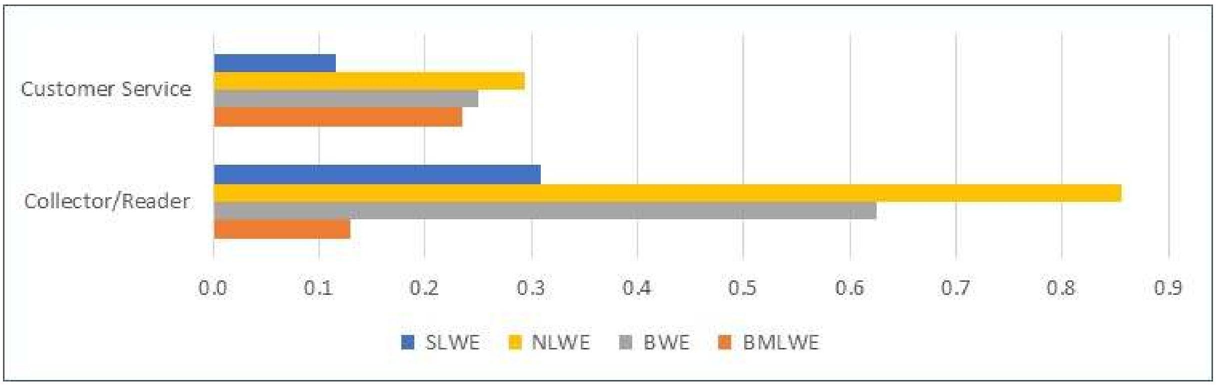

Figure B 1-9 Number of customer service and collection/meter reading staff according to the by-laws per 1000 current subscribers.

The same issue can be seen when using the number of units, or the potential number of customers, and to a larger extent.

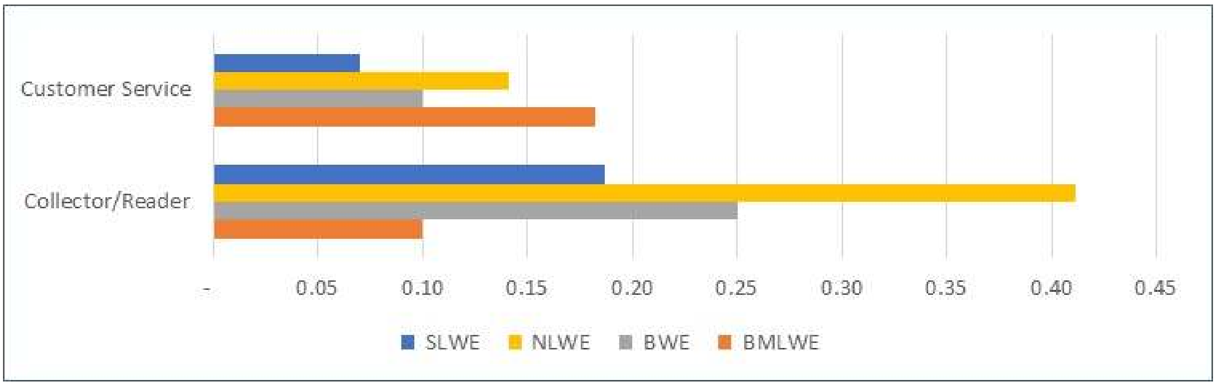

Figure B 1-10 The number of customer service and collection/meter reading staff according to the by-laws per 1000 units or potential customer.

Similarly, for technical job types including engineering management, dividing the number of staff according to the by-laws by the number of units or the water produced leads to different results for each WE.

Figure B 1-11 The number of technical staff
according to the by-laws per 1000 units and million cubic meter produce.

B.1.4 Personnel education level

Except for few cases where the title includes the terms "engineer" or "graduate", the organisational diagram does not specify the education level of employees. The education levels for employees and contracted staff were gathered, interpreted, or estimated based on the available data.

Table B 1-6 Number of personnel by education.

Variable	Unit	Type	BMLWE
University degree personnel	No.	Employee	61
Basic education personnel	No.		38
Other qualification personnel	No.		287
Unknown	No.		-
University degree personnel	No.	Contracted	48
Basic education personnel	No.		103
Other qualification personnel	No.		639
Unknown	No.		-
University degree personnel	No.	Total	109
Basic education personnel	No.		141
Other qualification personnel	No.		926
Unknown	No.		-

Looking at the latest staff information, there is a varying level of education that cannot be interpreted positively or negatively without setting clear job descriptions and minimum required qualifications. This and the need for transparency stress the need for clear hiring criteria and job descriptions.

Table B 1-7 Performance indicators of personnel education.

Variable	Unit	Type	BMLWE
University degree personnel	%	Employee	16%
Basic education personnel	%		10%
Other qualification personnel	%		74%
Unknown	%		0%
University degree personnel	%	Contracted	6%
Basic education personnel	%		13%
Other qualification personnel	%		81%
Unknown	%		0%
University degree personnel	%	Total	9%
Basic education personnel	%		12%
Other qualification personnel	%		79%
Unknown	%		0%

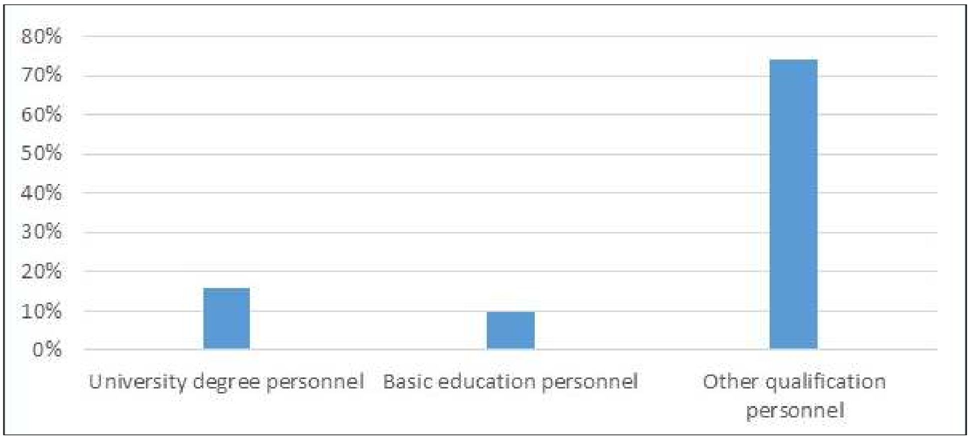

Figure B 1-12 Education level of employees.

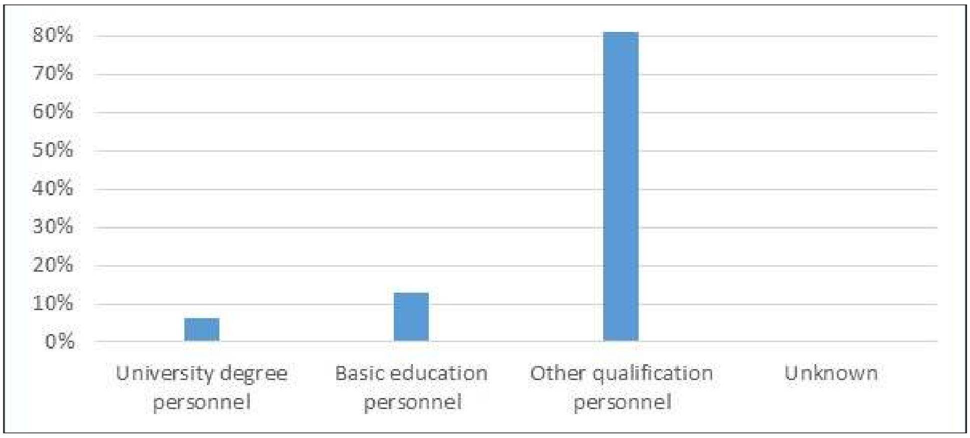

Figure B 1-13 Education level of contracted staff.

B.1.5 Training

BMLWE provided the total number of training hours for 2020, which was about half of that of previous years.

Table B 1-8 Training variables.

Variable	Unit	Type	BMLWE
Training	Hours/employee	Employee	618

Table B 1-9 Training performance indicators.

Variable	Unit	Type	BMLWE
Training	Hours/employee	Employee	0.53

B.1.6 Employee health and productivity

No information was provided in relation with employee health and productivty.

Table B 1-10 Training performance indicators.

Variable	Unit
Working accidents	No.
Absenteeism	days
Absenteeism due to accidents or illness at work	days
Absenteeism due to other reasons	days
Overtime work	hours

Due to the absence of data, the indicators in relation with productivity was not calculated. It is of great importance to ask the WE to establish a data base in relation with the necessary data to calculate the productivity of staff.

Table B 1-11 Employee health and productivity performance indicators.

Variable	Unit
Working accidents	No./100 employees
Absenteeism	days/employee
Absenteeism due to accidents or illness at work	days/employee
Absenteeism due to other reasons	days/employee
Overtime work	%

B.1.7 Diagnosis of challenges

To assess the factors leading to low performance on in personnel management, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths • Trial and error using on-demand staffing contracts and seconded staff helped provide a better assessment of the needed specialties and number of staff for each. • ERP system allows the integration of an HR model with the payroll as currently used in BWE.
Weaknesses • No job descriptions, clear assignment of responsibilities, or clear criteria for health and safety. • Dysfunctional employee evaluation process. • No or outdated or insufficient written procedures increase the demand on the knowledge of key staff members. • Higher level positions assigned to employees without required qualifications. • Contracted staff expecting a place in a new WE set up. • The scope of training is often restricted to a few employees due to the age of and positions assigned to employees. • WE is restricted in investing in personnel improvements given that most functional staff is contracted.
Opportunities • Economically and socially attractive job opportunities. • Technological opportunities in training and distant learning.
Threats • Political environment does not support hiring. • Current by-laws do not support WE in acquiring the needed functions, specialties, and relative number of staff for each.

B.1.8 Recommended actions

The shape of reformed water establishments translates directly into its organization and its staff. Among the gaps found during the assessment with regard to the by-laws are the following

- A mixture of detailed and generic job descriptions at the level of the organization units, and the complete lack of job descriptions and responsibilities at the level of individual positions.
- Outdated unit job responsibilities that lack sufficient consideration if at all for some of the major functions such as GIS as a central database for assets and subscribers, widespread metering and meter reading, IT system management, central call centre and command centre, among others.
- Little correspondence between the decreed number of staff and the scope of the function.

On the staffing side, major issues have led to the accumulation of hurdles and difficulties for any restructuring attempt. Some of the main issues on the staffing side are:

- With the current restrictions on hiring and firing, there is a high dependence on personnel contracts and donor-funded seconded staff, some of them may not have been able to work at the WE even if the hiring doors were open due to their positions not existing in the by-laws, the number in the by-laws being lower than the actual needs, but most importantly having to qualify through the public hiring system.
- Most leadership positions are filled by assignment and often with personnel that could not have been formally appointed for the positions. Upon restructuring, these individuals may be treated unjustly and may harbour resentment if their service in their assigned roles was ignored. At the same time, most of the cases found cannot possibly find a normal path to qualify to the jobs currently filled by assignment.

To improve the organization structure and staff's performance, it is recommended to:

1. Assess the pertinence of the present Organisation Chart in light of today's challenges the WE is facing, mainly but not only in the fields of wastewater, data acquisition and processing, water quality, and else; in addition to the fields of management and development
2. Propose a new Organization Chart in line with the above, including job description and qualification requirements for each staff member down to the level of first line supervisors
3. Set up a staff's performance monitoring body/system based on specific targets to achieve and performance indicators.
4. Initiate necessary legal steps in order to implement this new organisation chart, and to allow the WE to fill in the vacant positions.
5. Identify staff capacity building needs and set up an adequate training program to bring staff's performance to a satisfactory level in terms of the services to provide.

B.2 WATER LOSS

The procedure for assessing water loss performance is a process that has been developed while inherently considering that the nature of the problem is rife with unknown. However, the challenge posed in Lebanon may stress this procedure beyond its normal shape. The assessment of water loss can proceed in two directions, top-down and bottom-up.

B.2.1 Top-down assessment

Top-down assessment of water loss starts with the measurement, calculation, and/or estimation of the total water loss using system input water volume and the billed authorized consumption during the period. Secondly, estimations are made for each kind of apparent loss, i.e., customer meter under-registration, unauthorized consumption, and data acquisition and handling errors. Starting with the calculation of the total non-revenue water we have the following data from 2020:

Table B 2-1 System input volume calculation, for the year 2020.

Quantity	Unit	BMLWE
Water produced	m³	221,819,075
Water imported	m³	-
Water exported	m³	-
System input volume	m³	221,819,075

The net system input is the same as the production estimates since BMLWE claimed no import or export of potable water across establishment lines. However, and due to the existence of local operating municipalities and comities, this may not be the case. That is since the WE ideally has ownership and responsible for bulk water production throughout its service areas. Such relationship may therefore be seen as that of water export.

The accuracy of the production quantity is uncertain. The production estimates are subject to several issues such as:

- Almost all quantities are based on estimates of production performance and approximate working hours.
- When the source is metered, the meter is often dysfunctional or incorrectly installed.
- When the meter is functional, most readings are not based on regular reading of the source meters but on multiplying the nominal flow measured by the estimated operating hours.
- The estimates may not consider all sources or update for sources that were dysfunctional for a large portion of the duration.
- Most importantly, the extent of each of the problems listed above is neither known nor can be estimated by the WE.

BMLWE estimates that around 75% of bulk water is metered, therefore providing more accurate production quantities given that larger projects are monitored by SCADA and more data is documented. For Areas or systems without Bulk metering information, there is no way to verify their level of accuracy without performing an audit and a revision of the estimation of water production based on consistent procedures for:

- Identifying the volumes of metered sources and estimates based on metering.
- Identifying metered quantities based on different meter technologies and conditions.
- Surveying and verifying the readings and flow rates for metered sources.
- Documenting and calculating the hours of operation.
- Assignment of error values and the calculation of the overall accuracy.

Therefore, and given all the above, ±5% is given to metered water, ±20% is given to unmetered water, therefore yielding approximately ±9% accuracy.

Table B 2-2 System input volume error range at 95%, for the year 2020.

Quantity	Unit	BMLWE
System input volume mean	m^3	221,819,075
Metered	%	75%
Uncertainty	%	9%
Uncertainty	m^3	19,963,717
System input volume min	m^3	201,855,358
System input volume max	m^3	241,782,792

Looking at the billed authorized consumption, the main issue encountered is that metering is not a common practice and the actual water consumed by the customers cannot therefore be known at high accuracy.

Table B 2-3 Quantity billed, for the year 2020.

Quantity	Unit	BMLWE
Billed authorised mean consumption	m^3	202,483,385
Billed and metered	m^3	56,620,990
Billed and unmetered	m^3	145,862,395
% quantity "metered"	%	28%
Metered subscribers Avg. consumption for metered	No. m^3/day	21,756 7.13

To alleviate the issue of low customer metering, we looked at the customers labelled as “metered” and the average metered consumption. It must be noted that without an auditing of the metering practices the percentage of actual metering quantities based on real readings cannot be determined.

Moreover, when calculating the average consumption of metered customers, the results can reach 7 cubic meters per day. In the case of BMLWE the explanation given was that metering was prevalent for high-consuming subscribers. If these figures were to be used as a general estimation of the actual consumption for the average subscriber, the quantities consumed would exceed the production by several times, yet if assumed to be the actual consumption for the illegal connections and illegal units the result would be greater than the estimated production quantities.

Table B 2-4 A test of the plausibility of average metered consumption as a representative quantity, for the year 2020.

Quantity	Unit	BMLWE
Avg. consumption for metered	m^3/day	7.13
Estimated residential units	No.	500,000
Total consumption (test)*	m^3	1,377,340,000*
Water produced	m^3	221,818,895
Real losses (test)	m^3	(1,155,521,105)
Plausibility	m^3	Implausible

**Assuming full production*

In any case, and assuming the production quantities are within the assumed 20% error range, or reasonable, it would also be reasonable to assume that the true average consumption is less that 1 cubic meter per day until better data is available.

This value can be assumed anything from 0.5-1.0 cubic meters per day, with no indicator on where should the average estimate lie. Also, this value could be significantly different to other WEs. This makes the top-down estimate unbalanced. Moreover, of this stresses the need that to achieve systematic and sufficient knowledge about the actual customer demand and consumption and therefore the extent and type of water loss, the following actions are needed:

- Auditing of metering practices and determination of the extent of using real readings.
- Investigation of the type of subscription and the average consumption for each type such as residential, commercial, etc.
- Collection of a representative sample of temporary customer metering of randomly selected group of unmetered customers using high accuracy static meters.
- Study of metering accuracy and issues faced such as meter aging, air, and intermittent supply by the temporary installation of using high accuracy static meters in series.
- Collection of municipal registration numbers for different units for each region and conducting a study on the extent of unauthorized consumption.

B.2.2 Bottom-up assessment

Attempting to tackle the issue from the other direction, we ought to visit the different factors used for understanding real losses, mainly leakage, and specifically in the local context.

B.2.2.1 Estimation of real losses based on DMAs field measurements

The bottom-up estimate of real losses is ideally conducted at the level of a District Metered Area (DMA), where the night flowrates provide an estimate of night leakage, and the different pressure values help find the average daily leakage. However, this may not be applicable to the local context because :

6. Continuously supplied DMAs only exist in a few areas in Lebanon that are far from being representative.
7. Assuming that night flowrates do reflect leakage rates because there is no water consumption at the consumers' level may not be correct in the absence of continuous supply. Due to water rationing, the individual water tanks in each and every house in Lebanon may not be full at dusk because of water cut-offs during the day, and fill up through night time water supply.

In any case, real losses estimation based on field investigation at the level of DMAs are not available in Lebanon. It is therefore necessary to resort to another method to estimate these losses.

B.2.2.2 Estimation of real losses based on leakage indicators

IWA approach to real losses calculation based on plausible ranges of leakage indicators, is as follows:

$$\textbf{Real loss} = \textbf{UARL} \times \textbf{ILI}$$

Where:	*Real Loss*	is the volume of water lost per year
	UARL	is the Unavoidable Annual Real Loss indicator
	ILI	is the Infrastructure Leakage Indicator

2.2.2.1 Calculating the UARL volume

The UARL volume is given by the following formula:

$$UARL\ (l/d) = P \times (18 \times Lm + 0.8 \times Nc + 25 \times Lp)$$[1]

Where:
P = Average operating pressure.
Lm = Length of main, in Km.
Nc = Total number of connections
Lp = Total lengths from property limit to private gauge/meter, in m
For Lebanon, it is considered that Lp = 0 as all gauges/meters are close to the property limit.

The average operating pressure requires local throttling to ensure higher areas receive water. Network topographies are steep and elevation differences may often reach and exceed the recommended limits of 50 – 70 meters, therefore causing large pressure variations. The average pressure at any given point is estimated at between 30±5 meters as a rough

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[1] *Source : IWA*

estimation at one standard deviation, or 30±10 m at 95% confidence limit. Therefore an average value of ***P = 30 m*** will be adopted fo rthe calculation.

The length of main is obtained from SLWE's GIS system : ***LM = 10 000 km***.

The number of service connections is calculated based on the estimated total number of housing units in the jurisdiction of BMLWE (500 000) and the estimated number of connections per housing unit (6), which gives a ***Nc = 83 333***

Therefore, the UARL can be calculated as follows:

• Average pressure	30 m
• Length of mains	10 000 km
• № of connections	83 333

UARL = 7 400 m³/day
UARL = 2 701 000 m³/year

2.2.2.2 Estimating the Infrastructure Leakage Indicators (ILI)

The ILI is the choice indicator for real loss benchmarking and making comparisons due to its high sensitivity to performance and low sensitivity to local conditions. It is still impossible to guess the ILI without real data. It has a defined lower limit of 1 and considered ideal for developing countries at 2, which means that the actual real losses are twice the UARL.

Figure B 2-1 below shows average values of ILI for a number of cities in Europe and Australia, ranging from 1 to 10. As a comparison, the ILI values of some utilities in the Balkan, as given by the *Leaks Suite Library*, range from around 4 to 19.

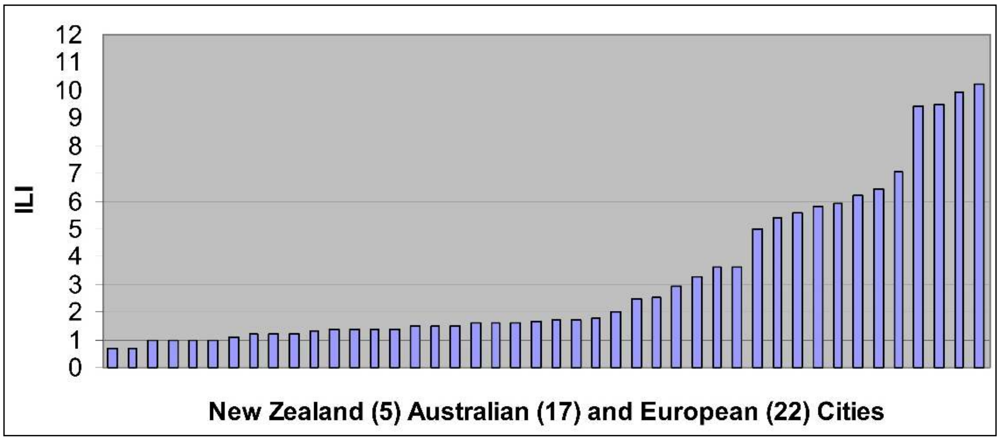


Figure B 2-1 Average ILI values for various cities

In the case of Lebanon in general, given that networks' material is mostly Ductile Iron or HDPE, with low leakage risk, and given the intermittent water supply conditions coupled to the financial situation the WEs are facing, an ***ILI of 8*** is a plausible as a general assumption at this stage.

2.2.2.3 Calculating the Real Losses

Based on the above, the Real Losses are calculated as follows :

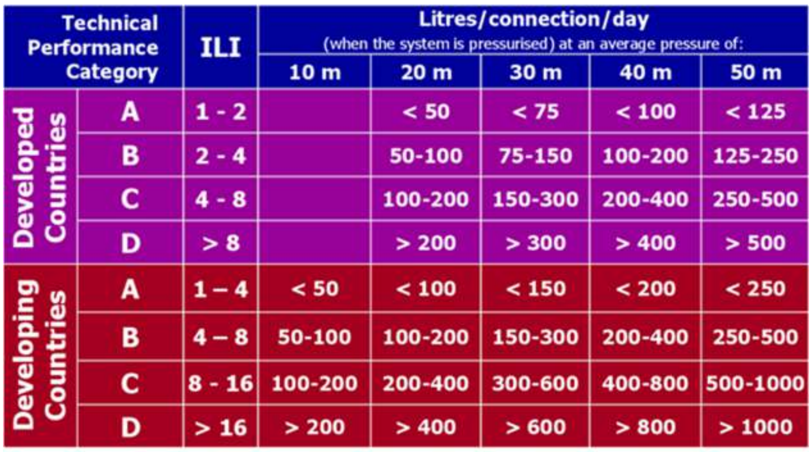
Real losses = UARL x ILI = 2 701 000 x 8 = 21 608 000 m³/year

The above is for a 24h continuous supply, which isn't the case. Assuming a 10 hours supply per day, we have :

UARL for 10 hours supply per day : 21 608 000 x 10 / 24 = 9 003 333 m³/year

The yearly production in 2020 of BMLWE being 221,818,895 m³ the real losses amount to 4% of the production.

Assuming supply is continuous, the losses per connection would approximately be 600 to 700 l/connection/day. Referring to Figure B 2-2 below, and for 30 meters of pressure, the performance is at level D, which is plausible.



Technical Performance Category		ILI	Litres/connection/day (when the system is pressurised) at an average pressure of:				
			10 m	20 m	30 m	40 m	50 m
Developed Countries	A	1 - 2		< 50	< 75	< 100	< 125
	B	2 - 4		50-100	75-150	100-200	125-250
	C	4 - 8		100-200	150-300	200-400	250-500
	D	> 8		> 200	> 300	> 400	> 500
Developing Countries	A	1 – 4	< 50	< 100	< 150	< 200	< 250
	B	4 – 8	50-100	100-200	150-300	200-400	250-500
	C	8 - 16	100-200	200-400	300-600	400-800	500-1000
	D	> 16	> 200	> 400	> 600	> 800	> 1000

Figure B 2-2 General guideline for real loss performance levels

Also calculating the cubic meters per kilometre, which would be a more relevant performance indicator given the low estimated connection density which amounts to approximately 6 cubic meters per kilometre per day for BMLWE when the system is pressurised, which is low.

Table B 2-5 Evaluation of network size based on provided information showing implausible results.

Quantity	Unit	BMLWE
Length of mains (est.)	km	10,000
Units	No.	500,000
Units density	No./km	50
Subscribers	No.	387,163
Subscriber density	No./km	39

Table B 2-6 Estimating an approximate network size In plausible relation to estimated number of units.

Quantity	Unit	BMLWE
Units	No.	500,000
Units per connection	No./No.	6.0
Connections	No.	83,333
Connection density	No./km	8

Table B 2-7 Estimating the number of service connections.

Quantity	Unit	BMLWE
Units	No.	500,000
Units per connection	No./No.	6.0
Connections	No.	83,333
Connection density	No./km	8

Table B 2-8 Estimating the unavoidable real losses.

Quantity	Unit	BMLWE
Avg. Pressure	No.	30
Length of mains	km	10,000
Connections	No.	83,333
UARL	m^3/day	7,400
UARL	m^3/year	2,701,000

Table B 2-9 Estimating the real losses for an ILI of 8 for all WEs.

Quantity	Unit	BMLWE
UARL	m^3/year	2,701,000
Supply continuity	Hour	15
ILI	N/A	8
Real losses (test)	m^3	13,505,000
Real losses	l/c/day	444
Real losses (w.s.p)	l/c/day	710
Real losses	m^3/km/day	3.7
Real losses (w.s.p)	m^3/km/day	5.9

Attempting to calculate the accuracy limits for the above estimates would result in a very high range and therefore these figures provide a guidance towards further investigation.

Proceeding to estimate the unauthorized consumption, and based on this result for real losses, we proceed by estimating the average consumption for all units, then subtracting the consumption for the legal customers. Given the low real metering rates the apparent losses from meter under-registeration and data acquisition errors were considered negligible.

Table B 2-10 Estimating the apparent losses for an ILI of 8 for the WE.

Quantity	Unit	BMLWE
System input volume	m^3	221,818,895
Real losses	m^3	13,505,000
Consumption	m^3	208,314,075
Consumption	m^3/day	570,723
Consumption per unit	m^3/day	1.14
Authorised consumption	m^3	161,303,004
Unauthorised consumption	m^3	47,011,071
Water loss	m^3	60,515,891

The results were found very sensitive to the number of connections, which are estimated to range to be within a plausible range of ±30%. In any case, this analysis cannot reach a better conclusion with the current data. To be able to proceed further with more accurate bottom-up analysis based on the knowledge of network size and operation the following is needed:

- Study of connection density based on customer building information.
- Field survey of different networks for evaluating the average operating pressure.
- Development of distribution reports showing number of hours supplied to each network.
- Desktop and field evaluation of the extent of network GIS completion especially at the distribution network level.

B.2.3 Performance Indicators

As presented in Table B 2-11, the selected performance indicators for the area of water loss have been calculated. Revisiting the confidence limits, and to illustrate the lack of accuracy, the following are the calculations for the uncertainty for the NRW values that are based on the fewest estimations for BMLWE.

Table B 2-11 Estimation uncertainty for the NRW variables.

Variables	Unit	Value	± % Error	Reliability	Est. Err.	Std. Err.	Variance
System input volume	m^3	221,819,075	9%	Low	2.E+07	1.E+07	1.E+14
Billed authorised consumption	m^3	202,483,385	2%	High	4.E+06	2.E+06	4.E+12
Non-Revenue Water	m^3	19,335,690	**105%**	Low	2.E+07	1.E+07	1.E+14

And calculating the uncertainty for the percentage the errors are generally high.

Table B 2-12 Estimation uncertainty for the NRW performance indicator.

Performance indicator	Unit	Value	± % Error
Non - Revenue Water	%	9%	106%

Therefore, when assessing accuracy bands, and given the issues with data accuracy and reliability, the safe approach is to assume the lowest band for both accuracy and reliability until systematic auditing is implemented.

Table B 2-13 Water loss performance indicators with applicable benchmarks.

Quantity	Unit	BMLWE	Benchmark	Accuracy	Reliability
Non-Revenue water	%	9%	N/A	42% - 105%	Low
Water loss	%	27%	N/A	27% - 64%	Low
Water losses per connection	l/c/d	1,990	N/A	47% - 67%	Low
Water losses per mains length	m^3/km/day	17	N/A	32% - 57%	Low
Apparent loss index (ALI)	N/A	5	1.0	23% - 69%	Low
Real loss per connection (w.s.p)	l/c/day	710	N/A	80% - 86%	Low
Real loss per mains length (w.s.p)	m^3/km/day	5.9	N/A	73% - 79%	Low
ILI (assumes)	N/A	8	2.0	50%	Low

In detail, the assessment of accuracy was conducted for BMLWE as the following tables illustrate.

Table B 2-14 BMLWE Water loss analysis with accuracy calculation.

Variables	Unit	Value	± % Error	Value min	Value max	Reliability	Est. Err.	Std. Err.	Variance
Length of mains	km	10,000	10%	9,000	11,000	Mid	1.E+03	5.E+02	3.E+05
Units	No.	500,000	10%	450,000	550,000	Low	5.E+04	3.E+04	7.E+08
Units per connection	No./No.	6	33%	4	8	Low	2.E+00	1.E+00	1.E+00
Connections	No.	83,333	36%	53,414	113,252	Low	3.E+04	2.E+04	2.E+08
Avg. Pressure	No.	30	33%	20	40	Low	1.E+01	5.E+00	3.E+01
UARL	m^3/day	7,400	50%	3,716	11,084	Low	4.E+03	2.E+03	4.E+06
ILI (assumed)	N/A	8	50%	4	12	Low	4.E+00	2.E+00	4.E+00
Supply continuity	Hour	15	10%	14	17	Low	2.E+00	8.E-01	6.E-01
Real losses	m^3/day	37,000	71%	10,634	63,366	Low	3.E+04	1.E+04	2.E+08
System input volume	m^3/day	607,723	9%	553,028	662,419	Low	5.E+04	3.E+04	8.E+08
Consumption (SIV-RL)	m^3/day	570,723	11%	510,005	631,442	Low	6.E+04	3.E+04	1.E+09
Unit consumption	m^3/day	1.14	15%	0.97	1.31	Low	2.E-01	9.E-02	7.E-03
Subscribers	No.	387,163	1%	383,291	391,035	High	4.E+03	2.E+03	4.E+06
Legal consumption	m^3/day	441,926	15%	377,250	506,602	Low	6.E+04	3.E+04	1.E+09
Illegal consumption	m^3/day	128,797	69%	40,086	217,509	Low	9.E+04	5.E+04	2.E+09
Water loss (RL+AL)	m^3/day	165,797	56%	73,251	258,344	Low	9.E+04	5.E+04	2.E+09
Water loss	%	27%	57%	12%	43%	Low	2.E-01	8.E-02	6.E-03
Water losses per connection	l/c/day	1,990	67%	657	3,322	Low	1.E+03	7.E+02	5.E+05
Water losses per mains length	m^3/km/day	17	57%	7	26	Low	1.E+01	5.E+00	2.E+01
Billed authorised consumption	m^3/day	554,749	2%	543,654	565,844	High	1.E+04	6.E+03	3.E+07
Apparent loss index (ALI)	N/A	5	69%	1	8	Low	3.E+00	2.E+00	3.E+00
Real loss per connection (w.s.p)	l/c/day	710	80%	139	1,282	Low	6.E+02	3.E+02	8.E+04
Real loss per mains length (w.s.p)	m^3/km/day	6	73%	2	10	Low	4.E+00	2.E+00	5.E+00

B.2.4 Diagnosis of challenges

To assess the factors leading to low performance in water loss management, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers PESTEL external factors.

Strengths • Successful pilot projects in BMLWE to reduce physical losses using good water distribution practices that can be replicated.
Weaknesses • No clear roles for water loss assessment, planning, and reduction at the WE. • WE distribution personnel perform water distribution independently from the best interest of the WE. • Distribution network information is largely missing and not clean from GIS in many areas.
Opportunities • Interest in NRW project funding.
Threats • No supervisory or regulatory accountancy by the Ministry on the WE to reduce NRW. • With the currency crises the financial feasibility of reducing NRW is diminished. • Social resistance against legal subscriptions especially without fair metering. • Social resistance against customer metering by high volume consumers. • No centralised and consolidated data for parcels, buildings, and units to aid in illegal use management and no recent aerial images. • Mountainous topography and large differences in elevations complicate and increase the cost of good water distribution design practices.

B.2.5 Recommended actions

The goal was to find better estimates of water loss variables by conducting the exercise done above at the level of water systems, regional departments, as well as the entire WE. That would have allowed us to consider a set of water systems or regions as having more accurate data than others, and therefore help make better estimates at the wider level. However, as presented, much of the data needed is not found even at the level of the water establishment.

Therefore, in summary, it is recommended to:

B.2.5.1 Pilot Area

Identify, in close coordination with the WE, one pilot area to convert into DMA and carry out within this area detailed studies for:

- Detailed customers census in order to assess the consumption needs and its geographic repartition.
- Detailed distribution network survey followed by a hydraulic modelling.
- Installation of bulk flow meters on strategic locations, and water meters on a number of house connections (if not all).
- Assessing the water losses.

B.2.5.2 Non Revenue water studies

The lack of data coupled with absence of DMAs impacted the accuracy and quality of the NRW results. Given this finding, the following actions are recommended:

- Implement low cost high impact intervention, the so-called “quick wins” typically the commercial/apparent loss reduction measures instead of the more capital-intensive reduction measures targeting the physical/real loss. The activities consist of customer database update through door-to-door surveys to identify illegal practices, leaks on the service connections, and improved meter management, …
- Implement DMAs for demonstration and trial purposes. The DMAs are used as a diagnostic tool in quantifying physical losses (through bottom-up assessment), and to validate the results of the NRW assessment (top-down assessment).
- Prepare a NRW Reduction Strategy/Plan based on pilot projects outcome and set the NRW targets with the required budget.
- Promote the NRW problem ownership and introduce organizational measures such as working groups, NRW units to boost the implementation capacity.

B.2.5.3 Shidting to metred consumption policy

Metered consumption is the end key for reducing NRW, Opex, and overall water consumption. In fact BMLWE applies water metering in parts of Beirut and elsewhere.

However, based on lessons learned from past experiences in BMLWE and the other WE, it appears that this is not a top priority, where water resources are not sufficient, and a number of prerequisites are to be implemented before systematically installing water meters, out of which:

- Setting up a team to operate and manage meters’ maintenance and reading.
- Selecting the most adequate meter type based on the adopted reading policy.

- Securing continuous supply in the areas where the meters shall be installed, in order to encourage the consumers to subscribe and accept the idea of water metering.

Water metering projects may be systematically implemented over the whole jurisdiction once the above is implemented and running smooth.

B.3 ENERGY

While energy cost data was possible to collect, energy use in energy units was more complicated. The energy use information was not collected and still unkown

Table B 3-1 Energy use variables.

Variable	Unit	BMLWE
Energy consumed from grid	kWh	
Energy generated from fuel	kWh	
Renewable energy generation	kWh	
Energy recovery	kWh	

The energy use performance indicator was not calculated due to unavailabilty of energy use data and estimations.

Table B 3-2 Energy use performance indicator.

Performance indicator	Unit	BMLWE	Benchmark
Unit energy consumption	kWh/m³		Lower is better
Energy consumed from grid	%		Comparative
Energy generated from fuel	%		Lower is better
Renewable energy generation	%		Higher is better
Energy recovery	%		Higher is better

The energy performance is a complex issue that became more complex with the increasing fuel shortages. BMLWE has adapted their pumping schedules to align best with grid energy availability, and therefore the extent of the problem would not be realized by calculating the use of each energy source.

An increase in energy availability could on one hand lead to:

- Increased service delivery and longer supply hours.
- Decreased water quality issues due to less cross-contamination during network emptying.
- Decreased need for network resizing in terms of pipe diameters and storage volumes.
- Simpler water distribution and less dependence on local water distribution operators.
- Decreased expenditure on fuel and generators.
- Decreased station and network repairs due to decreased water hammering and vacuum conditions.

But on the other hand, and at least in during the transition could lead to:

- Increased energy costs due to longer working hours.

- Increased water consumption and therefore greater apparent losses.
- Increased real losses due to improved supply continuity.

Therefore, the general impact would be positive if measures were taken to control water losses and improve energy efficiency through better design and regulation of pumping.

To assess the factors leading to low performance on in energy use and management, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths

- Pilot projects for energy generation have been implemented, and projects for energy recovery have been discussed.

Weaknesses

- No records of energy use at WE requiring EDL to share this data.
- No assessment of energy use using local fuel generators.
- Most pumping lines lack a study for energy reduction potential.
- Incomplete knowledge of the system and the relationship between pumping locations and the quantities supplied.

Opportunities

- Interest in energy efficiency project funding.

Threats

- No supervisory or regulatory accountancy by the Ministry on the WE to improve energy use efficiency.
- With unpaid EDL invoices the financial feasibility of reducing energy use is diminished.
- Mountainous topography and political water availability increases the difficulty of reducing energy use.

Due to the limitations in data availability, technical analysis of energy use becomes guesswork. While the records for the cost of energy for both grid energy and fuel are available financially, there were no estimates for fuel consumption in terms of energy units.

Therefore, the needed improvements include:

- Identification and continuous update of water supply systems as they exist in their actual current form.

- General asset survey and identification of billed grid locations and functions.
- Field study of generator energy use using samples of different sizes of generators.
- Developing a procedure for documenting fuel use and operating hours of generators.

These actions can be integrated with efforts taken in the areas of water loss and water systems.

B.4 WATER SYSTEMS

The assessment of water systems will no doubt be compromised by the quality of data available. The data provided from the WE generally showed:

- Lack of completeness and comprehensiveness.
- Lack of completeness or regular update regarding the status of assets whether they are planned, under construction, awaiting hand-over, in use, or out of service.
- Lack of completeness regarding asset ownership, who it is operated by, and which water system it serves.
- Lack of a primary central data system for producing asset information and the reliance on various sources and personal knowledge.
- No standard asset types or asset hierarchy, even if work has been done for creating these standards.

B.4.1 Water resources

The assessment of water resources looks at production, treatment, and reuse. The indicators look at the WE level due to the lack of more granular data given that:

- Surplus in water production capacity at the WE level does not mean sufficiency of water resources at the local level.
- The topography of current water systems is not documented. The NWSS proposed and defined water systems as a strategic water security measure but the actual situation does not correspond to that proposal.
- Resources of the regional departments at the WE may geographically be located in one region but supplying other regions. Until the water systems are documented and the quantities crossing from one region to another are estimated regional assessment cannot be concluded.

Table B 4-1 Water production and treatment assets.

Variable	Unit	BMLWE
Number of water supply systems	No.	29
Wells	No.	315
Springs	No.	29
Dams	No.	3
Treatment plants	No.	12

Moreover, when examining the production capacity, the following assumptions have to be made:

- Maximum operating hours, and whether the capacity reported is artificially reduced due to the shortage of electricity.
- The current safe yield and whether the capacity reported pertains to theoretical or outdated levels.

With these limitations in mind and proceeding to look at the available data, the estimates given or calculated for water production capacity for the WE are as follows:

Table B 4-2 Water resource variables.

Variable	Unit	BMLWE
Wells daily production capacity	m³/day	527,196
Springs daily production capacity	m³/day	484,160
Dams daily production capacity	m³/day	364,680
Total daily production capacity	m³/day	1,376,036
Daily treatment capacity	m³/day	1,376,036
Maximum water treated daily	m³/day	
System input volume	m³/day	607,723

Where in the case of BMLWE the production capacity was calculated using nominal output at continuous 24/7 operation, and the treatment capacity assuming all produced water will be treated.

Table B 4-3 Water resource performance indicators.

Performance indicator	Unit	BMLWE
Water production capacity utilisation	%	44%
Treatment plant capacity utilisation	%	
Reuse supplied water	%	0%

Calculating capacity utilization, it can be seen that while on average production is limited by demand satisfaction during the winter season in some locations, it is also limited by grid power availability and the economy of local energy production.

For the WE to be able to accurately assess supply sufficiency, the following studies are needed:

- Technical assessment of current sources safe yields and maximum working hours.
- Assessment of source water quality and the sufficiency of the current level of water treatment.
- Mapping of supply topography and definition and update of supply systems.

- Evaluation of the current and future demand for distribution zones.

B.4.2 Storage

Storage capacity at the level of the WE may not reflect local water storage sufficiency but provides a quick insight in some cases.

Table B 4-4 Water storage variables.

Variable	Unit	BMLWE
Raw water storage capacity	m^3	10,800,000
Number of transmission and distribution storage tanks	No.	754
Treated water storage capacity	m^3	513,850

Table B 4-5 Water storage performance indicators.

Performance indicator	Unit	BMLWE
Raw water storage capacity	days	17.80
Transmission and distribution storage capacity	days	0.85

For the WE to be able to accurately assess storage capacity, the following studies are needed:

- Completion and auditing of reservoir storage capacity information.
- Mapping of storage topography and definition and update of supply systems as well as distribution zones supplied by each reservoir.
- Evaluation of the current and future demand for distribution zones.

B.4.3 Metering

B.4.3.1 Present situation

During the past decade, BMLWE, with funding from the World Bank and USAID, had domestic water meters installed in the following distribution sections:

- In North Beirut distribution section : 20 000 smart meters
- In Upper Matn distribution section : 26 000 smart meters
- In Kesrouane distribution section : 12 000 meters

However, none of the areas fitted with individual flow meters is set as DMA with bulk metering.

On the other hand :

- Meters in North Beirut and Upper Matn are not read to date. Or at least readings are not used for invoicing, the subscribers in these areas are still invoiced as "gauged" subscribers.
- Meters in Kesrouane area were read, and subscribers invoiced accordingly until 2019. Since ten, due to the increase in fuel (and therefore transportation) cost, meters are not read and subscribers are not charged.

  Recently (2022) BMLWE commissioned a private company to read all the meters in Kesrouane so that BMLWE preparea the billing including all arrears.

B.4.3.2 Metering needs

To estimate the size of bulk metering needed, we look first at the production and transmission bulk metering that applies to sources, reservoirs, and pump station. The number would not match exactly the actual need of bulk meters but could provide a minimum benchmark that one bulk meter is installed in every location at minimum. To calculate the number of plants, we add the number of sources and reservoirs given above to the estimated number of pump stations.

Table B 4-6 Pumping stations and pumps.

Variable	Unit	BMLWE
Pumping stations	No.	398
Pumps	No.	767

Therefore, we have the bases for the performance indicators as follows:

Table B 4-7 Metering base variables in year 2020.

Variable	Unit	BMLWE
Total plants (sources, PSs, TPs, Reservoirs)	No.	1,511
Connections	No.	83,333
Subscribers	No.	387,163

The actual performance in metering for each kind is estimated form the data gathered where possible as follows:

Table B 4-8 Metering performance variables in year 2020.

Variable	Unit	BMLWE
Production and transmission meters	No.	896
District meters	No.	65
Subscriber meters	No.	21,756

Therefore, the performance in BMLWE can be calculated. Bulk metering in BMLWE is the highest compared to other WEs. It is worth noting that it was reported that in BMLWE the average number of connections for each DMA has been small therefore while the number per 1000 connections may be high the actual implementation is closer to 20-30%.

Table B 4-9 Metering performance indicators.

Performance indicator	Unit	BMLWE	Benchmark
Production and transmission meter density	No./plant	59%	100%
District meter density	No./1000 connections	78%	100%
Customer metering	%	6%	100%

Metering is essential for measuring some of the most vital water establishment metrics in NRW and energy use. Given that the target/benchmark is to reach 100% or complete metering of all sources, plants, districts, and customers, the implementation could be gradual and slow. To be able to better conceive strategies, invest in, track, and evaluate the performance in metering, the following are needed:

- Survey of water production, treatment, storage, and pumping facilities and transmission systems and evaluation of bulk metering needs.
- Bulk meter survey and calibration to determine conditions and maintenance needs.
- Survey of customer meters and evaluation of their condition as to re-evaluate the current level of performance based on active and functional meters.
- Development of meter management modules and procedures.
- Investigation of private sector opportunities for the specialised maintenance of advanced metering equipment.

B.4.4 Diagnosis of challenges

To assess the factors leading to low performance in water system management, including difficulties in producing the needed data, we attempt portray the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths • Focus on water resource sufficiency and storage capacity expansion across the WE. • SCADA and automation have been initiated in BMLWE and should be implemented.
Weaknesses • The level of water treatment cannot be assured especially at small disperse sources. • WE does not have the capacity to manage large numbers of bulk and customer meters. • Information about facilities is rarely updated, highly dubious, and incomplete on GIS. • Distribution networks layouts are largely missing. • As a rule, small water resources are unmetered, or meters are dysfunctional.
Opportunities • Funding opportunities focus on water resources, storage, and associated measurement and control technologies. • Investment in customer meter is interesting to funding agencies.
Threats • Many small production and transmission facilities increase the complexity of asset management and the cost of SCADA. • Vulnerability of field equipment and accessories

B.4.5 Recommended actions

In summary, and with many common actions recommended across technical areas, the following recommendations can be made for the Development of a systematic facility and asset status update mechanism to eliminate the constant need for repeating surveys. This includes the following:

B.4.5.1 Master plan / Strategy

BMLWE has master plans prepared for Jbeil, Kesrouane, and Metn districts. However, there is not a general master plan covering the whole jurisdiction, in particular the Chouf

On the other hand, in 2018 BMLWE set a five-year plan for the implementation of a number of infrastructure projects. It is necessary to re-assess the relevance of these projects in line with the prevailing economic crisis, in particular:

- Conduct a cost benefit analysis for the capital investment projects needed in the near term for improved decision making

- Prioritize infrastructure projects based on a standard analysis grid

B.4.5.2 Digitalisation

The various data whether financial or technical should be centralized in one data centre or digital platform, therefore it is necessary to:

- Carry out an assessment of all data acquisition/processing systems in use at the WE and design a new data centre, to be implemented by steps, in the view of a central digitalization system for the whole WE. Based on the outcome of this assessment, the below steps would be carried out, in all or partially.

- Carry out studies for the improvement/replacement - if deemed necessary - of the existing ERP system, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.

- Carry out studies for the improvement and extension - if deemed necessary - of the existing GIS system to cover the acquisition of all technical data, with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building.

- Carry out studies for the design of a data acquisition and processing system to cover the monitoring and management of the production and distribution flows; with the view of future integration within a central digitalization system; and prepare Tender Documents for the implementation of such a system, including WE's staff training and capacity building. Supply and installation of the required remote sensors for the operation of the systems shall not be part of these Tender Documents.

- Implementation of the digitalization system.

B.4.5.3 Water production – Available water resources

Presently, the water production is not adequately monitored; the production figures provided by BMLWE are based on operators' *best estimate*.

Therefore, it is necessary to:

- Carry out a general survey of all water sources presently in service; assess the status of the existing flow measurement equipment if any;

- Prepare Tender Documents for the implementation of flow/yield measurement equipment on all water sources, linked to the central production data center.
  Because the cost for installing measurement equipment on all the water sources presently in service is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

B.4.5.4 Water distribution

Here again, the distributed flow provided by the WE is an operator's *best estimate*, due to the lack flow measurement at the level of the distribution centres or reservoirs.

Therefore, it is necessary to:

- Carry out a general survey of all distribution zones and identify the feeding point(s) of each, and assess the status of the existing flow measurement equipment at each feeding point, if any
- Prepare Tender Documents for the implementation of flow/consumption measurement equipment on each feeding point of each distribution zone, linked to the central production data center.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.
- Identify existing DMAs and/or areas that could possibly be turned into DMAs, and identify possible locations for the installation of bulk flow/consumption meters on the distribution network, linked to the central production data center; and prepare Tender Documents for the supply and installation of such equipment.
  Because the cost for installing measurement equipment on all the distribution zones is expected to be high, these Tender Documents shall be divided into separate Lots, as may be required.

B.4.5.5 Production cost optimisation

With the present financial situation, energy has become the major component of production cost, nearing 90 %. BMLWE's strategy is to implement renewable energy sources such as hydroelectric or solar, in addition to shifting from underground to surface water sources, where possible. However, there is no comprehensive view of the subject.

Therefore, it is necessary to carry out a general *Cost Optimisation Master Plan* covering in details all the available options over the WE's jurisdiction, and setting up the upper threshold of what could be possibly achieved in this field.

B.4.5.6 Taking over the wastewater sector

BMLWE is reluctant to take over the wastewater sector for reasons detailed under Sub-section before.

In the meantime, financing must be provided from sources other than BMLWE own funds (GoL or donors) to:

- Outsource the operation and maintenance of each treatment plant and related network to private operators via performance-based contracts.

- Hire a sewage treatment expert seconded to the WE in order to oversee the execution of these contracts

B.5 OPERATION AND MAINTENANCE

One of the areas suffering from the most data shortage is operation and maintenance. While asset information can be recovered to an extent in the future, the records of today's work will be lost if not documented within a short space of time. Moreover, the practice to record daily work is often adequate when the management is trying to constantly diagnose the problems, find weak areas, and strive to improve performance in with a long-term vision and a continuous strive for achieving success. On the other hand, when the establishment is weakened by various external and internal factors, the management process may get broken and simple requests such as filling out a work order may become impossible to fulfil.

B.5.1 Inspection and calibration

As expected, no records were available on inspection and calibration activities. BMLWE attempted to develop a maintenance system that would detail these work orders in the future however currently the data is not available.

The suggested benchmark is a preliminary one and will require specialized input in both asset type-related and facility-related considerations.

Table B 5-1 Inspection and calibration performance indicators.

Performance indicator	Unit	BMLWE	Benchmark
Pump inspection	%		100%
System valve inspection	%		100%
Control valve inspection	%		100%
Reservoir cleaning	%		100%
Network inspection	%		100%
Service connection inspection	%		100%
Instrument and inspection and calibration	%		100%
System flow meters calibration	%		100%
Pressure meters calibration	%		100%
Water level meters calibration	%		100%
Water quality sensor calibration	%		100%
Control unit inspection and calibration	%		100%
Electrical panel inspection	%		100%

The importance of preventive and predictive inspection of system assets as well as the calibration of instruments are vital for avoiding the collapse of service quality and sustaining resilience. Moreover, the ability of the public sector to maintain quality control over an operational contract is empowered by requesting and auditing daily inspection activities instead of waiting until a failure occurs -often due to the lack of inspection and preventive maintenance.

Currently, these processes may not be performed regularly and sufficiently, however, every establishment performs a varying level inspection activity through its operators and technicians at the production plants and pumping stations and sometimes daily. To be able to monitor and improve the performance in this area, the following is needed:

- Assessment of preventative maintenance needs and schedules for each asset type and specifically for each facility.
- Establishing procedures for updating the preventative maintenance plan when needed.
- Investigation of private-sector opportunities for providing specialized regular scheduled inspections and calibrations when the WE cannot.
- Adoption of standard reporting practices to be applicable with the WE’s maintenance system.

B.5.2 Rehabilitation and replacement

Rehabilitation and replacement in general, including corrective maintenance produced during rehabilitation efforts, are often the last resort for a failing segment of the system. Therefore, an exceedingly high level of rehabilitation and replacement is not ideal. They are still a necessary fact that some parts of the system will need rehabilitation and therefore a WE should demonstrate investment in that area.

Due to often requiring external contracts, data exists, if not by any means reliably comprehensive.

Table B 5-2 Rehabilitation and replacement variables.

Variable	Unit	BMLWE
Mains rehabilitation and replacement	km	
Service connection rehabilitation and replacement	No.	
System valve rehabilitation and replacement	No.	
Control valve rehabilitation and replacement	No.	
Pump rehabilitation and replacement	No.	
System flowmeter rehabilitation and replacement	No.	
Customer flowmeter rehabilitation and replacement	No.	
Leaks repaired	No.	

More precise information is needed which can be achieved by regular and systematic work documentation in digital format.

Table B 5-3 Rehabilitation and replacement performance indicators.

Performance indicator	Unit	BMLWE
Mains rehabilitation and replacement	%	
Service connection rehabilitation and replacement	%	
System valve rehabilitation and replacement	%	
Control valve rehabilitation and replacement	%	
Pump rehabilitation and replacement	%	
System flowmeter rehabilitation and replacement	%	
Customer flowmeter rehabilitation and replacement	%	
Leaks repaired	No./100 km	

Values about rehabilitation and replacement were not made available for the TA. We should note that rehabilitation and maintenanace are not excuted in a schedule manner. The most of rehabilitation works are corresponding to corrective interventions. We didn't find any tool or document for the planification of rehabilitation and maintenance works. It is of great intrest that the WE starts to introduce the concept of planned rehabilitation programs covering all tye of works as corrective, planned and preventive rehabilitation.

B.5.3 SCADA

The evaluation aims at evaluating the level of automation and remote monitoring and control of water facilities. This has only been concluded in BMLWE where a number of facilities of concern have been chosen as a proxy for the number of control units, and the level of automation and remote control has been given as follows:

Table B 5-4 SCADA variables.

Variable	Unit	BMLWE
Control units	No.	1,842
Automated facilities	No.	1,088
Remotely controlled units	No.	120

That allows the calculation of the level of performance in implementing SCADA system as follows:

Table B 5-5 SCADA performance indicators.

Performance indicator	Unit	BMLWE
Facility automation degree	%	59%
Facility remote control degree	%	7%

Ideally, control units should be used to represent points on the production and transition system such as pump control panels, reservoir inlet and outlet valves, and other critical system valves.

Even given that the estimation of these points is possible, comparison with actual automated control points from BMLWE refers to the number of individual power board in facilities or sub facilities instead and does not take into account the complete needs of automation. Therefore, and to improve the analysis and management of the automation efforts the following are needed:

- Survey of facilities to define control units of interest.
- Evaluation of each control unit's criticality within the framework of safety planning and crises mitigation as well as instrumentation and metering needs.
- Investigation of private sector opportunities for the specialized maintenance of SCADA systems.

B.5.4 Vehicles

Vehicle availability is vital for establishing field presence and traversing the service areas to operate and maintain assets.

Table B 5-6 Vehicle availability variables.

Variable	Unit	BMLWE
Operating vehicles	No.	86
Length of mains	km	10,000
Subscribers	No.	387,163

Table B 5-7 Vehicle availability performance indicators.

Performance indicator	Unit	BMLWE
Vehicle availability	No./100	0.9
Vehicle availability	No./100	0.2

B.5.5 Customer metering

Asides from owning the needed customer meter assets, the use of customer meters for calculating quantities and billing amounts are needed.

Table B 5-8 Customer metering variables.

Variable	Unit	BMLWE
Customer meter read	No.	12,007
Customers billed based on metering	No.	12,007
Customer meters	No.	21,756

In BMLWE, meter reading and billing proceeds every 6 months in Keserwan.

Table B 5-9 Customer metering performance indicators.

Performance indicator	Unit	BMLWE	Benchmark
Customer meter reading efficiency	%	55%	100%
Customers billed based on metering	%	55%	100%

B.5.6 Water quality testing

The table shows the number of water quality sampls and tests carried out in BMLWE.

Table B 5-10 Water quality testing variables.

Variable	Unit	BMLWE
Required treated water quality tests	No.	24,204
Required aesthetic tests	No.	648
Required microbiological tests	No.	22,908
Required physical-chemical tests	No.	648
Required radioactivity tests	No.	576
Required water quality tests carried out	No.	5,114
Aesthetic tests carried out	No.	392
Microbiological tests carried out	No.	4,330
Physical-chemical tests carried out	No.	392
Radioactivity tests carried out	No.	-

Table B 5-11 Water quality testing performance indicators.

Performance indicator	Unit	BMLWE
Aesthetic tests carried out	%	8%
Microbiological tests carried out	%	85%
Physical-chemical tests carried out	%	8%
Radioactivity tests carried out	%	0%

B.5.7 Diagnosis of challenges

To assess the factors leading to low performance in operation and maintenance, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths

- Experience in and attempt at designing or acquiring maintenance management and quality management systems at BMLWE.

Weaknesses

- Lacking manpower and qualifications required to set up, update, and operate the system.
- Requests and work orders affecting financial decisions such as material requests are required to be paper based and manually signed, limiting the application of maintenance systems.
- Difficulty in narrowing down the assets requiring preventive maintenance, inspection, or calibration and the required maintenance for each.
- Difficulty in assessing the sampling and quality testing of sources and networks according to the Lebanese standards.
- Maintenance information is often lacking, and when available focus to major contracted works at facilities.
- No records of network failures that may aid in assessing the condition of network assets.
- WE has no capacity to perform acceptable levels of regular maintenance.

Opportunities

- Technology is available that enables the implementation of comprehensive management and control over operations and maintenances with minor overhead.

Threats

- Reliance on external contractors weakens the ability to closely monitor and manage maintenance activities.

B.5.8 Recommended actions

Similar to previously mentioned points in the area of systems, with the additional focus on water quality and meter management systems and systematic update. Primarily, a work order system that works across the office and the field and based on GIS is key for planning, implementing, and evaluating operation and maintenance practices and related costs. Specifically:

- Study of the scheduled maintenance needs for each asset type and development of a maintenance program. This will also help identify the needs of staffing and vehicles for the WE.

- Completion of and standardisation of maintenance forms for BMLWE, review of existing systems, and planning revisions and development of capable maintenance management system upgrade and the integration with mobile applications for field functions.
- Study of and update of the water sampling and testing needs for BMLWE. This will also help identify the needs of staffing and vehicles for BLWE.
- Review of existing water quality systems, reporting capability, regulatory compliance, and planning revisions and development of capable water quality system upgrade and the integration with mobile applications for field functions.
- Study of the cost and benefit of customer metering for both simple flow meters and smart static meters with remote reading capabilities. This will also help identify the needs of staffing and vehicles for the WE.
- Development and enforcement of a criteria for inspecting and assessing the quality of water mains and service connections and the development of a replacement strategy that minimizes pipe replacement before all attempts at maintenance have been taken, and where replacement proves to be a more cost-effective solution.

In summary to enhance efficiency and reduce the cost of O&M, it is necessary to design a modern preventive/corrective maintenance system, and implement it in the view of central digitalization system for the whole WE.

B.6 QUALITY OF SERVICE

B.6.1 Service coverage

Supply coverage is a key performance indicator. Determining the coverage ratio in cases where 100% cannot be assumed requires information about the total number of units. In the case of Lebanon, the total number of units is more often estimated using utility data, so we chose rough estimates of the number of units for the purpose of this assessment.

A better estimation can be made by assuming that the number of units served by the WE is equal to the total number of subscriptions.

Table B 6-1 Service coverage variables in 2020.

Variable	Unit	BMLWE
Units	No.	500,000
Subscribers	No.	387,163
Unit supplied legally by WE	No.	387,163
Unit supplied by other entities	No.	
Unit supplied by illegal connections	No.	

It therefore remains that service coverage cannot be determined, especially since the expected coverage by all entities and means is expected to be close to 100%. The ratio of illegally connected units can still be estimated, if with a large margin of uncertainty coming from estimating the total number of units.

Table B 6-2 Service coverage performance indicators.

Performance indicator	Unit	BMLWE
Service coverage	%	
Unit supply coverage legally by WE	%	77%
Unit supply coverage by other entities	%	
Unit supply coverage by illegal connections	%	23%

B.6.2 Supply continuity

Supply continuity is a key performance indicator. Continuity often means good level of service, more satisfied customers, fewer water quality risks, and longer asset life. The performance is usually affected by bad maintenance and shortage in water resources. In the case of Lebanon, continuity is primarily affected by power availability, therefore also storage capacity. Local power generation is possible, and some sources can be operated for extended periods, yet it is not feasible for the WE to always generate power in all locations when power supply from the grid is not available.

Given the imposing situation beyond the control of WE, the issue of continuity has often remained in the background. Efforts done by BMLWE helped improve the hours of supply in some networks to reach 24/7 in North Beirut, as well as large parts of the network have been supplied longer hours with water supply availability from larger treatment plants and transmission systems. The resulting hours of supply are still not known, and previous estimates focused more on source operating hours not distribution supply hours.

To find a reasonable number we used the BMLWE supply schedule for some summer months of 2019 where detailed network supply regimens were given. Using water quantity as a proxy for the number of customers, or population in general, the following estimate was produced:

Table B 6-3 Supply continuity variables.

Variable	Unit	BMLWE
Avg. supply duration	h/day	14.8
Listed number of networks	No.	441
Network with 23 h/day or more	No.	73
Estimated customers with continuous supply	%	17%

The resulting performance can be therefore calculated for BMLWE.

Table B 6-4 Supply continuity performance indicators.

Variable	Unit	BMLWE	Benchmark
Supply continuity	%	61%	100%
Population receiving continuous supply	%	17%	100%

B.6.3 Water quality compliance

Assessment of water quality compliance requires clear standards and transparent reporting. The number of potable water tests carried out were provided by BMLWE.

Table B 6-5 Water quality compliance base variables.

Variable	Unit	BMLWE
Treated water quality tests carried out	No.	5,144
Aesthetic tests carried out	No.	392
Microbiological tests carried out	No.	4,330
Physical-chemical tests carried out	No.	392
Radioactivity tests carried out	No.	-

Data was provided by BMLWE for both testing compliance showing that the results were 100% compliant, but the provided explaination was that a sample and testing are repeated after any issue arrised and therefore all cases are taken care of. It should be stated that the compliance percentages should apply to the required samples by regulation.

Table B 6-6 Water quality compliance performance variables.

Variable	Unit	BMLWE
Quality of supplied water	No.	5,144
Aesthetic tests compliance	No.	392
Microbiological tests compliance	No.	4,330
Physical-chemical tests compliance	No.	392
Radioactivity tests compliance	No.	-

The resulting compliance levels therefore cannot be taken without the review of the standards and requirements for sampling and testing, covered under the technical part.

Table B 6-7 Water quality compliance performance indicators.

Performance indicator	Unit	BMLWE	Benchmark
Quality of supplied water	%	100%	100%
Aesthetic tests compliance	%	100%	100%
Microbiological tests compliance	%	100%	100%
Physical-chemical tests compliance	%	100%	100%
Radioactivity tests compliance	%		100%

B.6.4 Response speed

Improving customer service depends on improving the speed of performing the services, especially in the case of Lebanese WE, where encouraging users to legally subscribe and install a meter can be hampered by long waiting time, especially for new users.

Unfortunately, the speed of service data could not be collected, and to our best knowledge is in some cases difficult to consolidate from the systems and paperwork, and in other cases impossible.

Table B 6-8 Response speed performance indicators.

Performance indicator	Unit	BMLWE	Benchmark
Average response time to customer complaints	Hours		48
New connection establishment time	days		14
Time to install a customer meter/gauge	days	~ 4	14
Connection repair time	days		1

The suggested benchmark is indicative and should be revised by the supervisory body or regulator.

Therefore, to improve the measurement -and therefore management- of response speed the following is needed:

- Completion of the digitisation of customer transactions, especially in remote offices and where systems are prone to power failures.
- Design of reports in the customer management systems that capture time of request instigation and time of completion.
- Use of mobile application for distribution departments that include customer service requests and work orders.

B.6.5 Customer complaints

Reducing the need for customer complaints and the time to respond to customer complaints are essential part of the mission of any water utility. However, in the case of Lebanon, the number of recorded complaints is abnormally low. Moreover, the number of complaints is generally higher in the better served larger cities and towns than remote villages. If anything, the numbers record the extent in which customers interact officially with the WE, as opposed to submitting complaints informally to a WE staff member, not having a legal subscription to allow complaining, or not expecting a response from a WE, especially in the remote areas.

We summarised an estimate of the needed variables from the data provided as follows:

Table B 6-9 Customer complaints variables.

Variable	Unit	BMLWE
Billing complaints and queries	No.	
Service complaints	No.	13,961
Pressure complaints	No.	
Continuity and interruption complaints	No.	
Water quality complaints	No.	

And the results show that BMLWE has the highest relative recorded number of complaints, which in this case could be considered the highest in performance given that it demonstrates the effort that BMLWE has taken in diverging customer calls gradually to the central call centre. Some parts of Mount Lebanon have not been taken under control, but a large portion of the population in the service area has been. Moreover, the working hours for the complaint centre has been increased to 10 pm, therefore increasing the chance for customers to contact BMLWE and report their issues.

Table B 6-10 Customer complaints performance indicators.

Performance indicator	Unit	BMLWE
Billing complaints and queries	No./1000 customer	
Service complaints per connections	No./1000 customer	36.1
Pressure complaints	No./1000 customer	
Continuity and interruption complaints	No./1000 customer	
Water quality complaints	No./1000 customer	

BMLWE has initiated one or more systems of documenting complaints over the years. However, common issues are seen such as:

- Partially incomplete campaigning for centralising a call centre and a centralised operations command to allow centralised control. Otherwise, local centres operating using the same system and procedures can perform similarly.
- Incomplete internal capacity and internal management of staff to re-route customer requests through the call centre.
- Inconsistent attribution of complaint types.
- No separation between claims and reports of incidents such as leaks and service complaints.
- No method for documenting billing complaints.

Therefore, and to allow for improved receiving and handling of customer complaints the following are needed:

- Standardisation of report types and definitions, including the separation of incident reports and service complaints.
- Development of a standardised customer application to enhance customer communication, to be managed by each WE independently.

B.6.6 Diagnosis of challenges

To assess the factors leading to low performance on in service quality, including difficulties in producing the needed data, we attempt at portraying the situation using a SWOT analysis that considers at PESTEL external factors.

Strengths

- Customer care centre website and mobile applications available for customers' communication.

Weaknesses

- No sufficient capacity for responding to all customer complaints.
- Large volumes of customer complaints remain to be processed outside of official channels.

Opportunities

- Mobile applications provide a technological solution for saving cost and staff needed to achieve wider communication with customers.
- Relaunching of WE with awareness campaigns, while maintaining good performance, may help establish trust and cooperation with users.

Threats

- In some parts of BMLWE, water users have not developed the habit of contacting the call centre to report service complaints.
- Power shortages hinders the possibility of constant supply.

Recommended actions

A strong customer service function that looks into both technical and administrative issues related to service delivery is key. Some work has been attempted by UNICEF and USAID have stumbled against the lack of data. Initialising subscriber data is therefore key and an element that has proven to be beyond simple interventions and beyond WE's own resources. That, and with the current widespread use of mobile applications in Lebanon, managing water subscription should not be more difficult than managing a mobile data plan, and complaining about service quality should be as easy as ordering delivery meals. Building strong communication with customers is a low hanging fruit for establishing change and good will for better water services and increased responsibility over bill payment by the customer.

With the aforementioned improvements needed for identifying system components and managing operations and maintenance, on the customer side, the following is recommended:

- Investment in a standardized if not necessarily centralised customer application that allows for:
    - Complete updating its subscribers' database
    - Ensure necessary staff is available, trained, and motivated
    - 24/7 reporting of complaints and observations such as leakage or water theft.
    - Live tracking of the status of their reports.
    - Immediate update of scheduled or unscheduled water interruptions, source quality issues, and any general announcements.

  - Calculation of complaint types, average response times, size of backlog.
- Promotion of the call centres or call desks into 24/7 complaint and command/control centres. Available SCADA as well as minor investments in remote monitoring of pressure and flow can assist the centre perform more informed decisions.
- Targeted promotion of legal subscription in areas where improved WE capacity, asset conditions, and resource sufficiency can be ensured.
- Phone and web surveys of statistically representative random sample of users to assess concerns and reporting of anonymous subscription statuses across all regions.
- Study for evaluating of the size and capacity of fields units needed in each regional department for performing satisfactory complaint handling to achieve improved service delivery.

APPENDICES

APPENDIX 1. Selection of performanc indicators

The IWA's performance Indicators for water supply services offer a rich selection of performance indicators that capture different areas of interest for monitoring the performance of water establishments. However, for the case of Lebanon, not all these indicators are relevant, pressing, or even sufficient.

Several issues of special interest to Lebanon include:

- The personnel assessment assumed for most water utilities depends on the permanently employed personnel. While there are often other sources for the work force such as daily labor or operating contracts, they are usually small and of less interest than official employees. In the case of Lebanese Wes, and due to difficulty of securing government approvals for the hiring of new employees, most of working staff has been composed of contracted people with no official employment status. Monitoring the evolution of the staff profile is therefore of great interest.
- Subscribers represent a fraction of served connections. Using the number of legal subscribers to size the system therefore would negate the strategic goal of improving subscriptions and therefore collections. Also of interest is that even if the service area and responsibilities of Wes are well defined, many municipalities and committees have taken over the role of water and wastewater utility management and provide to their own districts or in mixed districts -a situation that may not continue if the Wes have the needed capacity to take over. The actual size of the service area and the monitoring of illegal use and supply by other entities are of great interest in Lebanon.
- Customer metering has become a normal method of operation in water utilities, yet in Lebanon it remains the exception. That and the high prevalence of illegal connections, the assessment of non-revenue water based on billed amounts becomes much less effective and much more uncertain. Moreover, the information about metered production quantities is almost non-existent even for the few metered bulk sources. Therefore, it is of great interest to estimate the actual legitimate consumption as well as the illegal connections as a first step in water loss evaluation.
- Power supply for pumping is an intricate issue that includes grid power intermittency, bureaucracy in getting approvals for subscriptions, using less cost-efficient local generators that depend on the availability of fossil fuels. The assessment and monitoring of power sources and their effects on supply continuity is therefore of great interest in Lebanon.
- The IWA performance Indicators assume a situation with clearly defined treatment plants and bulk water imports being the main sources of water, while in many parts of the region a large array of water sources includes wells, springs, dams, sizes small and large, treated by many local chlorination machines or large treatment plants. It is therefore of great interest to monitor the type and quality of different kinds of supply sources.

We will now present the original performance indicators as sourced from the IWA reference and the proposed indicators for use for this assessment. At a later stage, and based on dedicated work for setting up a performance monitoring system, a final set of indicators will be defined. The IWA performance indicators for personnel supply services include a section on personnel, as shown in the table below.

Table B 6-11 Appendix to Section B - Performance indicators in the area of personnel.

Code	Area	Performance indicator	Unit
Pe1	Total personnel	Employees per connection	No./1000 connections
Pe2		Employees per water produced	No./(10^6m^3)
Pe3	Personnel per main function	General management personnel	%
Pe4		Human resources management personnel	%
Pe5		Financial and commercial personnel	%
Pe6		Customer services personnel	%
Pe7		Technical service personnel	%
Pe8		Planning & construction personnel	%
Pe9		Operations & maintenance personnel	%
Pe10	Technical services personnel per activity	Water resources and catchment management personnel	No./(10^6m^3)
Pe11		Water resources and catchment management personnel	No./(10^6m^3)
Pe12		Transmission, storage and distribution personnel	No./100 km
Pe13		Water quality monitoring personnel	No. /1000 tests
Pe14		Meter management personnel	No. /1000 meters
Pe15		Support service personnel	%
Pe16	Personnel qualification	University degree personnel	%
Pe17		Basic education personnel	%
Pe18		Other qualification personnel	%
Pe19	Personnel training	Total training	Hours / employee
Pe20		Internal training	Hours / employee
Pe21		External training	Hours / employee
Pe22	Personnel health and safety	Working accidents	No./100 employees
Pe23		Absenteeism	days / employee
Pe24		Absenteeism due to accidents or illness at work	days / employee
Pe25		Absenteeism due to other reasons	days / employee
Pe26	Overtime	Overtime work	%

We are proposing using more detailed classifications due to the emphasis on comparing personnel business areas from different Wes where departments are less comparable. Also for comparing where the shortage of staff is affecting how the Wes are adhering to the organisational by-laws, detailed job types were used.

Table B 6-12 Appendix to Section B – Proposed performance indicators in the area of personnel.

Area	Performance indicator	Unit
Total personnel	Employees per connection	No./1000 connections
	Employees per customer	No./1000 customers
	Employees per water produced	No./(10^6m^3)
	Permanent employees	%
Personnel per business area	Customer service	No./1000 connections
	Distribution	No./(10^6m^3)
	Engineering	%
	Facilities	No./(10^6m^3)
	Finance	%
	General	%
	HR	%
	Water quality	%
Personnel per job type	Auxiliary – Clerical	No./(10^6m^3)
	Auxiliary – Driver	%
	Auxiliary – Guard	%
	Auxiliary – Office boy	%
	Collector / Reader	No./1000 meters
	Customer service	No./1000 customers
	Financial / Administrative	%
	Management	%
	Management (Eng.)	%
	Technical – Driver	%
	Technical – Engineer	%
	Technical – Labourer	%
	Technical – Other	%
	Technical – Water quality	No./1000 samples
Personnel qualification	University degree personnel	%
	Basic education personnel	%
	Other qualification personnel	%
Personnel	Training	Hours / employee
Personnel health and safety	Working accidents	No./100 employees
	Absenteeism	days / employee
	Absenteeism due to accidents or illness at work	days / employee
	Absenteeism due to other reasons	days / employee
Overtime	Overtime work	%

The IWA performance indicators for water supply services also include a section on water resources, physical systems, and operations as shown in the tables below.

Table B 6-13 Appendix to Section B - IWA performance indicators in the area of water resources.

Code	Area	Performance indicator	Unit
WR1	Water resources	Inefficiency of use of water resources	%
WR2		Water resources availability	%
WR3		Own water resources availability	%
WR4		Reuse supplied water	%

Table B 6-14 Appendix to Section B - IWA performance indicators in the area of physical systems.

Code	Area	Performance indicator	days
Ph1	Treatment	Treatment plant utilization	%
Ph2	Storage	Raw water storage capacity	days
Ph3		Transmission and distribution storage capacity	days
Ph4	Pumping	Pumping utilization	%
Ph5		Standard energy consumption	kWh/m³/100m
Ph6		Reactive energy consumption	%
Ph7		Energy recovery	%
Ph8	Transmission and distribution	Valve density	No./km
Ph9		Hydrant density	No./km
Ph10	Meters	District meter density	No./1000 connections
Ph11		Customer meter density	No./connections
Ph12		Metered customers	No./customer
Ph13		Metered residential customers	No./customer
Ph14	Automation and control	Automation degree	%
Ph15		Remote control degree	%

Table B 6-15 Appendix to Section B - IWA performance indicators in the area of operation.

Code	Area	Performance indicator	Unit
Op1	Inspection and maintenance of physical assets	Pump inspection	%
Op2		Storage tank cleaning	%
Op3		Network inspection	%
Op4		Leakage control	%
Op5		Active leakage control repairs	No./100 km
Op6		Hydrant inspection	%
Op7	Instrumentation calibration	System flow meters calibration	%
Op8		Meter replacement	%
Op9		Pressure meters calibration	%
Op10		Water level meters calibration	%
Op11		On-line water quality monitoring equipment calibration	%
Op12	Electrical and signal transmission	Emergency power systems inspection	%
Op13		Signal transmission equipment inspection	%
Op14		Electrical switchgear equipment inspection	%
Op15	Vehicles	Vehicle availability	No./100 km
Op16	Mains, valves and service connection rehabilitation	Mains rehabilitation	%
Op17		Mains renovation	%
Op18		Mains replacement	%
Op19		Replaced valves	%
Op20		Service connection rehabilitation	%
Op21	Pump rehabilitation	Pump refurbishment	%
Op22		Pump replacement	%
Op23	Operational water losses	Water losses per connection	m³/connection
Op24		Water losses per mains length	m³/km/day
Op25		Apparent losses	%
Op26		Apparent losses per system input volume	%
Op27		Real losses per connection (w.s.p)	l/c/day
Op28		Real losses per mains length (w.s.p)	l/c/day
Op29		Infrastructure leakage index	N/A
Op30	Failure	Pump failures	days/pump
Op31		Mains failures	No.100km
Op32		Service connection failures	No./1000 connections
Op33		Hydrant failures	No./1000 hydrants
Op34		Power failures	hours/pumping stations
Op35		Water point failures	No./water points
Op36	Water metering	Customer reading efficiency	%
Op37		Residential customer reading efficiency	%
Op38		Operational meters	%
Op39		Unmetered water	%
Op40	Water quality monitoring	Test carried out	%
Op41		Aesthetic tests carried out	%
Op42		Microbiological tests carried out	%
Op43		Physical-chemical tests carried out	%
Op44		Radioactivity tests carried out	%

We propose a redesign and emphasis in a similar way but in ways more relevant to the situation in Lebanon. One section combines indicators for water loss as shown in the table below.

Table B 6-16 Appendix to Section B - Proposed water loss performance indicators.

Performance indicator	Unit
Non-revenue water	%
Water loss	%
Water losses per connection	l/c/day
Water losses per mains length	m³/km/day
Apparent loss index (ALI)	N/A
Real loss per connection (w.s.p)	l/c/day
Real loss per mains length (w.s.p)	m³/km/day
Infrastructure leakage index (ILI)	N/A

Where water loss here is used specifically for this context to represent the difference between the estimated system input and authorized consumption, while non-revenue water is used for the difference between the system input and the billed amounts.

One section details energy indicators relevant to the situation of Lebanon as shown in table below.

Table B 6-17 Appendix to Section B - Proposed energy performance indicators.

Performance indicator	Unit
Unit energy consumption	kWh/m³
Energy consumed from grid	%
Energy generated from fuel	%
Renewable energy generation	%
Energy recovery	%

One section details system indicators relevant for Lebanon as shown in the table below.

Table B 6-18 Appendix to Section B - Proposed performance indicators in the area of water systems.

Area	Performance indicator	Unit
Resources	Water production capacity utilisation	%
	Treatment plant capacity utilisation	%
	Reuse supplied water	%
Storage	Raw water storage capacity	days
	Transmission and distribution storage capacity	days
Metering	Production and transmission meter density	No./plants
	District meter density	No./1000 connections
	Customer metering	%
SCADA	Facility automation degree	%
	Facility remote control degree	%

One section details remaining operations and additional maintenance indicators relevant for as shown in the table below.

Table B 6-19 Appendix to Section B - Proposed performance indicators In the area of operations and maintenance.

Area	Performance indicator	Unit
Inspection and calibration	Pump inspection	%
	System valve inspection	%
	Reservoir cleaning	%
	Control valve inspection	%
	Network inspection	%
	Service connection inspection	%
	Instrument and inspection and calibration	%
	Systems flow meters calibration	%
	Pressure meters calibration	%
	Water level meters calibration	%
	Water quality sensor calibration	%
	Control unit inspection and calibration	%
	Electrical panel inspection	%
Rehabilitation and replacement	Mains rehabilitation and replacement	%
	Service connection rehabilitation and replacement	%
	System valve rehabilitation and replacement	%
	Control valve rehabilitation and replacement	%
	Pump rehabilitation and replacement	%
	System flowmeter rehabilitation and replacement	%
	Customer flowmeter rehabilitation and replacement	%
	Leaks repaired	No./100 km
Vehicles	Vehicle availability	No./100 km
	Vehicle availability	No./1000 customer
Customer metering	Customer meter reading efficiency	%
	Customers billed based on metering	%
Quality monitoring	Aesthetic tests carried out	%
	Microbiological tests carried out	%
	Physical-chemical tests carried out	%
	Radioactivity tests carried out	%

Of great importance, the IWA performance indicators for water supply services include a section on the quality of service as shown in the table below.

Table B 6-20 Appendix to Section B - IWA performance indicators in the area of quality of service.

Code	Area	Performance indicator	Unit
QS01	Service coverage	Households and business supply coverage	%
QS02		Buildings supply coverage	%
QS03		Population coverage	%
QS04		Population coverage with service connections	%
QS05		Population coverage with public taps or standpipes	%
QS06	Public taps and standpipes	Operational water points	%
QS07		Average distance from water-points to households	m
QS08		Per capita water consumed in public taps and standpipes	l/person/day
QS09		Population per public tap or standpipe	persons/day
QS10	Pressure and continuity of supply	Pressure of supply adequacy	%
QS11		Bulk supply adequacy	%
QS12		Continuity of supply	%
QS13		Water interruptions	%
QS14		Interruptions per connection	No./1000 connections
QS15		Bulk supply interruptions	No./delivery point
QS16		Population experiencing restrictions to water service	%
QS17		Days with restrictions to water service	%
QS18	Quality of supplied water	Quality of supplied water	%
QS19		Aesthetic tests compliance	%
QS20		Microbiological tests compliance	%
QS21		Physical-chemical tests compliance	%
QS22		Radioactivity tests compliance	%
QS23	Service connection and meter	New connection efficiency	days
QS24		Time to install a customer meter	days
QS25		Connection repair time	days
QS26	Customer complaints	Service complaints per connections	No./1000 connections
QS27		Service complaints per customer	No./customer
QS28		Pressure complaints	%
QS29		Continuity complaints	%
QS30		Water quality complaints	%
QS31		Interruption complaints	%
QS32		Billing complaints and queries	No./customer
QS33		Other complaints and queries	No./customer
QS34		Response to written complaints	%

And similarly, we propose a simpler section more relevant for the case of Lebanon as shown in the table below.

Table B 6-21 Appendix to Section B - Proposed performance indicators in the area of quality of service.

Area	Performance indicator	Unit
Coverage	Service coverage	%
	Unit supply coverage legally by WE	%
	Unit supply coverage by other entities	%
	Unit supply coverage by illegal connections	%
Continuity	Supply continuity	%
	Population receiving continuous supply	%
Water quality	Quality of supplied water	%
	Aesthetic tests compliance	%
	Microbiological tests compliance	%
	Physical-chemical tests compliance	%
	Radioactivity tests compliance	%
Response speed	Average response time to customer complaint	Hours
	New connection establishment time	days
	Time to install a customer meter	days
	Connection repair time	days
Customer complaints	Billing complaints and queries	No./1000 customer
	Service complaints per connections	No./1000 customer
	Pressure complaints	No./1000 customer
	Continuity and interruption complaints	No./1000 customer
	Water quality complaints	No./1000 customer

While not all these indicators will be relevant to decision makers at high levels, or can be currently calculated with sufficient accuracy, the offer a broad overview of the establishments needs for the sake of this assessment. A selected list of Key Performance Indicators can then be extracted at the upcoming activity.

APPENDIX 2. Selection of assessment benchmarks

Benchmarks are needed to give the performance indicators meaning and value. When selecting benchmarks for different performance indicators and given that in most cases there remains a general lack of internationally approved standards giving exact figures to follow. Some exceptions may exist at this stage such as the following:

1. Staff to connections:
   Tynan and Kingdom (2002) studied water utilities of different levels of performance and found that a staff size of 5 per 1000 connections was achievable by the top group of utilities. Since then, this figure has been adopted, and sometimes increased to express the size for utilities running both water and wastewater services.

2. Non-Revenue Water as a ratio of system input volume (% NRW):
   While the IWA, AWWA, and the EU recommend against using this indicator as a target or a benchmark, Tynan and Kingdom found that 23% or less represents the performance level of the top performing utilities. We assess that a percentage can be used as a target when guided by other indicators such as ILI and ALI but not based on ad-hoc percentages. Also the percentage of NRW cannot be used to compare utility performance.

3. Infrastructure Leakage Index (ILI):
   The ILI is recommended by the IWA, AWWA, and the EU as the indicator for benchmarking performance on physical (or real) loss performance. This indicator assesses the condition of leakage of infrastructure operating at a certain water pressure given its characteristics, and therefore assesses physical assets condition as well as the speed of repair of leaks, yet does not assess the performance in pressure management. Moreover, the results of ILI will vary widely based on assumptions about supply continuity and pressure in networks, neither of which are currently recorded in Lebanese WEs. Still, and since ILI is based on deviation from an ideal, the ideal of ILI for developed countries is the Unavoidable Annual Real Loss (UARL), while the ideal for developing countries is twice the UARL.

4. Apparent Loss Index (ALI):
   The ALI is a simple indicator to calculate and is the ratio of commercial (or apparent) loss to 5% of the billed authorized consumption, here 5% representing the ideal for developed countries. For developing countries 10% is used, meaning that the target for commercial losses should be less than 10% of the billed quantities.

5. Supply continuity:
   A major KPI, supply continuity is agreed to be a required objective by the international water organisations, and also referenced by Tynan and Kingdom. A 24/7 supply is an agreed-upon target, and fewer supply hours will jeopardise risk for both the conditions of the physical network assets and the health of the customer.

6. Number of water quality samples from distribution networks:
   The Lebanese water quality standards provides detailed requirements for water quality testing. These tests can differ in the number of samples. The WHO on the other hand recommends one monthly sample for every 10,000 people serviced plus 10 additional samples. For a utility serving one million people this amounts to 1320 samples annually.

Otherwise, we followed the following principles:

- A benchmark can be more ambitious than an improvement target which is more concrete and can be used for accountability.
- A benchmark can start as a high ideal if impossible to achieve (e.g. 0% or 100%)
- A general direction of higher or lower may be used instead of a fixed value.
- Performance of basic tasks is expected to occur at least annually.

Strategically, more or less strict standards may need to be adopted as in the case of sensitive electronics used in SCADA may require stricter and more frequent control compared to regular network isolation valves. In either case and given the status of maintenance that is expected in Lebanese WEs, any reference standard that can be established is preferable to the lack of one.

In some cases the performance indicators are not immediately tied to the efforts of the establishment or controlled by them. An example is the number of failures where better operation could indeed lead to fewer cases of failures, yet the number of cases will not be fully dependent on the level of effort and failures will eventually occur regardless.

The resulting benchmarks can therefore either be set as an ideal goal the WEs should aspire to reach, or a comparative assessment of achievement that can be compared between WEs or regions within the WE and will evolve with the evolution of performance.

SECTION C
FINANCIAL PERFORMANCE DIAGNOSIS

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C. 1 INTRODUCTION

Water utilities in Lebanon are public establishments created in year 2000, under Law 221, and fully implemented in 2005, that merged regional water authorities and committees into four water establishments.

By law, these establishments are independent, state owned water utilities, responsible for production, distribution, and billing for water, wastewater, and irrigation services, under the tutelage of the ministry of energy and water, that formulates policy and regulates fees.

As such, these establishments have to produce, ahead of each year, a balanced budget, to be approved by the ministry, and present externally audited financial results at the end of the year. In order to present a balanced budget, most establishments would overestimate revenues, and understate expenditures.

The water code law 77 – 2018 amended by law 192 – 2020, and still pending proposes a commercial approach to service delivery by separating water, waste water, and irrigation operations both technically and financially , and allowing for contracting service providers in limited areas within each territory : private operators, municipalities, or water committes.

If and when implemented, the water code would require modifications to the organizational structure of the establishments, and the adoption of generally accepted accounting principles, standards, and procedures, away from the currently used public accounting system.

To this end, many attempts have been made since 2005, mainly:

- To map, assess and evaluate fixed assets (identification, ownership, valuation, replacement cost, amortization…)
- Review and amendments to organization charts adopted in 2005.
- Implement a commercial accounting system : SAFEGE, X7/PIMS (2005-2009), USAID, ERP Msft Navision (2011 – to date).
- Tariff analysis that require the calculation of “cost of goods sold” was limited by determination of production volumes by water source, manpower and operation and maintenance costs corresponding to production facilities, and actual water consumption by billed customers.
- Survey of residents, beneficiaries, illegal connections.
- Pilot projects to address NRW : Bulk, district, and household water meters, SCADA system.

Not withstanding above, financial results of the water establishment have been reviewed with actual numbers provided, and constitute a starting point for planning for future activities.

Additionally, a cost recovery study has been performed using the numbers of the year 2019 as base values (before the economic crisis) to simulate the impact of the hyperinflation on the opex cost.

Therefore, section C is organized in two main chapters:

- The first chapter presents a review of the actual financial numbers and figures of the WE where results will constitue the basis for planning for future activities.

- The second chapter summarises the main findings and key recommendations resulted from the cost recovery study.

C. 2 REVIEW OF THE FINANCIAL SITUATION

C. 2.1 Book keeping and related matters

Bookkeeping is a matter of concern with some WEs far in advance and following good practices and due accounting principles, while others are not up to standards. For the latest, data are somehow unstable and confusing.

As far as financial reporting is concerned, the situation is somehow confusing with WEs maintaining in parallel two systems. The first is a requirement of the MoEW and is an administrative budget with authorization for payments and associated budgets. The second is more business oriented trying to meet financial commercial reporting standards.

The flaw is that the admin system is extremely time and effort consuming preventing the finance department to concentrate on the financial & commercial reporting systems.

The second flaw is sometimes financial reports are extracted from the admin budget and sometimes from the commercial ledgers. The two systems are not compatible and reconciliation of the two systems is cumbersome.

When it comes to financial data capture, the double entry principle is required for commercial ledgers but not for the budget presentation required by the ministry.

Meanwhile some WEs are in line with International Financial Reporting Standards (IFRS).

Table C 2-1 Balance sheet and statement of revenues and expenditures

	NLWE	SLWE	BWE	BMLWE
Balance sheet (Assets & liabilities)	Partial[1]	Yes	No	Yes[2]
Statement of revenues and expenditures	Yes	Yes	Yes[3]	Yes[4]

While only 2 WEs have a balance sheet recording assets and liabilities, other have partial records with assets registry incomplete or statement of revenues not properly recorded. The same applies to stock management and control. For instance, current revenues of a year might also include collected arrears from previous years.

Due to the dual accounting systems, the statement of revenues and expenditures is also unstable and questionable with some WE not recording some key expenditures (Energy, taxes, out-sourced activities etc.). The same applies to subsidies which are included or not into the revenues.

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[1] Asset inventory not completed
[2] No free access to the balance sheet was given to the technical assistance
[3] Subject to clarification
[4] Subject to clarification

In addition, it is worth mentioning that the grants of some donors are not, or improperly recorded in the books leading to a distorted vision of the situation. Many inconsistencies were detected with confusion between accrued and cash revenues and confusion between opex and capex. In the same line of thought, payments of previous years are recorded in the current year conducting to inaccurate collection rate. The same applies to irrigation which is sometimes included in the revenues and opex and sometimes excluded.

Each WE has developed its own info system with no standards proposed/imposed by the MoEW. Thus comparisons, benchmarking, exchange of information, reconciliation and production of standard reports are questionable. At this point, it is worth mentioning that there is a tendency to use the Enterprise Resource Planning (ERP) which is an integrated package addressing the billing, collection, the accounting and assets management etc. Such package has been made available through USAID; however, this software has not been fully implemented, and sometimes produces doubtful reports.

Bookkeeping policy and procedures manuals are not available and financial statements are not audited except by “la Cour des Comptes” which concentrates on formal administrative issues and not on the core business and financial aspects. In other words, and despite a legal requirement, no chartered accountant is hired for the provision of auditing and ascertaining the accuracy and regularity of the financial statements.

On the organizational side, the customer management or commercial issue is not yet identified as a must and the billing/collecting is falling under the responsibility of the admin/finance manager or HR dpt. We are of the opinion that such absence is part of the culture in Lebanon whereby the final user is regarded as a subscriber but not as customer. Such statement does not apply in the specific case of SLWE where a customer’s affairs department is officially displayed in the organization chart.

Annual reports are produced by some WEs but no on a standardized form, with long delays in publication. Generally speaking, the annual report is a mix between existing situation, yearly activities and results, and future projects.

As a conclusion, the combination of incomplete and fuzzy commercial records and financial statements not up to standards does not allow to have a crystal-clear vision of the financial situation of the WEs. Such opinion is to be adjusted on a case-by-case basis.

Meanwhile, for the purpose of this exercise, the consultant has used its best endeavour in order to clarify and depict a reasonable financial & commercial situation of the WEs.

As a consequence, all figures, ratios and calculations displayed in the report reflect “our best estimates”.

C. 2.2 Methodology used

For the purpose of this exercise our methodology is based on the collection and display of key data encompassing technical, commercial and financial pieces of information. The objective is to combine these data, produce some relevant ratios for displaying a clear picture of the situation of the WE.

Table C 2-2 Key figures

Key figures	Unit
Nbr. of customers	Nbr.
Of whom water meters	"
Volume produced & entering into the system	m³/year
Volume billed/subscribed	m³/year
Est. NRW rate	%
Accrued revenues (including Irrigation)	LBP
Annual collection rate	%
Actual revenues of the year	LBP
Operating cost	"
Operating result (EBITDA)	"
EBITDA in %	%
Operating result while taking the collection rate (EBITDA)	LBP
EBITDA in % while taking the collection rate	%
Cash situation end of the year	LBP
Receivables end of the year	"
Est. Amortization	“
Average selling price/m³	LBP
Average collected /m³	"
Operating cost /m³	"

Subject to availability of the data, all pieces of information are to be collected throughout many fiscal years for trend identification purpose.

Table C 2-3 Fiscal years for each WE

	Fiscal years
BMLWE	2016 - 2020
BWE	2008 - 2020
SLWE	2017 - 2020
NLWE	2017 - 2020

Meanwhile, throughout this exercise, we will highlight the particulars of the WE and stress strengths and weaknesses. Whenever relevant, explanatory graphs are displayed.

On the financial side, we concentrated on profitability, liquidity and solvency of the WE. A particular attention is paid to the EBITDA (Earnings Before Interest, Tax, Depreciation & Amortization) which reflects the profitability of the business together with the capacity to produce sufficient cash-flow. Such concept refers more or less to the French “Marge Brute”.

C. 2.3 Results of the Financial review

C. 2.3.1 Quality, accuracy and consistency of data collected

Acceptable, but we make some reservation since balance sheets were not made available to the TA. Most of the data captured were extracted from the budget which is somehow questionable.

All data highlighted in yellow color mean "not made available to the Technical Assistance"[5]

C. 2.3.2 Key figures

In the following, we present the key figures we collected from BMLWE for the period between the year 2016 and the year 2020.

The key figures as collected from BMLWE are as follow:

- Number of customers
- Customers with water meters
- Volume produced
- Volume billed
- Non-Revenue Water (NRW)
- Accrued revenues (turn over)
- Annual collection rate
- Actual revenues
- Operating cost
- Operating result
- Cash situation
- Receivables end of the year
- Amortization.

The table blow includes, in addition to the above, some calculated figures as the average selling price of m^3, the average collected per m^3, and the operating cost per m^3 .

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[5] Reasons for not disclosing the data are sometimes the “confidentiality” or the information is not available.

Table C 2-4 Key figure for BMLWE

		2016	2017	2018	2019	2020
Nber of customers	Nber	367,233	373,749	373,504	381,306	387,163
Of whom water meters	"	19,163	19,700	20,544	21,143	21,756
Volume produced & entering into the system	m³/year	190,369,035	204,864,280	201,959,245	223,936,990	221,818,895
Volume billed/subscribed	m³/year	189,493,400	193,512,050	194,995,410	199,197,290	202,483,385
Est. NRW rate	%	0,5%	5,5%	3,4%	11,0%	8,7%
Accrued revenues (including Irrigation)	LBP	118,998,030,576	124,364,329,686	125,264,738,399	152,068,346,850	154,637,983,383
Annual collection rate	%	82%	79%	80%	71%	61%
Actual revenues of the year	LBP	97,219,855,593	98,156,480,595	100,358,216,184	107,921,029,053	93,876,910,081
Operating cost	"	85,344,091,570	78,545,364,198	83,848,850,921	89,145,964,363	79,488,693,571
Operating result (EBITDA)	"	33,653,939,006	45,818,965,488	41,415,887,478	62,922,382,487	75,149,289,812
EBITDA in %	%	28%	37%	33%	41%	49%
Operating result while taking the collection rate (EBITDA)	LBP	11,875,764,023	19,611,116,397	16,509,365,263	18,775,064,690	14,388,216,510
EBITDA in % while taking the collection rate	%	12%	20%	16%	17%	15%
Previous Years collections		20,567,094,314	16,666,633,511	16,658,473,937	13,398,827,364	17,947,706,715
Write offs Previous years		54,845,676,616	2,491,141,643	14,378,587,247	137,115,000	159,308,000
Cash situation end of the year	LBP	Not made available				
Receivables end of the year (current year+previous)	LBP	117,786,949,907	124,837,023,844	118,706,484,875	149,317,860,308	191,971,918,895
Est. Amortization		Not made available				
Average selling price/m³	LBP	628	643	642	763	764
Average collected /m³	LBP	513	507	515	542	464
Operating cost / m³	LBP	450	406	430	448	393

Of great importance is the comparison of the average collected per m³ v/s its production cost. It can be seen for the period between 2016 and 2020 that BMLWE was able to recover the operating cost and to make profits. Cost recovery is detailed in Section C. 3.

C. 2.3.3 Comments on key figures

Table C 2-5 Situation of BMLWE

	BMLWE year 2020	
	Accrued	**Actual**
Turn over	154,637,673,382	
Subsidies		
Total actual revenues		93,876,910,081
Other Operating cost	-39,001,286,827	-39,001,286,827
Personnel	-40,487,406,744	-40,487,406,744
EBITDA	75,148,979,811	14,388,216,510
Amortization	Not available	
Operating result	**75,148,979,810**	**14,388,216,509**
Other revenues/expenditures	Not available	
Cost of debt	Not available	
Net result		

The situation in BMLWE can be briefly depicted as follows:

- The price of water service while taking into account the collection is meeting the O&M costs although the trend is a matter of concern since the EBIDTA trend is declining slowly.
- The collection rate was quite decent but, since 2017, the trend is decreasing from 80 down to 60%.

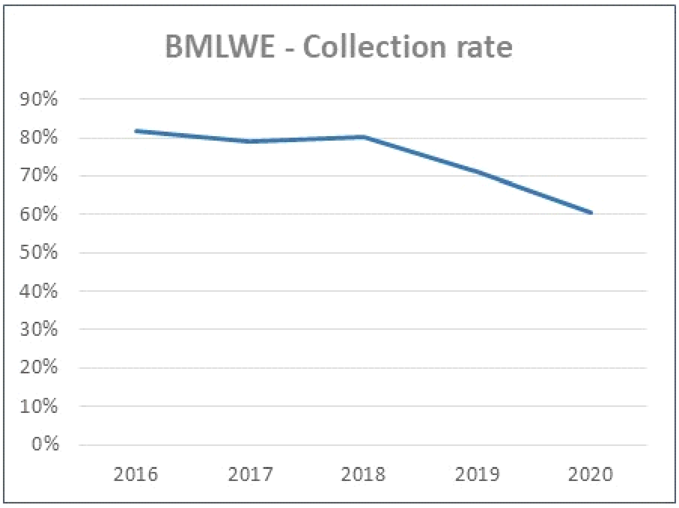

Figure C 2-1 BMLWE Collection rate

- Collection rates decline all over the regions under the jurisdiction of the BMLWE as shown below.

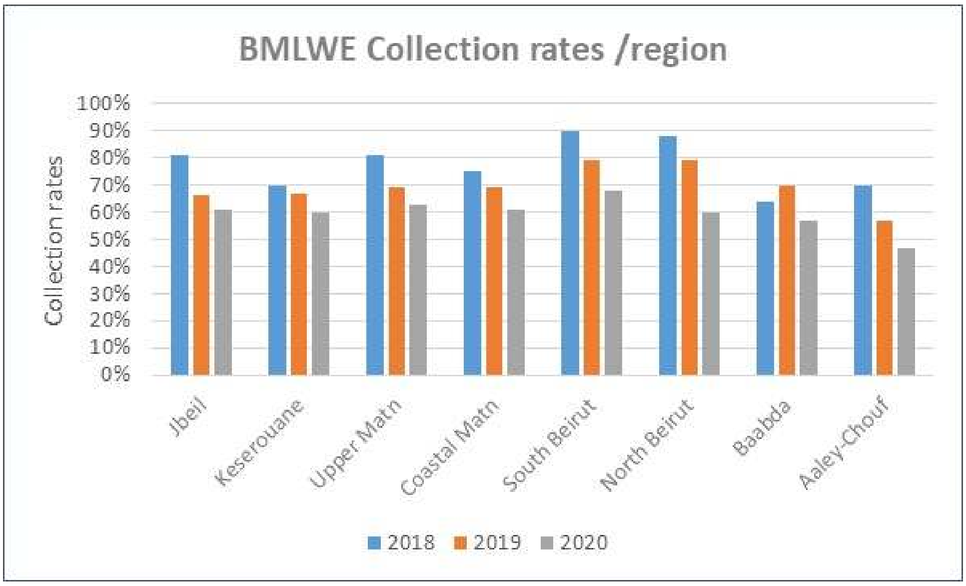

Figure C 2-2   BMLWE Collection rate per region

- BMLWE has developed a strategy for progressively introducing water meters, including smart water meters. In 2020, 6% of the customers are metered. 56% of these meters are concentrated in the Keserwane region. Such new feature is good and is to be encouraged.

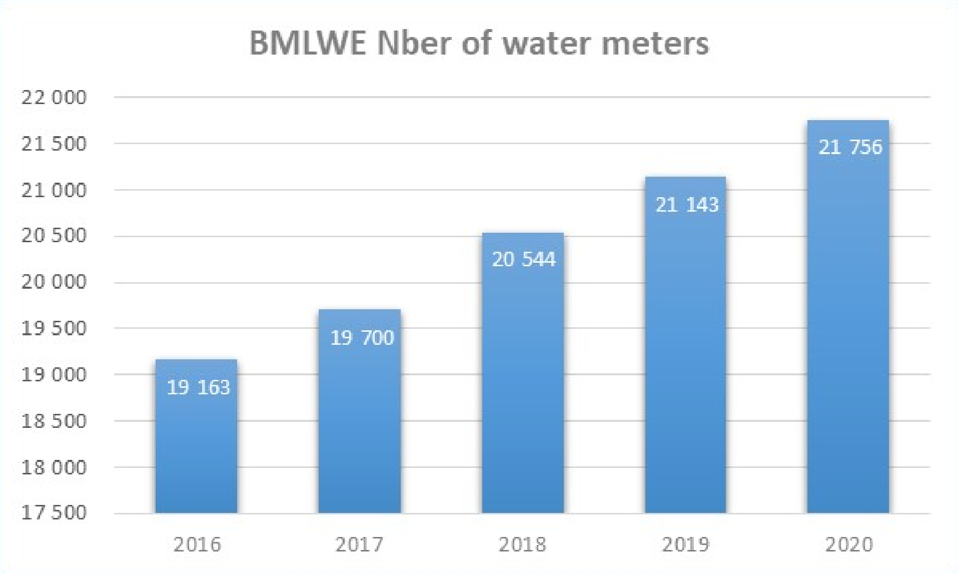

Figure C 2-3   BMLWE Number of water meters

- NRW is shown below.One of the major concerns regarding the reliability of the NRW rate as displayed hereunder:

Table C 2-6 Volume produced and volume billed

	2016	2017	2018	2019	2020
			(m³/year)		
Volume produced	190 369 035	204 864 280	201 959 245	223 936 990	221 818 895
Volume billed	189 493 400	193 512 050	194 995 410	199 197 290	202 483 385
Est NRW rate	0.5%	5.5%	3.4%	11.0%	8,7%

Surprisingly the NRW rate is extremely low whenever compared with similar water systems where good performance means 20% or 30% NRW while taking into account the unavoidable rate of losses. As a comparison, reasonable calculation in NLWE or SLWE displays 40% technical and commercial losses. In the specific case of BMLWE, and provided that measurements at the production level are more or less correct, this demonstrates that BMLWE is selling more water that what is actually delivering to the consumers (not negligible number of vacant premises, intermittent supply, actual consumption below subscribed volume, …)

- On the financial performance, the Earnings Before Interest, Depreciation and Amortization (EBITDA) while taking into consideration effective payments is still in the green territory with an anticipated concern for year 2020 and probably for 2021.

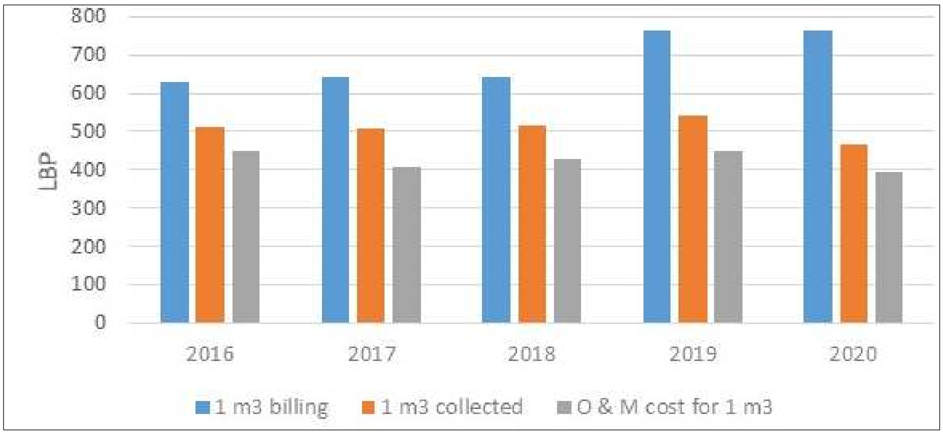

Figure C 2-4 BMLWE price & cost for 1 m³

- Due to the decline of the collection rate, cash problems are to be anticipated and most likely an increase of accounts receivable.
- In absence of comprehensive balance sheet:
    - No info regarding the outstanding debt of BMLWE
    - No info regarding the cash situation and the liquidity ratios.

C. 3 COST RECOVERY

C. 3.1 Definition

Cost recovery is the ratio of expenses over cash flow.

Expenses include all operational expenditures (Opex) and asset depreciation expenditures (Capex). However, under this study, Capex are not considered because :

- No data is available about the asset value of any of the four WE. This is one of the issues to be addressed in the future.
- Due to the present financial situation, the WEs are pretty much far from achieving Opex recovery. Their major challenge is to be able (and get the means) to implement required measures to gradually improve cost recovery, in order to achieve balance in the coming five or six years.

Therefore, in this study by Cost Recovery it is meant Opex Cost recovery.

C. 3.2 Cost recovery and the impact of the financial crisis

Table C 3-1 below shows the cost recovery ratios based on the financial situation that was prevailing in 2019, when the exchange rate USD/LBP was stable, and based on the water tariff in force then. It can be seen that BMLWE was achieving 112% Opex recovery.

However, everything has changed since. The financial crisis had major impact on Opex while the cash flow is still the same as no tariff adjustment is made to date.

Table C 3-2 below shows the cost recovery analysis based on the financial indicators of 2022.

The EDL tariff of 2019 is multiplied by 13 in 2022. This figure is calculated based on the following assumptions:

- EDL tariff in 2019 : 170 LBP/kWh. this is the average rate charged by EDL for the WEs, including subscriptions and else, but not including VAT.
- EDL tariff for the first six months of 2022 will remain unchanged (same as 2019)
- EDL tariff for the second half of2022 will be raised to 0.21USD (according to a verbal communication from MoEW)
- Exchange rate = 20 000 LBP/USD as per Manassah platform.

Table C 3-1 Opex recovery analysis (2019 financial situation)

Operational Revenues : 145 305 M LBP	Cash Flow : 100 261 M LBP	Total OPEX : 89 425 M LBP

Financial Indicators (Base value)

Exchange Rate :	1 500	LBP/USD
Fuel :	850	LBP/l
Gazoline :	25 000	LBP/20 l
Transportation :	8 000	LBP/day
EDL/Gen. % :	78%	EDL
EDL increase factor :	1.00	
CPI :	115	
Salaries increase factor :	1.00	
Including new WWTPs :	No	
Tariff increase factor :	1.00	

(Avg. bill amount : 405 000 LBP)

Collection rate assessment

Invoiced :	145 305 M LBP
Collected :	100 261 M LBP
Collection Rate	69%
Cost recovery	112%

Subscriptions rate assessment

Volume Produced	224 000 K m³	
Volume Billed	199 000 K m³	
Technical losses	6%	(ILI = 8)
Subscriptions Rate	94.54%	
Potential invoicing	153 698 M LBP	

OPEX Breakdown

HR	45 715 M LBP
Power	26 632 M LBP
EDL	19 039 M LBP
Generators	7 447 M LBP
Donations	146.25 M LBP
Consumables	984 M LBP
Paid by WE	984 M LBP
Donations	0 M LBP
O&M	12 429 M LBP
Paid by WE	12 298 M LBP
Donations	131 M LBP
Administrative	3 665 M LBP

SUBSCRIPTION RATE

TOTAL OPEX RECOVERY RATE

Amount to recover : 89 425 M LBP

	COLLECTION RATE														
SUBSCRIPTION RATE	**69%**	**71%**	**73%**	**75%**	**77%**	**79%**	**81%**	**83%**	**86%**	**88%**	**90%**	**92%**	**94%**	**96%**	**98%**	**100%**
95%	112%	115%	119%	122%	126%	129%	132%	136%	139%	142%	146%	149%	152%	156%	159%	162%
95%	113%	116%	119%	123%	126%	129%	133%	136%	140%	143%	146%	150%	153%	156%	160%	163%
95%	113%	116%	120%	123%	127%	130%	133%	137%	140%	144%	147%	150%	154%	157%	160%	164%
96%	114%	117%	120%	124%	127%	131%	134%	137%	141%	144%	148%	151%	154%	158%	161%	164%
96%	114%	117%	121%	124%	128%	131%	134%	138%	141%	145%	148%	152%	155%	158%	162%	165%
96%	114%	118%	121%	125%	128%	132%	135%	138%	142%	145%	149%	152%	156%	159%	162%	166%
97%	115%	118%	122%	125%	129%	132%	136%	139%	142%	146%	149%	153%	156%	160%	163%	167%
97%	115%	119%	122%	126%	129%	133%	136%	140%	143%	146%	150%	153%	157%	160%	164%	167%
98%	116%	119%	123%	126%	130%	133%	137%	140%	144%	147%	151%	154%	157%	161%	164%	168%
98%	116%	120%	123%	127%	130%	134%	137%	141%	144%	148%	151%	155%	158%	162%	165%	169%
98%	117%	120%	124%	127%	131%	134%	138%	141%	145%	148%	152%	155%	159%	162%	166%	169%
99%	117%	121%	124%	128%	131%	135%	138%	142%	145%	149%	152%	156%	159%	163%	166%	170%
99%	118%	121%	125%	128%	132%	135%	139%	142%	146%	149%	153%	156%	160%	163%	167%	171%
100%	118%	122%	125%	129%	132%	136%	139%	143%	146%	150%	154%	157%	161%	164%	168%	171%
100%	119%	122%	126%	129%	133%	136%	140%	143%	147%	151%	154%	158%	161%	165%	168%	172%

Table C 3-2 Opex recovery analysis (2022 financial situation)

Operational Revenues : 145 305 M LBP			Cash Flow : 100 261 M LBP			Total OPEX : 739 999 M LBP		
Financial Indicators (Typical 2022)			**Collection rate assessment**			**OPEX Breakdown**		
Exchange Rate (base = 1 500) :	20 000	LBP/USD	Invoiced :	145 305	M LBP	HR	106 675	M LBP
Fuel (base = 850) :	19 700	LBP/l	Collected :	100 261	M LBP	Power	438 678	M LBP
Gazoline (base = 25 000) :	375 000	LBP/20 l	Collection Rate	69%		EDL	256 286	M LBP
Transportation (base = 8 000) :	64 000	LBP/day	Cost recovery	14%		Generators	178 981	M LBP
EDL/Gen. % (base = 78%) :	78%	EDL				Donations	3411.029	M LBP
EDL increase factor :	13.00		**Subscriptions rate assessment**			Consumables	16 952	M LBP
CPI (base = 115) :	700		Volume Produced	224 000	K m^3	Paid by WE	16 952	M LBP
Salaries increase factor :	2.00		Volume Billed	199 000	K m^3	Donations	0	M LBP
Including new WWTPs :	Yes		Technical losses	6%	(ILI = 8)	O&M	155 385	M LBP
			Subscriptions Rate	94.54%		Paid by WE	153 877	M LBP
Tariff increase factor :	1.00		Potential invoicing	153 698	M LBP	Donations	1 508	M LBP
(Avg. bill amount : 405 000 LBP)						Administrative	22 309	M LBP

SUBSCRIPTION RATE	**COLLECTION RATE**															
	69%	**71%**	**73%**	**75%**	**77%**	**79%**	**81%**	**83%**	**86%**	**88%**	**90%**	**92%**	**94%**	**96%**	**98%**	**100%**
	TOTAL OPEX RECOVERY RATE Amount to recover : 739 999 M LBP															
95%	14%	14%	14%	15%	15%	16%	16%	16%	17%	17%	18%	18%	18%	19%	19%	20%
95%	14%	14%	14%	15%	15%	16%	16%	16%	17%	17%	18%	18%	18%	19%	19%	20%
95%	14%	14%	14%	15%	15%	16%	16%	17%	17%	17%	18%	18%	19%	19%	19%	20%
96%	14%	14%	15%	15%	15%	16%	16%	17%	17%	17%	18%	18%	19%	19%	19%	20%
96%	14%	14%	15%	15%	15%	16%	16%	17%	17%	17%	18%	18%	19%	19%	20%	20%
96%	14%	14%	15%	15%	15%	16%	16%	17%	17%	18%	18%	18%	19%	19%	20%	20%
97%	14%	14%	15%	15%	16%	16%	16%	17%	17%	18%	18%	18%	19%	19%	20%	20%
97%	14%	14%	15%	15%	16%	16%	16%	17%	17%	18%	18%	19%	19%	19%	20%	20%
98%	14%	14%	15%	15%	16%	16%	17%	17%	17%	18%	18%	19%	19%	19%	20%	20%
98%	14%	14%	15%	15%	16%	16%	17%	17%	17%	18%	18%	19%	19%	20%	20%	20%
98%	14%	15%	15%	15%	16%	16%	17%	17%	17%	18%	18%	19%	19%	20%	20%	20%
99%	14%	15%	15%	15%	16%	16%	17%	17%	18%	18%	18%	19%	19%	20%	20%	21%
99%	14%	15%	15%	15%	16%	16%	17%	17%	18%	18%	18%	19%	19%	20%	20%	21%
100%	14%	15%	15%	16%	16%	16%	17%	17%	18%	18%	19%	19%	19%	20%	20%	21%
100%	14%	15%	15%	16%	16%	16%	17%	17%	18%	18%	19%	19%	19%	20%	20%	21%

The financial situation of BMLWE – yet not comfortable in 2019 – is now critical.

It is mandatory to adopt a realistic tariffs policy, together with the necessary efforts to improve the Revenue Water and Collection rates. Figure C 3-1 shows the required tariff for Opex recovery, for various scenarios.

Assuming unchanged Collection and Subscriptions rates

Cost recovery rate	14%	20%	27%	33%	40%	47%	53%	60%	67%	73%	80%	87%	93%	**100%**
Tariff increase factor	1	1.49	1.98	2.47	2.96	3.45	3.94	4.44	4.93	5.42	5.91	6.40	6.89	**7.38**

Required bill amount for 100% Cost recovery : 2 580 000 LBP

Assuming 100% Collection; Subscriptions unchanged

Cost recovery rate	20%	26%	32%	38%	44%	51%	57%	63%	69%	75%	81%	88%	94%	**100%**
Tariff increase factor	1	1.31	1.63	1.94	2.26	2.57	2.89	3.20	3.52	3.83	4.15	4.46	4.78	**5.09**

Required bill amount for 100% Cost recovery : 1 780 000 LBP

Assuming 100% Collection and Subscriptions

Cost recovery rate	21%	27%	33%	39%	45%	51%	57%	63%	70%	76%	82%	88%	94%	**100%**
Tariff increase factor	1	1.29	1.59	1.88	2.17	2.47	2.76	3.05	3.35	3.64	3.93	4.23	4.52	**4.81**

Required bill amount for 100% Cost recovery : 1 680 000 LBP

Figure C 3-1 Required tariff revision

C. 3.3 Action for Opex Recovery

Due to the present social and financial situation, it is a fact that the WEs cannot achieve much in regard to improving the Collection and Revenue Water rates.

Figure C 3-2 below gives a possible (and plausible) progress that BMLWE can undertake regarding Collection and Revenue water improvement, in addition to tariff increase, in order to achieve Opex balance within the coming 5 years.

The proposed figures for progressive improvement in Collection and Revenue Water are set after discussion with the financial and technical departments of the WE. These, in their opinion, are realistic figures to be achieved.

Tariff increase requires political consensus in order for the WE to be allowed to gradually increase the tariff to the adequate level.

		Simulated, based on Typical 2022 financial data (see table below)					
	2019	2021	2022	2023	2024	2025	2026
Collection rate	69%	69.00%	74% (+5%)	80% (+6%)	88% (+8%)	96% (+8%)	104% (+8%)
Subscriptions rate	95%	95%	95% (+0%)	95% (+0%)	95% (+0%)	95% (+0%)	95% (+0%)
Tariff increase factor	1.00	1.00	4.30 (+330%)	4.73 (+10%)	5.44 (+15%)	7.16 (+32%)	7.16 (+0%)
Bill amount (for 1 m³/day, gauged)	**349 000 LBP**	**349 000 LBP**	**1 500 000 LBP**	**1 650 000 LBP**	**1 897 500 LBP**	**2 500 000 LBP**	**2 500 000 LBP**
2019 Revenue increase factor	1.00	1.00	4.61	5.48	6.93	9.97	10.80
Cost Recovery	112%	13.55%	62%	74%	94%	135%	146%
Cash flow/Opex Balance	**10 836 M LBP** (7.2 M$)	**-639 739 M LBP** (-32.0 M$)	**-277 854 M LBP** (-13.9 M$)	**-190 421 M LBP** (-9.5 M$)	**-44 783 M LBP** (-2.2 M$)	**259 233 M LBP** (13.0 M$)	**342 502 M LBP** (17.1 M$)
Cash flow/Opex Balance in case unchanged collection and subscription rates	**10 836 M LBP** (7.2 M$)	**-639 739 M LBP** (-32.0 M$)	**-309 080 M LBP** (-15.5 M$)	**-265 988 M LBP** (-13.3 M$)	**-194 887 M LBP** (-9.7 M$)	**-21 801 M LBP** (-1.1 M$)	**-21 801 M LBP** (-1.1 M$)

	Financial data	
	2019	2022
Exchange Rate :	1 500 LBP/USD	20 000 LBP/USD
Diesel cost	850 LBP/litre	19 700 LBP/litre
gazoline cost	25 000 LBP/20 litre	375 000 LBP/20 litre
Transportation :	8 000 LBP/day	64 000 LBP/day
Energy produced from EDL	78% EDL	78% EDL
EDL increase factor :	--	13.0 x 2019 rate
CPI	115	700
Salaries increase factor :	--	2.0 x 2019 rate
OPEX		**739 999 M LBP**

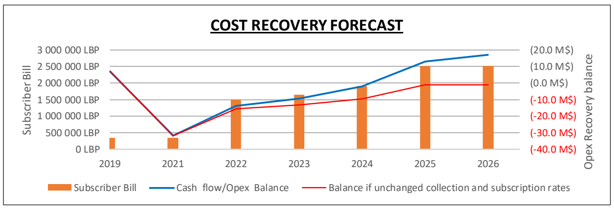

Figure C 3-2 Plausible gradual improvement in order to achieve Opex balance

C. 4 MAJOR RECOMMENDATIONS

In 2021 in the context of hyperinflation, the picture will probably deteriorate with revenues declining and O & M costs up rising.

Financially there is a risk that the public utility to be squeezed and quality of the service deteriorating.

The recovery of the WE is at stake with, first of all, an adjustment to the tariff level and this is to be addressed urgently.

As a result of the financial performance diagnosis, the WE shall take into consideration the following recommendations :

C. 4.1.1 Short term

There is an urgent need to adjust the water tariff level in 2022 to ensure that the WE remain operational in 2022. It is likely that due to the high rate of inflation in 2021, and the exchange rate on equipment and spare parts, operating costs will increase to a level the WEs cannot afford.

- Conduct a study to assess the weak collection efficiency and the inadequate customer records with focus on the reliance on contractual collectors (contract terms, remuneration, number of collectors and performance targets)
- Carry out studies for the assessment of the existing billing and payment processing system and the possibility of the introduction of improved billing technologies, with the view of future integration within a central digitalization system.
- Strengthen the geographic information system mapping to cover the subscribers' data and the records of properties showing all potential water customers.
- Undertake an economic analysis of production and cost taking into consideration the short-run and long-run to allow for a comprehensive pricing strategy that would allow to gradually recover the operational costs and eventually any future capacity expansion.
- Establish a tariff setting scheme and tariff reforms with mechanisms for obtaining the information on present and future costs of operation and mechanisms of indexation to adjust tariffs by inflation, energy prices and other items that are part of the cost schedule of BMLWE.
- Prepare a plan for recovery of outstanding debts. Such issue is to be addressed through an internal task force with possibility to compromise and reduce the debt against a down final payment. Such action's objective is to provide cash to the WE. This will require to produce an historical listing of all debtors and sort them by category and prepare an action plan for that particular purpose. Such difficult action can be made with internal resources of the WE or it can be outsourced.

C. 4.1.2 Mid/long term

- Prepare a standardized format for the annual report for the WE. The design and template should be made available through the TA and a consulting firm is to assist for implementation.
- Review and streamline all financial & bookkeeping procedures and standard chart of accounts through the WE with a long-term view to have the utilities audited by a first rank auditing firm.
- Reinforce in the WE the concept of NRW monitoring together with generalization of production/district metering.

SECTION D
DATA COLLECTED

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D. 1 BASIS AND PRINCIPLES OF DATA COLLECTION

The goal of this assessment is beyond performance evaluation or data collection as it also includes the simulation of a supervisory or regulatory audit and answer the following questions:

- How easily can an audit take place?
- What data is available and what data is not and therefore requires capacity building for improving?
- Which systems are producing good data and which systems need improvement?
- Can the WEs be benchmarked against each other and against international standards?
- Can the sub-regional department within the WE be used as bases of comparison?

Therefore, the process takes the shape of data collection but also investigates:

- Data sources available and systems producing data.
- Reliability and completion of said data.
- Accuracy in producing good targets and performance indicators for the supervisor or regulator.

The range period targeted was mainly the past five years from 2016-2020. However, when possible, data ranges from 2015 were taken. Often the only available information was the current 2021 which sometimes can be used as an estimate for 2020.

Although rarely, some information was available or could be calculated as an annual trend. This trend containing the years 2020 and/or 2021, and given that these years witnessed health and currency crises affecting revenues, power availability, data quality, and even human resources, these years would provide useful information but not one that can represent the past or future of the water establishments.

In the subsequent sub-sections are detailed some common methods used for data collection in different areas.

D.1.1 HUMAN RESOURCES

Human resources and personnel data is vital for evaluating the current performance and planning improvements. However, the WE under examination, the current staffing arrangements do not reflect a normal mode of operation. The WE hasn’t been able to freely hire or fire personnel and make up for this deficiency by promoting the responsibilities of current staff to fill the gap in authority to approve and conduct transactions, while procuring on-demand services to cover the shortage in manpower. Therefore, the analysis would benefit from both evaluating the current personnel situation as well as the situation that was envisioned in the WE by-laws.

The basis for data collection was the IWA water utility performance indicators and the needed variables. To prepare for the analysis in the field of human resources, we set out by seeking at the following data variables as needed for the IWA performance indicators for water supply services as follows:

Table D 1-1 IWA recommended variables related to personnel

Code	Variable	Unit
B1	Total personnel	No.
B2	General management personnel	No.
B3	Human resource management personnel	No.
B4	Financial and commercial personnel	No.
B5	Customer service personnel	No.
B6	Technical service personnel	No.
B7	Planning and construction personnel	No.
B8	Operations and maintenance personnel	No.
B9	Water resources and catchment management personnel	No.
B10	Abstraction and treatment personnel	No.
B11	Transmission, storage and distribution personnel	No.
B12	Water quality monitoring personnel	No.
B13	Meter management personnel	No.
B15	University degree personnel	No.
B16	Basic education personnel	No.
B17	Other qualification personnel	No.
B18	Total training time	Hours
B19	Internal training time	Hours
B20	External training time	Hours
B21	Working accidents	No.
B22	Absenteeism	Days
B23	Absenteeism due to accidents or illness at work	Days
B24	Absenteeism due to other reasons	Days
B25	Working time	Hours
B26	Overtime work	Hours

However, due to the specific situation of the Lebanese WEs, the adjusted table, more in line with the local context, was produced (see Table D 1-2 below).

Since the current personnel situation in the WE is abnormal due to restrictions on hiring, many of the employees are being assigned different jobs than those they were hired for. Reliance on personnel contracts, the by-laws detailing the staff for the WE provide most information that can be assessed to answer the question of: Is the official organizational diagram in accordance to the needs of service and performance?

Table D 1-2 Revised variables related to personnel

Variable	Unit
Total personnel	No.
By business	
Customer services	No.
Distribution	No.
Engineering	No.
Facilities	No.
Finance	No.
General	No.
HR	No.
Water quality	No.
By job type	
Auxiliary - Clerical	No.
Auxiliary - Driver	No.
Auxiliary - Office boy	No.
Auxiliary - Guard	No.
Collector / Reader	No.
Customer Service	No.
Financial / Administrative	No.
Management	No.
Management (Eng.)	No.
Technical - Driver	No.
Technical - Engineer	No.
Technical - Labourer	No.
Technical - Other	No.
Technical - Water Quality	No.

D.1.2 TECHNICAL DATA

Technical data needed relates to water system assets as well as operational variable related to water loss, energy use, and water quality. The basis for data collection was again the IWA water utility performance indicators and the needed variables. However, changes were made to accommodate the lack of data as well as the particulars of the situation in Lebanon. We set out to collect variables from several categories.

D. 1.2.1 Water resources

One category of interest is water resources which lists variable recommended by IWA (see Table D 1-3 below)

Also related is the group of physical asset variables related to water systems (see Table D 1-4 below).

Table D 1-3 IWA recommended variables related to water resources.

Code	Variable	Unit
A01	Annual yield capacity of own resources	m^3
A02	Maximum allowance of raw and treated water importation	m^3
A03	System input volume	m^3
A04	Maximum water treated daily	m^3/day
A05	Exported raw water	m^3
A06	Water produced	m^3
A07	Exported treated water	m^3
A08	Billed metered consumption	m^3
A09	Billed unmetered consumption	m^3
A10	Billed authorised consumption	m^3
A11	Unbilled metered consumption	m^3
A12	Unbilled unmetered consumption	m^3
A13	Unbilled authorised consumption	m^3
A14	Authorised consumption	m^3
A15	Water losses	m^3
A16	Unauthorised consumption	m^3
A17	Metering inaccuracies water losses	m^3
A18	Apparent losses	m^3
A19	Real losses	m^3
A20	Revenue water	m^3
A21	Non-Revenue water	m^3
A22	Reuse supplied water	m^3

Table D 1-4 IWA recommended variables related to physical water assets.

Code	Variable	Unit
C01	Raw water storage capacity	m^3
C02	Treated water storage capacity	m^3
C03	Daily treatment capacity	m^3
C04	Pumps	No.
C05	Pumping stations	No.
C06	Pumping stations capacity	kW
C08	Mains length	km
C09	Distribution main length	km
C10	System flow meters	No.
C11	District meters	No.
C12	Pressure meters	No.
C13	Water level meters	No.
C14	On-line water quality monitoring instruments	No.
C15	Control units	No.
C16	Automated control units	No.
C17	Remotely controlled units	No.
C18	Emergency power systems	No.
C19	Signal transmission equipment	kW
C20	Electrical switchgear	No.
C21	Main valves	No.
C22	Isolating valves	No.
C23	Hydrants	No.
C24	Service connections	No.
C25	Average service connection length	m

For the situation at hand, the proposed variables highly match the needs of technical assessment, yet additional details were needed for these categories which is due to its importance for the assessment and the Lebanese WEs and not from any assumptions about the availability of such details.

Table D 1-5 Additional variables related to water resources and water resource assets.

Variable	Unit
Number of water supply systems	No.
Wells	No.
Springs	No.
Dams	No.
Treatment plants	No.
Wells daily production capacity	m^3
Springs daily production capacity	m^3
Dams daily production capacity	m^3

D. 1.2.2 Operation

For the operations side, already partially covered, Table D 1-6 shows the IWA recommended variables related to energy. Yet a simpler and more relevant set of variables was adopted (Table D 1-7).

Table D 1-6 IWA recommended variables related to energy

Code	Variable	Unit
D01	Pumping energy consumption	kWh
D02	Maximum daily pumping energy consumption	kWh
D03	Standardisation factor	m^3x100m
D04	Reactive energy consumption	kVa
D05	Energy recovery	Wh

Table D 1-7 Proposed variables related to energy use

Performance Indicator	Unit
Pumping energy consumption	kWh
Energy consumed from grid	kWh
Energy generated from fuel	kWh
Renewable energy generation	kWh
Energy recovery	kWh

In terms of inspection and maintenance, Table D 1-8 shows the IWA recommended set of variables; while Table D 1-9 shows the and more relevant set adopted.

Table D 1-8 IWA recommended variables related to Inspection & Maintenance

Code	Variable	Unit
D06	Pumping inspection (power of inspected pumps)	kWh
D07	Storage tank cleaning (volume of cleaned tanks)	m^3
D08	Network inspection	km
D09	Leakage control (Length of network in DMAs)	km
D10	Leaks repairs due to active leakage control	No.
D11	Hydrant inspection	No.
D12	System flow meter calibration	No.
D13	Pressure meter calibration	No.
D14	Water level meter calibration	No.
D15	On-line water quality monitoring equipment calibrations	No.
D16	Emergency power systems inspection	kW
D17	Signal transmission equipment inspection	No.
D18	Electrical switchgear inspection	No.
D19	Permanent vehicles	No.
D20	Mains rehabilitation	km
D21	Mains renovation	km
D22	Mains replacement	km
D23	Replaced valves	No.
D24	Service connection rehabilitation	No.
D25	Pumps overhaul (power of overhauled pumps)	kW
D26	Pump replacement	kW
D27	Pump failures	days
D28	Mains failures	No.
D29	Service connection failures	No.
D30	Hydrant failures	No.
D31	Power failures	hour
D32	Water-point failures	No.

Table D 1-9 Proposed variables for inspection and maintenance

Variable	Unit
Pump inspection	No.
System valve inspection	No.
Control valve inspection	No.
Reservoir cleaning	m^3
Network inspection	km
Service connection inspection	No.
Instrument and inspection and calibration	No.
Replaced valves	No.
Mains rehabilitation and replacement	km
Service connection rehabilitation and replacement	No.
System valve rehabilitation and replacement	No.
Control valve rehabilitation and replacement	No.
Pump rehabilitation and replacement	No.
System flowmeter rehabilitation and replacement	No.
Customer flowmeter rehabilitation and replacement	No.
Leaks repaired	No.

D. 1.2.3 Water Quality

The IWA recommended variables related to water quality are highly reverent for this assessment and future performance evaluation. One missing issue is the required number of samples; but this may be set on due time, based on the number of water quality personnel.

Table D 1-10 IWA recommended variables related to water quality

Code	Variable	Unit
D46	Required treated water quality tests carried out	No.
D47	Required aesthetic tests carried out	No.
D48	Required microbiological tests carried out	No.
D49	Required physical-chemical tests carried out	No.
D50	Required radioactivity tests carried out	No.
D51	Treated water quality tests carried out	No.
D52	Water quality tests carried out	No.
D53	Aesthetic tests carried out	No.
D54	Microbiological tests carried out	No.
D55	Physical-chemical tests carried out	No.
D56	Radioactivity tests carried out	No.
D57	Water quality tests required	No.
D58	Aesthetic tests required	No.
D59	Microbiological tests required	No.
D60	Physical-chemical tests required	No.
D61	Radioactivity tests required	No.
D62	Compliance of aesthetic tests	No.
D63	Compliance of microbiological tests	No.
D64	Compliance of physical-chemical tests	No.
D65	Compliance of radioactivity tests	No.

In general, and given the centrality of technical data for the water establishments, estimates were made where possible and useful, and will be indicated as such. For the case of the water balance inputs, a water balance exercise is needed beyond simple calculations to establish reasonable estimates based on different approaches during the analysis.

D.1.3 CUSTOMER SERVICE DATA

Quality of service data covers service continuity, coverage, complaints, speed of service and the like. The quality of service is expected to be the main motivation and mission of the WEs and more generally the public sector as a whole.

The basis for data collection is the IWA water utility performance indicators and the needed variables. However, changes were made to accommodate the lack of data as well as the local specificities. We set out to collect variables from two categories: quality of service and demography.

Table D 1-11 IWA recommended variables related to quality of service

Code	Variable	Unit
F1	Population supplied	person
F2	Population supplied with service pipes	person
F3	Population served by public taps or standpipes	person
F4	Distance from water points to households	m
F5	Public taps and standpipes consumption	m^3
F6	Water points	No.
F7	Operational water-points	No.
F8	Public taps and standpipes	No.
F9	New connections establishment time	day
F10	New connections established	No.
F11	Customer meter installation time	day
F12	New customer meters installed	No.
F13	Connection repair time	day
F14	Connections repaired	No.
F15	Service complaints	No.
F16	Pressure complaints	No.
F17	Continuity complaints	No.
F18	Water quality complaints	No.
F19	Complaints on interruptions	No.
F20	Billing complaints and queries	No.
F21	Other complaints and queries	No.
F22	Written responses	No.

Table D 1-12 IWA recommended variables related to demography

Code	Variable	Unit
E1	Households and business supplied	No.
E2	Buildings supplied	No.
E3	Households and businesses	No.
E4	Buildings	No.
E5	Resident population	person
E6	Direct customer meters	No.
E7	Residential customer meters	No.
E8	Industrial customer meters	No.
E9	Bulk customer meters	No.
E10	Registered customers	customer
E11	Residential registered customers	customer

Also, some operational variables related to customers were recommended yet may not be applicable to the general situation in Lebanon as currently water metering is low.

Table D 1-13 IWA recommended variables related to operation of customer meters

Code	Variable	Unit
D39	Residential customer meter reading frequency	No. / meter
D40	Non-Residential customer meter reading frequency	No. / meter
D41	Bulk customer meter reading frequency	No. / meter
D42	Customer meter readings	No.
D43	Residential customer meter readings	No.
D44	Operational meters	No.
D45	Meter replacement	No.

However, to be better aligned with the objectives of this assessment and the local situation, the following table was selected to represent different aspects of service and the service area.

Table D 1-14 Revised variables related to service

Variable	Unit
Households and businesses (Units)	No.
Resident population	person
Units supplied legally by WE	No.
Units supplied by other entities	No.
Units supplied by illegal connections	No.
Population receiving continuous supply	No.
Time system is pressurised	No.
Average operating pressure	No.
Compliant response time	No.
New connections establishment time	No.
New connections establishment time	No.
Customer meter installation time	No.
Connection repair time	No.
Complaint response time	No.
Billing complaints and queries	No.
Service complaints	No.
Pressure complaints	No.
Continuity and interruption complaints	No.
Water quality complaints	No.
Metered customers	No.

The data collection will rely heavily on systems such as the billing system, client management system, which have been invested in heavily by donors and NGOs

D.1.4 ORGANISATIONAL UNIT RESPONSIBILITY FULFILMENT QUESTIONNAIRE

To assess and compare the outlined work responsibilities for the WE as per their organisational by-laws, a questionnaire was made in Arabic, tailored to the WE situation (See below a sample), that asks each unit if they implement the assigned tasks; and if not or not fully, then explain the perceived reasons.

No.	المسؤوليات	تحت التطبيق؟	الأسباب والنواقص
	مصلحة الموارد البشرية والمشتركين		
	دائرة الموارد البشرية		
	قسم شؤون المستخدمين والتدريب		
1	.درس حاجات المؤسسة من الموارد البشرية.		
2	.اقتراح شروط الاستخدام وسلسلة الرتب والرواتب وملاك المؤسسة, وتعديلاتها بالتنسيق مع سائر وحدات المؤسسة.		
3	.تنظيم المباريات والامتحانات واجرائها.		
4	.تحضير ملفات الاستخدام والترفيع وكل المعاملات العائدة لها.		
5	.تنظيم الملفات الشخصية وتبويبها.		
6	.مسك الاحصاءات العائدة للعاملين في المؤسسة وتحضير معاملات النقل والمكافآت والتأديب وانتهاء الخدمة وسائر المعاملات المتعلقة بشؤونهم الذاتية.		
7	.درس أوضاع المستخدمين وشؤونهم واحتياجاتهم من التدريب المتخصص بما فيها تلك المتعلقة بالحوافز التشجيعية.		
8	.استلام الاجازات الإدارية والمرضية العائدة لكافة المراكز واجراء الاحصاءات المرضية وتسجيلها وحفظها ومتابعتها.		
9	.تحضير جداول اسمية بدوام العاملين وايداعها المديرية العامة.		
10	.وضع جداول بالحضور الفعلي للعاملين وايداعها قسم الرواتب والأجور.		
11	.اصدار نشرات دورية تتضمن المعلومات الفنية والقواعد المتبعة في مراكز المؤسسة وتعميمها عليها.		
12	.إدارة مراكز التدريب والاشراف عليها.		
13	.تنظيم دورات على استعمال أجهزة الوقاية بالتنسيق مع مصلحتي المحطات والمشاريع والتوزيع والصيانة والاستثمار والسهر على صلاحية هذه الأجهزة وفعاليتها.		
14	.اعداد المستخدمين الجدد على ممارسة مهام وظائفهم في ضوء أهداف المؤسسة وطبيعة أعمالها بما في ذلك التدريب على تقديم الاسعافات الأولية.		
15	.تصميم برامج تدريبية متخصصة وإقامة دورات تدريبية دورية للعاملين في المؤسسة بالتنسيق مع كافة الوحدات.		
16	.تأمين معاملات التدريب في الخارج مع مراجع المختصة.		
17	.إدارة وتنظيم مكتبة مركزية لكافة المراجع تتضمن الكتب والمجلات والمطبوعات والمنشورات والأنظمة والبرامج المعلوماتية بالتنسيق مع كافة وحدات المؤسسة.		
18	.متابعة مصادر المعلومات المتعلقة بمهام المؤسسة واقتراح ما هو ملائم ومفيد.		

Figure D 1-1 An example of the organizational job responsibility questionnaire

Since the results of this questionnaire cannot be parametrized, it will serve as information gathering for later stages of the project and for truth-testing proposed improvements and interventions.

D.1.5 ACCOUNTING SYSTEM AND FINANCIAL DATA COLLECTION

D. 1.5.1 Major sources of data for financial analysis: The Trial balance

Many financial, budget, accounting data have been collected from the WE, but it was decided to present the data collected from the *General Ledger* point of view, because these sources are the most detailed source of data for the WE.

All Opex and Revenues of the WE presented in this section were collected from the General Ledger, which represents the record-keeping system for the WE transaction data, with debit and credit account records validated by a trial balance.

A trial balance is a report that lists the balances of all General Ledger accounts of a company at a certain point in time. The accounts reflected on a trial balance are related to all major accounting items, including assets, liabilities, equity, revenues, expenses, gains, and losses. It is primarily used to identify the balance of debits and credits entries from the transactions recorded in the General Ledger at a certain point in time.

The trial balance serves to detect any mathematical errors that occurred in the double-entry accounting system.

The trial balance collected, when fully filled, provide a record of each transaction that took place during the life of the WE. It holds account information that is needed to prepare the financial statements. The WE was asked to provide the last 6 years of data, from 2015 to 2020, in order to make a significant analysis and evaluate the sustainability of the WE based on several historical data.

Transaction data are disaggregated, by type, into accounts for assets, liabilities, owners' equity, revenues, and expenses as listed in the table below

Table D 1-15 Data accounts as per GAAP

1 Assets
11000 Cash
13100 Accounts Receivable
14000 Inventory
14600 Goods Issued Not invoiced
17200 Buildings
17800 Accumulated Depreciation
19000 Deferred Tax assets
2 Liabilities
21000 Accounts Payable
22300 Deferred revenue
23000 Goods Received not purchased
26200 Deferred tax liabilities
3 Equity
31000 Common Stock
4 Revenue
41000 Goods
42000 Services
5 Expenses
51100 Cost of Goods Sold
52500 Other operating expenses
53000 Price difference

It seems that this accounting system were developed some years ago with the USAID, but nobody has been able to confirm it.

The WE is expected to provide the following three major financial statements, as required under GAAP:

- The income statement
  It recaps the revenue earned by a company during the reporting period, along with any corresponding expenses; this includes revenue from operating and non-operating activities, allowing auditors, market analysts, investors, lenders, regulators, and any other stakeholders, to evaluate the company's financial cycle and results. It is sometimes referred to as the Profit and Loss (P&L) statement.

- The Balance Sheet
  It summarizes assets and sets them equal to liabilities and shareholder's equity. The balance sheet is an open snapshot of a company's assets and liabilities at a specific point in time.
  Balance sheets of the WE do not summarize assets correctly, so that even if it is balanced with liabilities, it gives a biased snapshot of the WE.

- The Cash Flow Statement
  It acts as a record of cash as it enters and leaves the company. The cash flow statement is crucial because the income statement and balance sheet are constructed using the accrual basis of accounting, which largely ignores real cash flow. Investors and lenders can see how effectively a company maintains liquidity, makes investments, and collects its receivables.
  The incoming and outgoing cash-flow of the WE seem to be correctly recorded, since WE accounting recording are sometimes audited. WE has to submit an annual budget, in which expenditures are authorized to a maximum amount.

D. 1.5.2 Administrative and budget organisation of the WE

WE is subject to the following legal obligations.

- Administrative budget, showing:
- Expenses as approved by the budget, divided in two chapter
  - Normal expenditure (chapter 1 of the budget, literally translated and referring to Opex)
  - Investment expenditure (chapter 2 of the budget, literally translated and referring to Capex)
- Revenues
  - Operating revenues
  - Non-operating revenues
- The cash balance
- Accounting corrections
- A technical evaluation and a financial evaluation of the establishment's assets,

- A Trial Balance or General Ledger based on accounting system according to GAAP principles
- An annual technical and financial report submitted to the Ministry, approximately in April each year.

D. 1.5.3 General note about Operational Expenditures

Opex are recorder in the Trial Balance under account №5, sorted by type.

However, a number of Opex are not recorded in the accounting system of the WE. This is the case of subsidies (never in cash) from donors and humanitarian associations in the form of supplies (i.e. repairing or replacement of equipment) or consumables (i.e. fuel for generators) to address emergency situations resulting from the current financial crisis and the inability of the WE to perform proper O&M.

As a result, the financial presentation performed herein after for the WE would be biased by these lacks.

D. 1.5.4 Auditing of the WE

The accounts of the WE are subject to:

- Annual internal and external audits. The latter are carried out by third party auditing companies.
- Random Central Inspection controls, coverings technical, administrative and financial aspects. This control has a regulatory dimension, as it concerns the legality of procedures.
- Court of Auditors control, essentially concerning the finances of the establishment.

D.1.6 LEGAL

Law № 221/2000 dated 26 May 2000, rectified by law № 241/2000 dated 7 August 2000 and amended by law № 377 dated 14 Dec 2001, restructured the water sector in Lebanon.

The law created four Regional Water Establishments (based in Beirut, Tripoli, Zahleh and Saida) to consolidate numerous smaller water authorities, having moral personality and financial and administrative independence with the following prerogatives:

1. Each of the Water Establishment handles the following within its field of utilization and competence:
    - Studying, implementing, exploiting, maintaining and renewing water projects to distribute potable and irrigation water and collecting, treating and getting rid of used water, according to the master plan for water and wastewater or upon previous approval by the Ministry to use public water resources or wastewater plant locations or discharge locations for wastewater.

- Suggesting tariffs for potable and irrigation water and discharging wastewater, while taking into consideration the general socio-economic conditions.
- Monitoring the quality of distributed potable and irrigation water and the quality of wastewater on outfalls and waste water discharges.

2. Each WE has his own regulations. The mentioned institutions shall conclude contracts with an auditing company that is in charge of drafting a report on financial statements, closing accounts and internal control system adopted within the institution.

On the administrative level, Article 5 of Law 221/2000 and its amendments states that the public water exploitation establishments are governed by a Board of Directors, including a CEO and six members appointed by decree. The Board is entrusted with establishing all the internal regulations.

The adoption of the Law 221 in 2000 led to the promulgation of a number of by-laws for BMLWE in 2005 as follows:

- Decree 14596 of 14/6/2005 – Rules of procedure
- Decree 14597 of 14/6/2005 – Operating rules amended by Decree 1759 of 16/4/2009
- Decree 14637 of 16/6/2005 – Financial regulations
- Decree 14877 of 1/7/2005 – Staff rules and regulations
- Decree 14915 of 5/7/2005 – Administrative organization

The regulations that were promulgated are identical for the four public establishments, namely: the rules of procedure financial regulations and staff rules and regulations.

The operating rules are the same for the public water establishments of the Bekaa, Beirut and Mount Lebanon, and North Lebanon, the only exception being the operating rules of SLWE. Articles 56 to 86 in the operating rules were not incorporated into the operating rules of SLWE. These articles specifically concern the classification of land, irrigation water users, administrative provisions relating to subscription, contract and duration, delimitation of irrigation perimeters, the increase or reduction of such perimeters, equipment, and the required infrastructure. This is obviously explained by the need to avoid encroaching on the prerogatives of the Litani River Authority in charge of irrigation in certain regions of South Lebanon.

The administrative organization of the public water establishments as promulgated in the decrees differs from one decree to another and is, therefore, not identical.

D. 2 COLLECTED DATA

D.2.1 HUMAN RESOURCES

D. 2.1.1 Human Resources as per By-Law 14913

Bylaw 14915/5 July 2005 (T*he Organisation of Beirut and Mount Lebanon Water Establishment and the Specification of its employees, grades, salary scale, and hiring conditions*) specifies an organisational set-up that can be summarised by the diagram below.

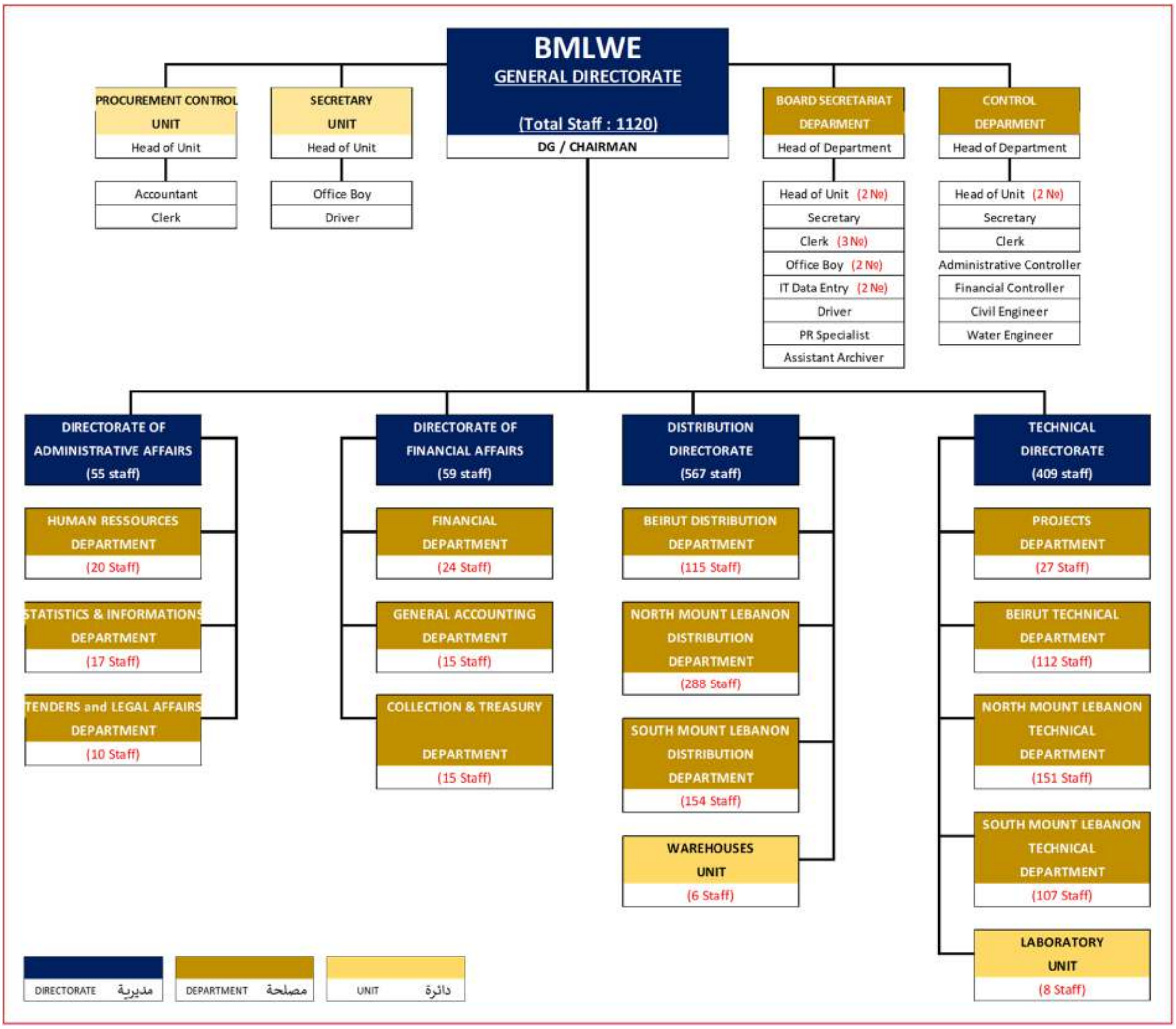

Figure D 2-1 BMLWE General Organigram

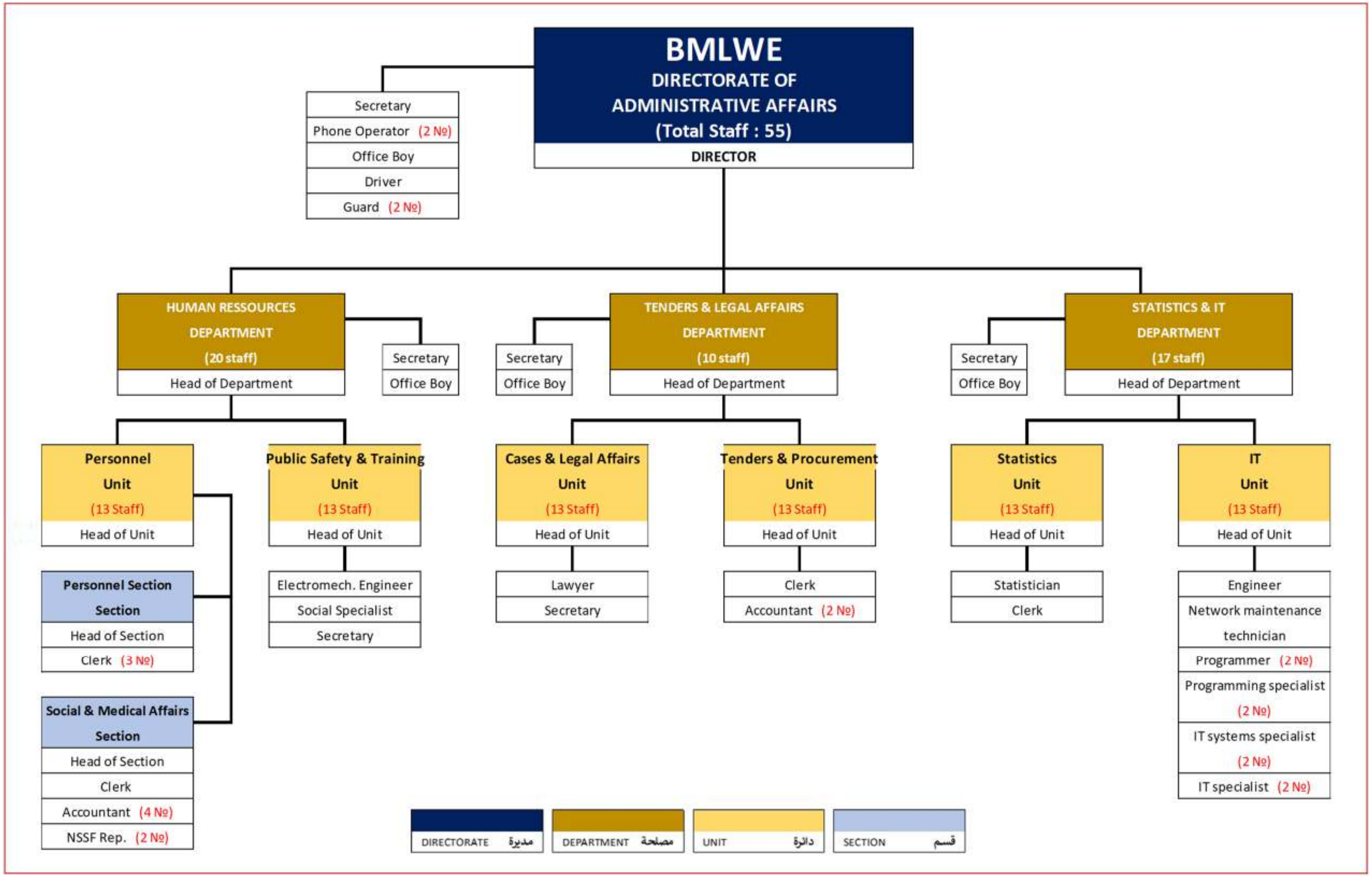

Figure D 2-2 BMLWE Administrative Affairs Organigram

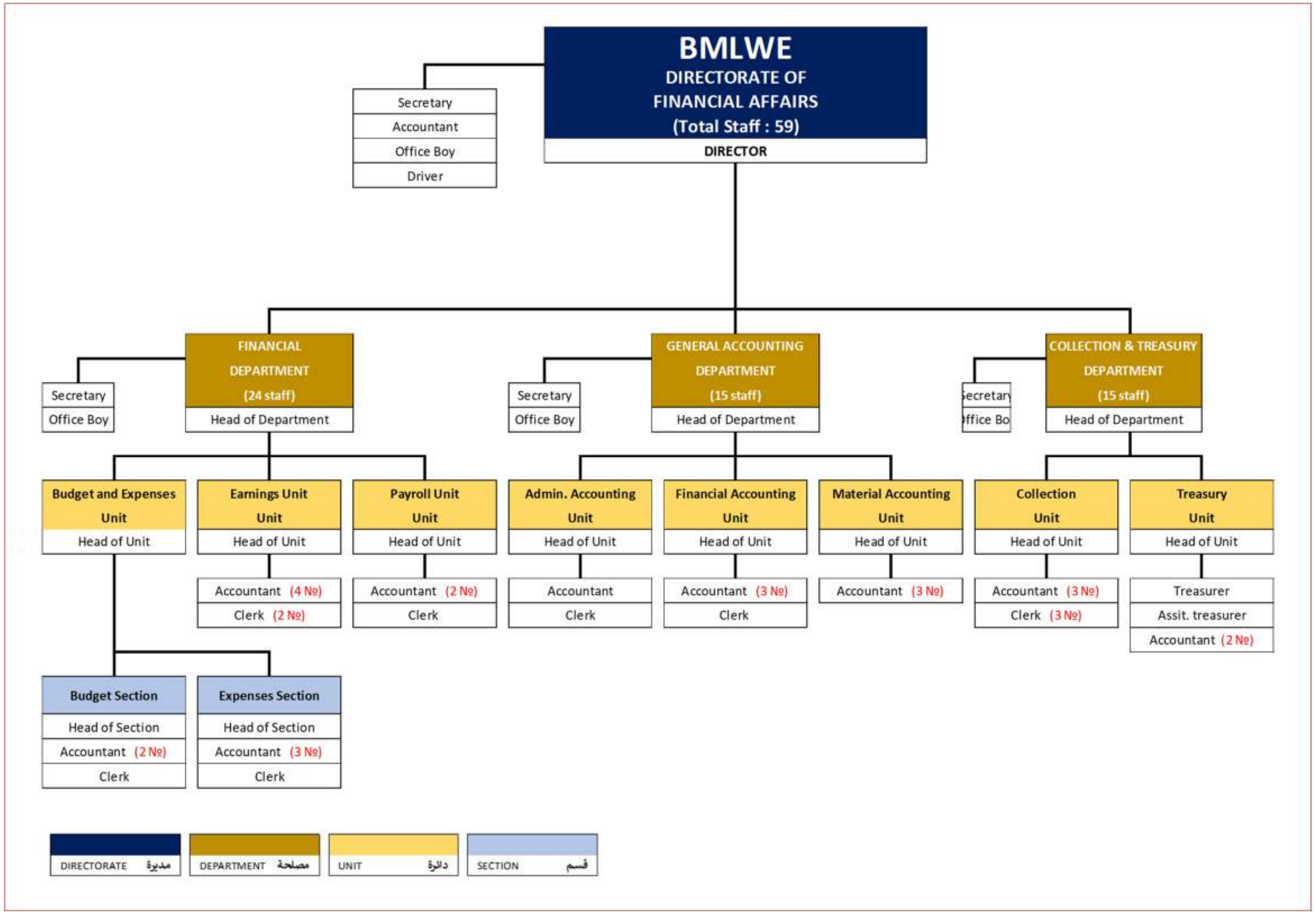

Figure D 2-3 BMLWE Financial Affairs Organigram

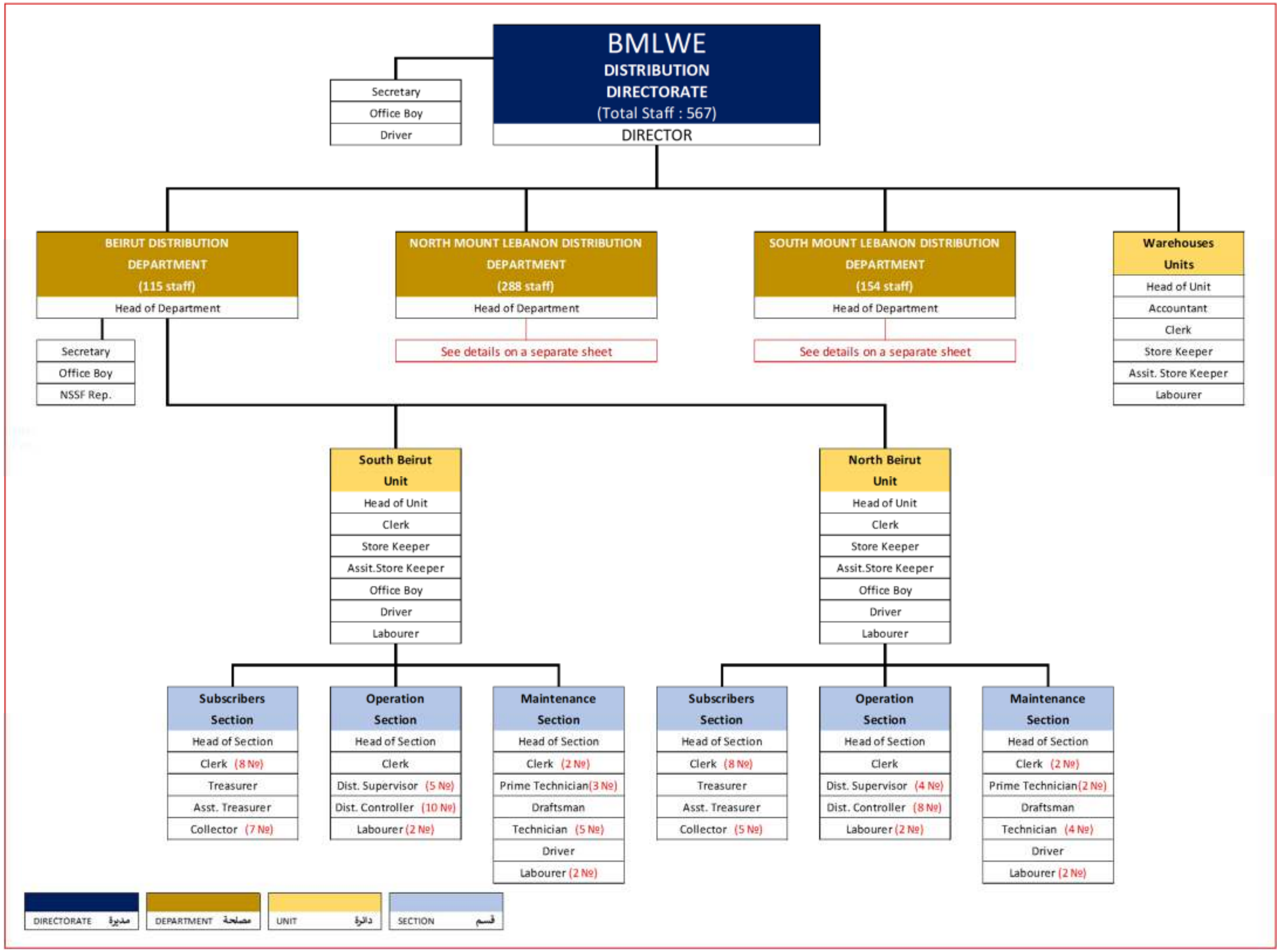

Figure D 2-4 BMLWE Distribution Department-Beirut

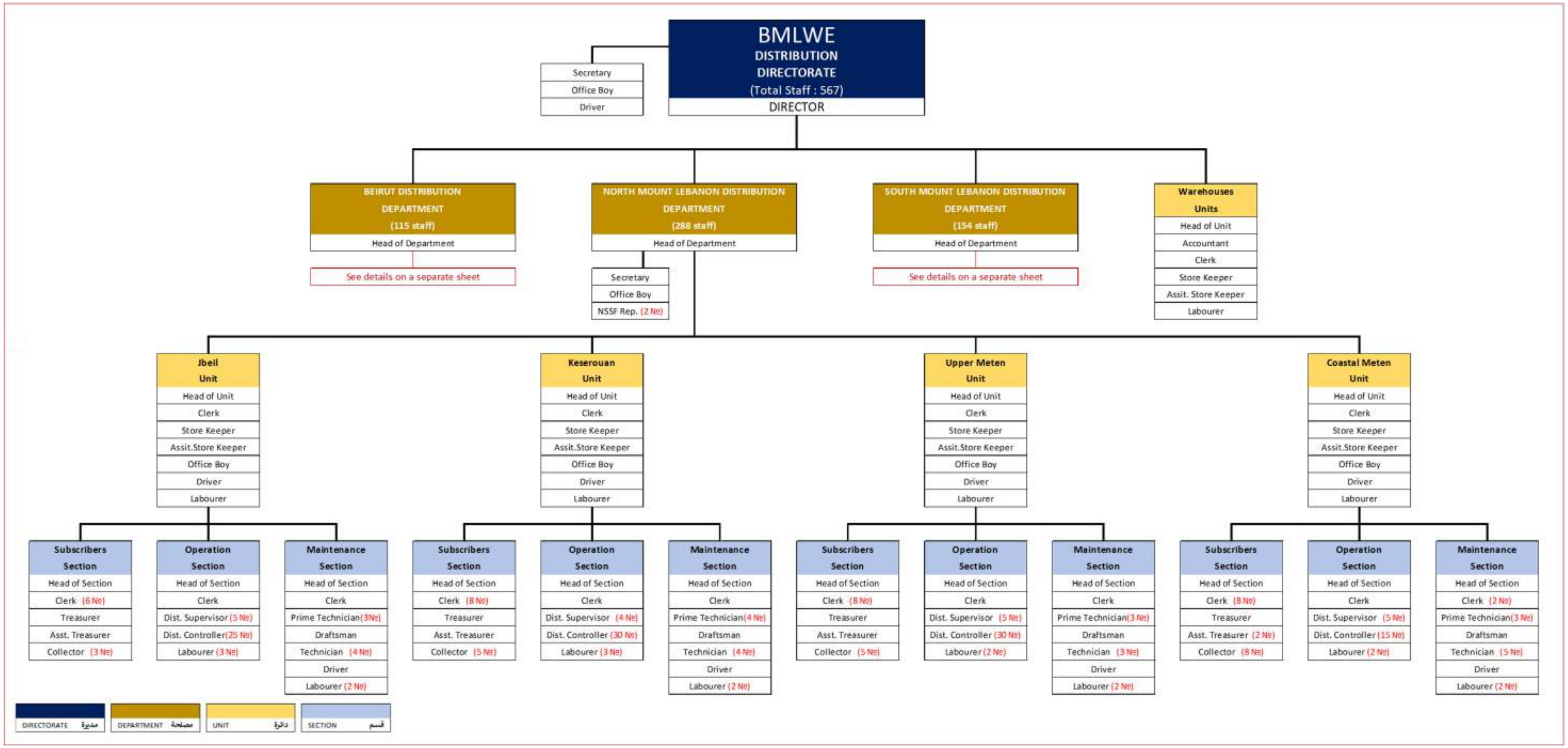

Figure D 2-5 BMLWE Distribution Department-North Mount Lebanon

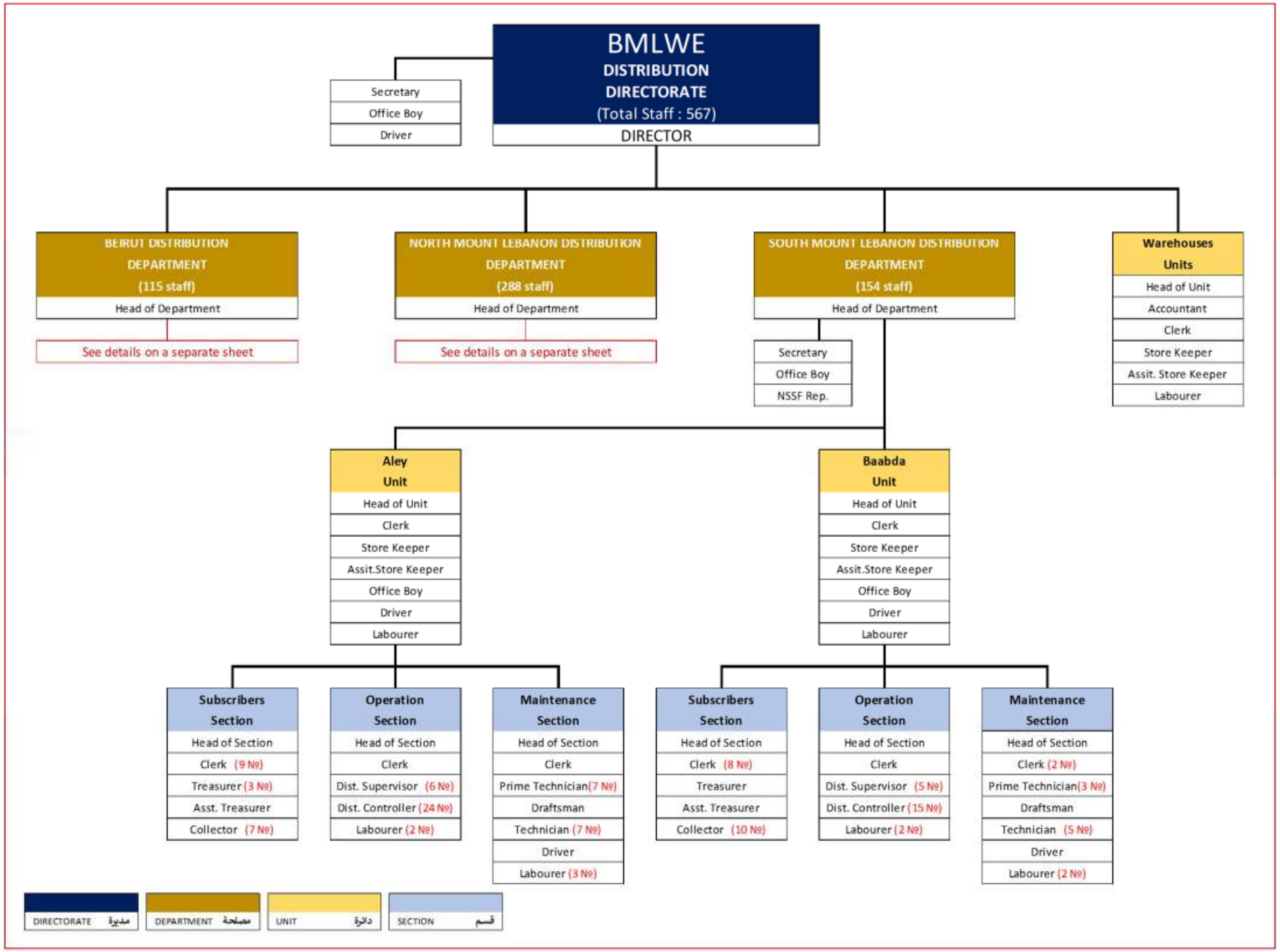

Figure D 2-6 BMLWE Distribution Department-South Mount Lebanon

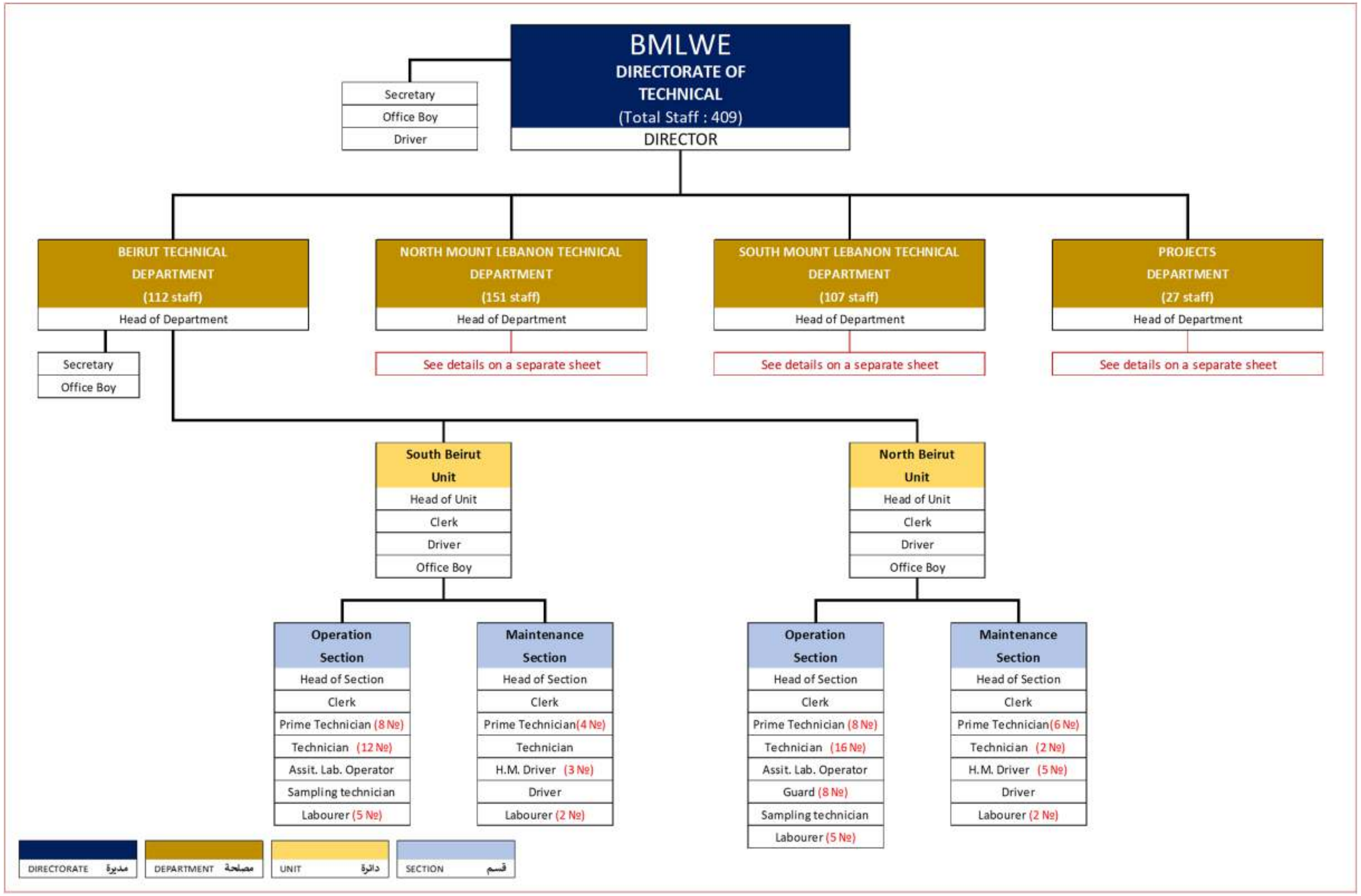

Figure D 2-7 BMLWE Technical Department-Beirut

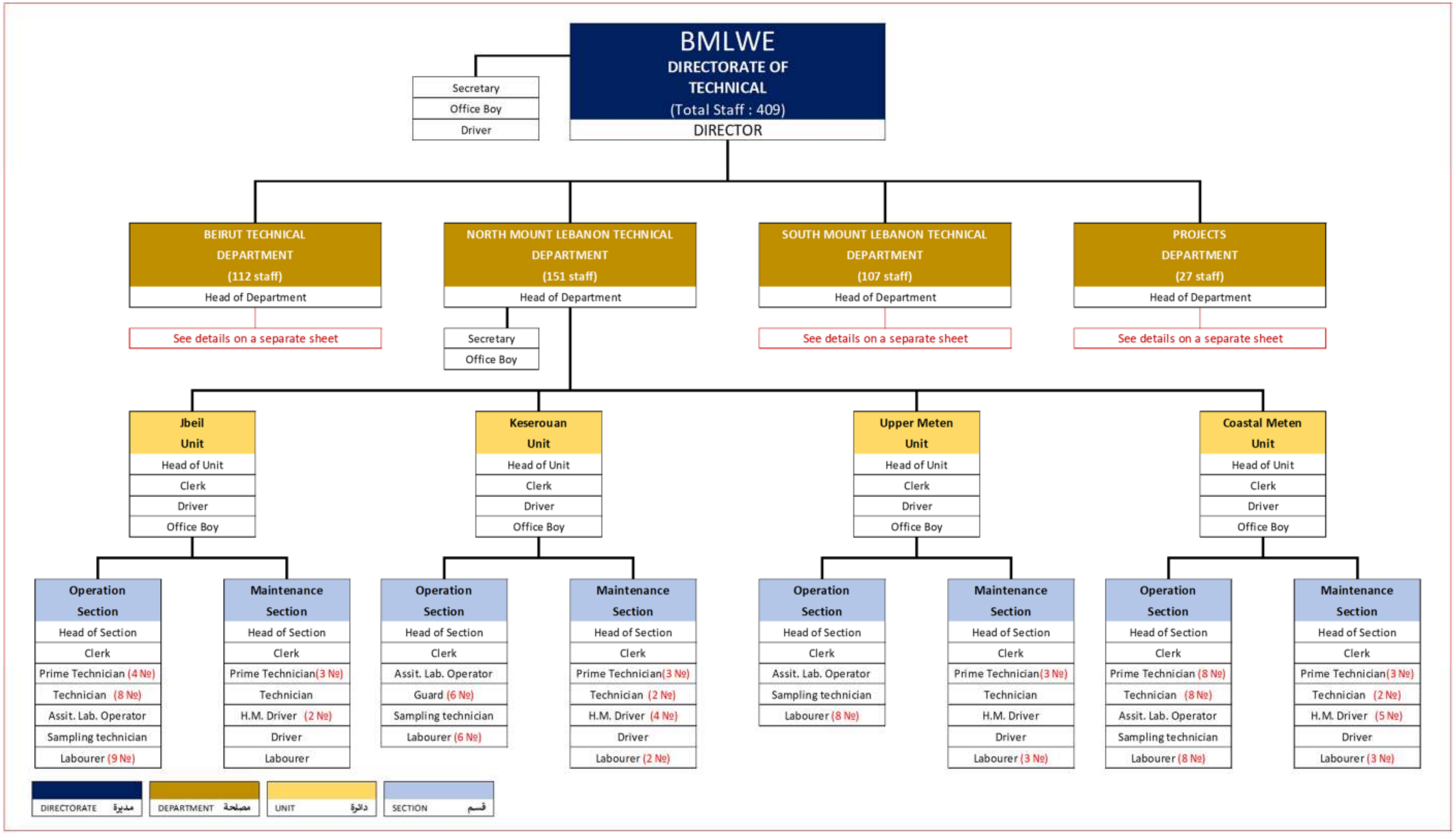

Figure D 2-8 BMLWE Technical Department-North Mount Lebanon

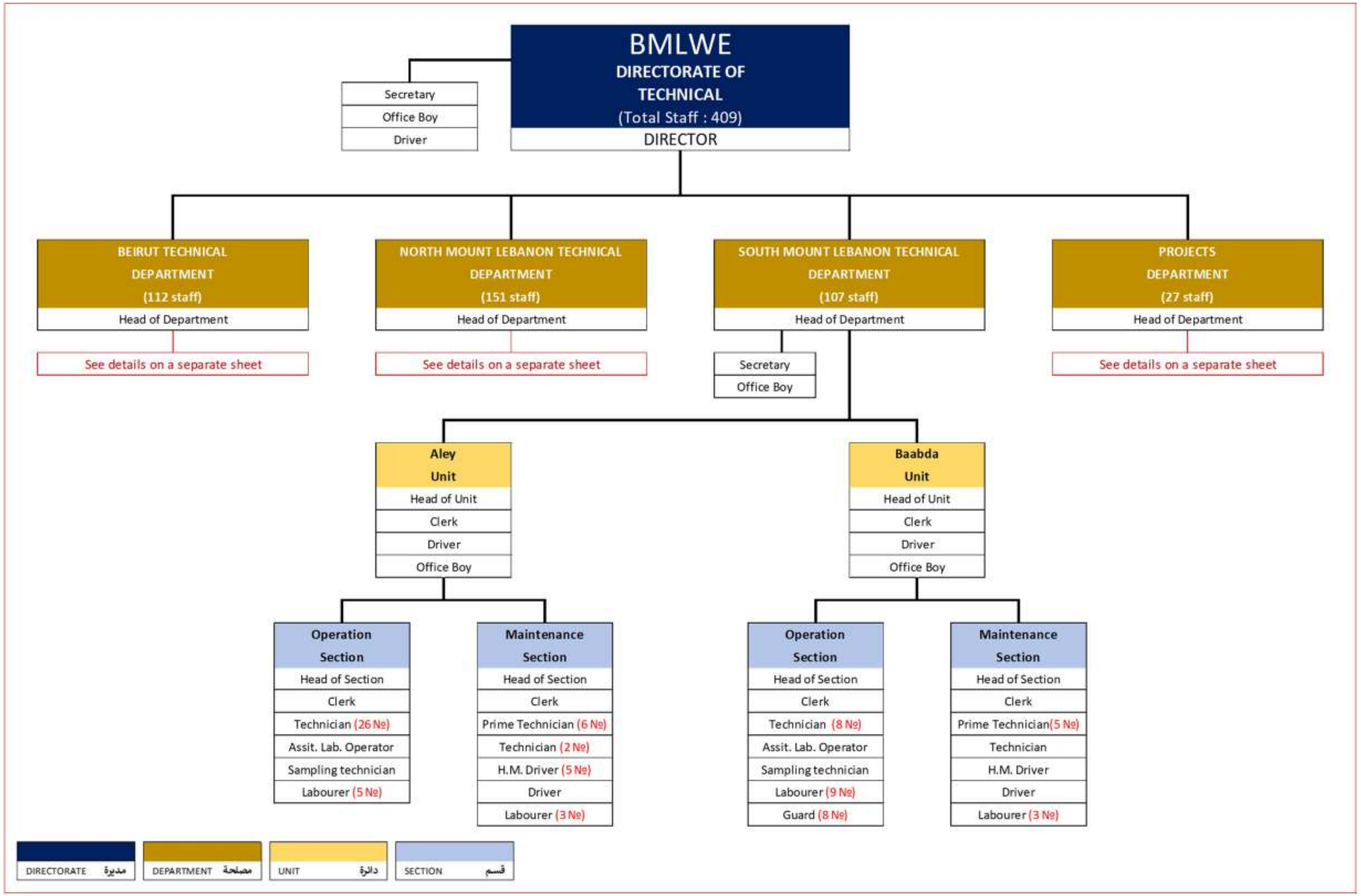

Figure D 2-9 BMLWE Technical Department-South Mount Lebanon

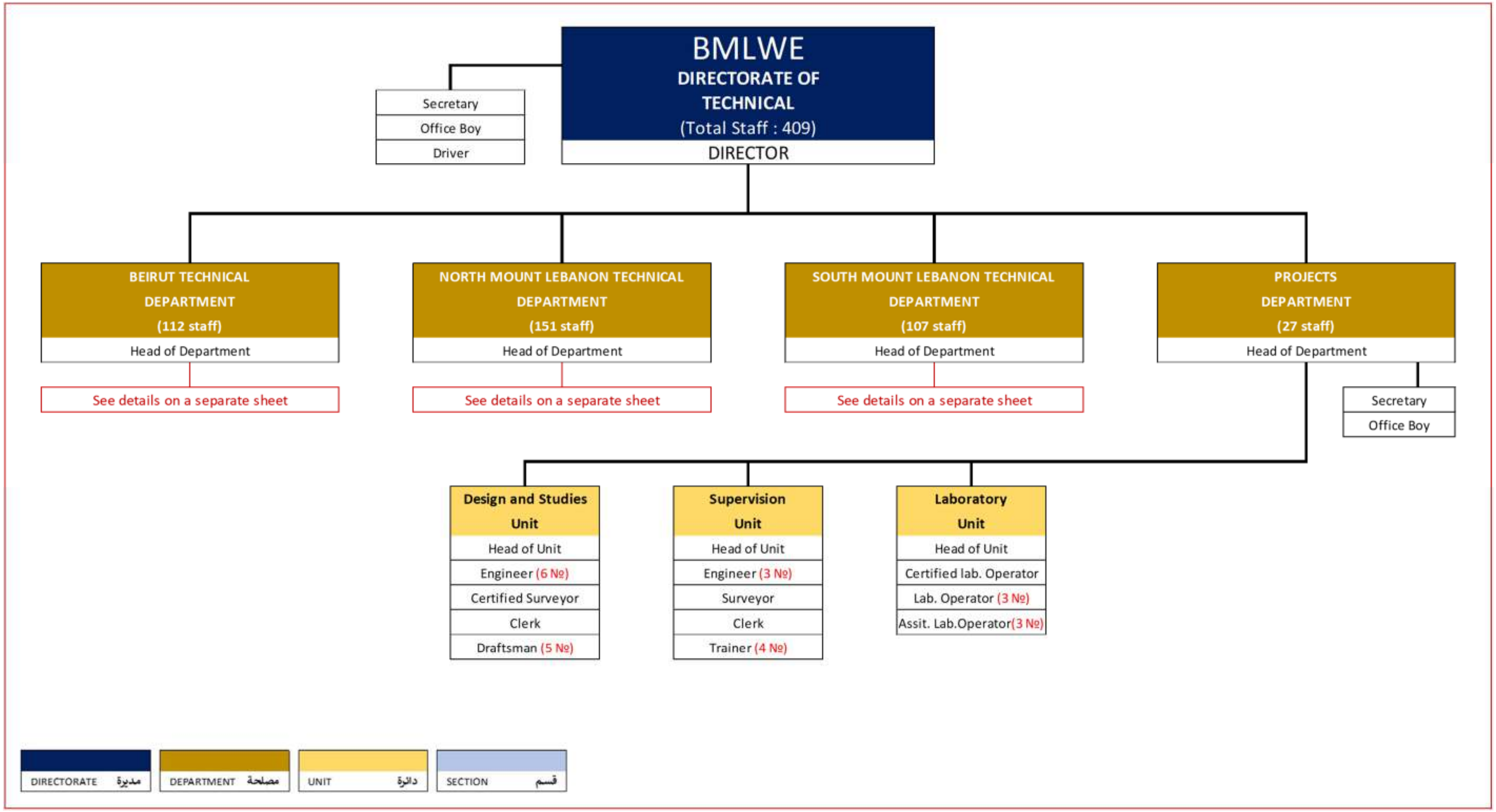

Figure D 2-10 BMLWE Projects Department

Of great interest is the number of staff assigned for each business function, regional department, and job type. This would allow the examination of how the envisioned organizational diagram can serve each and find areas that deviate from optimality. The required numbers of each job title are specified in the attached table of the by-law where the title and number of each position have been provided for BMLWE.

Table D 2-1 BMLWE staff distribution by business area according to BMLWE organizational by-laws.

Row labels	**Central**	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Grand Total**
Distribution	17	83	67	52	59	67	76	66	74	561
Engineering	27									27
Facilities	9	58	46	63	46	39	34	48	27	370
Finance	69									69
General	65									65
HR	20									20
Water quality	8									8
Grand Total	215	141	113	115	105	106	110	114	101	1120

Table D 2-2 BMLWE staff distribution by job type according to BMLWE organizational by-laws.

Row labels	**Central**	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Grand Total**
Auxiliary - Clerical	49	3	3	3	3	3	3	3	3	73
Auxiliary - Driver	6	4	4	4	4	4	4	4	4	38
Auxiliary - Guard	2		8	8			6			24
Auxiliary - Office boy	21	2	2	2	2	2	2	2	2	37
Collector/Reader		7	10	5	7	3	5	8	5	50
Customer Service		12	12	12	12	9	11	12	11	91
Financial / Administrative	48	6	4	4	4	4	4	5	4	83
Management	34	1	1	1	1	1	1	1	1	42
Management (Eng.)	14	6	6	6	6	6	6	6	6	62
Technical - Driver		5	1	5	3	2	4	5	1	26
Technical - Engineer	13									13
Technical - Labourer	1	17	17	12	12	16	14	16	16	121
Technical - Other	20	76.0	43	51	49	54	48	50	46	437
Technical - Water quality	7	2	2	2	2	2	2	2	2	23
Grand Total	215	141	113	115	105	106	110	114	101	1120

The extracted information will enable the analysis of the allocation of staff with comparison to the system size and customers for each regional department as well as BMLWE as a whole.

D. 2.1.2 Human Resources as collected from BMLWE

2.1.2.1 HR Department Information

A summary of employees and contracted staff information was given by the HR department. BMLWE attempted to estimate the different categories of staff as requested based on the IWA. The result was given accordingly and every employee in 2020 was accounted for.

Table D 2-3 Distribution of BMLWE employees by business area in 2020.

Employee business area	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
Total personnel	28	104	45	27	42	55	18	25	42	386
Central management personnel	8	1	1	1	2	1	0	0	0	14
Human resource management	1	0	0	0	0	0	0	0	0	1
Financial	15	10	3	4	2	3	2	7	4	50
Customer service	0	1	2	0	0	0	0	0	2	5
Technical service personnel	4	92	39	22	38	51	16	18	36	316

The same was given in total for previous years.

Table D 2-4 Distribution of BMLWE employees by business area.

Employee business area	2016	2017	2018	2019	2020
Total personnel	505	477	448	420	386
Central management personnel	16	16	16	16	14
Human resource management	1	1	1	1	1
Financial	50	50	50	50	50
Customer service	2	5	5	5	5
Technical service personnel	433	405	376	348	316

Also as requested, an estimate was made for dividing the technical staff into different business areas, however not all technical staff were accounted for. It remains useful to consider the results as an approximate.

Table D 2-5 Distribution of BMLWE employees by specialty in 2020.

Employee per technical business area	**Central**	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Total**
Planning and construction personnel	17	0	0	0	0	0	0	0	0	17
Pump station O&M	0	21	15	6	14	15	6	10	7	94
Treatment plants and wells	8	18	4	6	13	0	0	0	3	52
Network distribution	0	65	25	15	15	39	12	15	31	217
Water quality	1	0	1	0	0	1	0	0	1	4
Meter management personnel	2	0	0	0	0	0	0	0	0	2

And the same was given in total for BMLWE for previous years.

Table D 2-6 Distribution of BMLWE employees by specialty.

Employee per technical business area	**2016**	**2017**	**2018**	**2019**	**2020**
Planning and construction personnel	19	19	19	19	17
Pump station O&M	132	121	115	107	94
Treatment plants and wells	61	59	59	52	52
Network distribution	287	272	249	236	217
Water quality	4	4	4	4	4
Meter management personnel	2	2	2	2	2

The breakdown of employee level of education was also given at a higher accuracy.

Table D 2-7 Distribution of BMLWE employees by education in 2020.

Employee education level	**Central**	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Total**
University degree	28	4	4	2	5	4	4	4	6	61
Basic education	0	10	3	3	6	3	2	7	4	38
Other qualification	0	90	38	22	31	48	12	14	32	287

And the same was given in total for previous years.

Table D 2-8 Distribution of BMLWE employees by education.

Employee education level	2016	2017	2018	2019	2020
University degree	66	66	66	65	61
Basic education	39	39	39	38	38
Other qualification	400	343	343	317	287

Separate from the on-demand contract, a general sum was given for plant operation contracted staff.

Table D 2-9 BMLWE plant operations contracted personnel.

Plant operation contracted personnel	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
2021	0	37	0	0	35	0	5	0	0	77

One of the listed contracted staff is through direct contract. For the on-demand contract, an attempt was made to account for every staff member by business area.

Table D 2-10 Distribution of BMLWE on-demand contracted personnel by job type.

On-demand contracted personnel	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
Total personnel	32	102	102	192		104	154	50	54	790
Central management personnel	2	0	0	0		0	0	0	0	2
Human resource management	0	0	0	0		0	0	0	0	0
Financial	6	0	0	0		0	0	0	0	6
Customer service	12	2	2	6		4	4	6	4	40
Technical service personnel	12	100	100	186		100	150	44	50	742

Again, the staff were also divided by technical business area, yet the results cannot be consolidated with the totals given above.

Table D 2-11 Distribution of BMLWE on-demand contracted personnel by specialty.

On-demand per tech. business area	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
Planning and construction personnel	8	0	0	0		0	0	0	0	8
Pump station O&M	20	30	44	40		45	100	25	15	319
Treatment plants and wells	0	14	8	60		8	8	0	8	106
Network distribution	0	57	49	91		50	39	24	30	340
Water quality	4	1	1	1		1	1	1	1	11
Meter management personnel	0	0	0	0		0	6	0	0	6

The educational level was provided for the on-demand contract.

Table D 2-12 Distribution of BMLWE on-demand contracted personnel by education.

On-demand cont. education level	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
University degree	15	1	1	16		1	2	10	2	48
Basic education	17	5	6	37		4	17	14	3	103
Other qualification	0	96	95	139		99	135	26	49	639

The training hours were documented and provided.

Table D 2-13 BMLWE training hours.

Training hours	2016	2017	2018	2019	2020
Internal training hours	0	0	0	0	0
External training hours	2130	150	1506	1512	618

2.1.2.2 HR Department contracted personnel summary

Summary tables were provided by the HR department that classify the on-demand contracted personnel by job type according to latest summary in 2021. We consolidated the tables into one general table that shows numbers that exceed the values given above for 2020. In addition, 57 contracted personnel serve wastewater facilities that have not been included.

Table D 2-14 Distribution of BMLWE contracted personnel by specialty.

Job type	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
Engineer	15	0	0	2	0	0	0	0	0	17
Experienced graduate	14	3	1	0	0	2	1	1	1	23
Experienced technician	13	0	8	7	5	6	10	4	6	59
Technician	7	15	8	0	3	0	0	4	7	44
Labourer	37	157	79	59	50	112	162	46	57	759
Total	86	175	96	68	58	120	173	55	71	902

Assuming all technicians had basic education, which doesn't have to be the case, we can conclude the education profile.

Table D 2-15 Distribution of BMLWE contracted personnel by education.

Job type	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
University	29	3	1	2	0	2	1	1	1	40
Basic education	20	15	16	7	8	6	10	8	13	103
Other	37	157	79	59	50	112	162	46	57	759
Total	86	175	96	68	58	120	173	55	71	902

D.2.2 TECHNICAL DATA

D. 2.2.1 Water production, transmission, and distribution

2.2.1.1 Data provided from technical departments

Various system information was provided by BMLWE collected from various departments and compiled specifically for the technical assistance. The work spanned months of work and several staff members working across different departments and regions. Given that the data was compiled in such way, the results are evolving and more accurate information can be developed further. However, at present, it provides a good estimation for the objective of the analysis.

A count of water resources and treatment plants by region was updated specifically for the assessment.

Table D 2-16 BMLWE sources and treatment plants.

Resource	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
Wells	128	54	25	14	46	25	18	5	315
Springs	12	5	-	-	3	3	-	6	29
Dams	1	-	-	-	-	1	-	1	3
Treatment plants	1	5	1	-	2	1	-	2	12

The information collected including the names of some springs and treatment plants as follows:

Table D 2-17 BMLWE tapped water sources

Alley	Baabda	North Beirut	Jbeil	Keserwan	Upper Metn
Barouk spring Safa spring Raayan spring Qaa spring Qaysamani spring	Daychounieh spring Ain El Delbeh spring	Fowar Antelias spring Jeita spring Qachqouch spring	Afqa spring El Rweiss spring Qatra spring	Nabaa El Assal spring Moudiq spring Afqa spring Chabrouh dam	Assal spring Manboukh spring Jamajem spring Jouaizat spring Daychounieh spring Jeita spring Bqellaiaa dam

Table D 2-18 BMLWE Water Treatment Plants in service

Alley	Baabda	North Beirut	Jbeil	Keserwan	Upper Metn
Qaysamani	Daychounieh Bdedoun Wadi Chahrour Zhayma Hadath	Dbayeh	Jbeil (Old and New) Nahr Ibrahim	Chabrouh	Daychounieh Bqellaiaa

The production capacity for each type of resource was estimated assuming continuous 24/7 production, as well as the treatment capacity assuming all sources have the sufficient treatment capacity.

Table D 2-19 BMLWE production and treatment full potential capacity.

Production and treatment capacity (m³/day)	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
Wells daily production capacity	125,938	94,704	94,968	26,520	19,584	118,680	32,760	15,240	528,394
Springs daily production capacity	48,336	60,048	140,000	0	57,696	112,800	0	65,280	484,160
WTP daily production capacity	7,200	45,480	65,000	70,000	15,000	60,000	99,000	3,000	364,680
Daily treatment capacity	180,636	199,872	299,968	96,520	92,280	291,480	131,760	83,520	1,377,34

The actual production over the years has been calculated based on metering and estimation, where metering is estimated to be at around 75% of the volume produced. The amounts are detailed for 2020 by region in addition to water supplied for irrigation.

Table D 2-20 BMLWE annual potable water production.

Variable	2016	2017	2018	2019	2020
Production	190,369,035	204,864,280	201,959,245	223,936,990	221,818,895

The production capacity for each type of resource broken-down by region from the year 2017 up to the year 2020 has been also collected as follows:

Table D 2-21 BMLWE daily production from the year 2017 up to the year 2020..

	2017		2018		2019		2020	
	Springs	Wells	Springs	Wells	Springs	Wells	Springs	Wells
Jbeil	21,895	5,921	22,096	5,318	21,466	5,323	22,557	5,374
Kesserwen	67,601	50,762	63,739	44,871	90,222	47,363	95,964	40,805
Maten H.	32,196	7,649	32,804	7,447	41,551	5,188	40,784	5,591
Maten L.	79,614	26,072	75,540	19,641	87,865	6,863	90,513	5,843
Beirut (Nord)	31,808	22,758	37,648	8,273	33,902	25,269	32,790	32,300
Beirut (Sud)	58,409	7,774	62,586	31,184	84,818	17,332	71,038	15,661
Baabda	39,162	33,384	39,588	23,947	54,593	21,390	53,084	22,136
Chouf	15,726	2,967	14,799	3,706	16,197	4,236	17,523	4,134
Iklim	14,877	8,708	15,866	8,660	15,159	9,896	17,041	9,616
Aley	24,925	9,068	26,162	9,438	16,074	8,819	19,447	5,523

The production amounts are detailed for 2020 by region in addition to water supplied for irrigation.

Table D 2-22 BMLWE total production by region in 2020.

Variable	Potable water	Irrigation
Aley	26,749,000	2,410,560
Baabda	27,455,069	60,000
Beirut N.	23,757,773	-
Beirut S.	31,645,132	-
Jbeil	10,194,717	25,228,800
Keserwan	49,920,649	4,726,771
Metn C.	35,170,051	324,000
Metn U.	16,926,684	200,000
Grand Total	**221,819,075**	**32,950,131**

The level of water treatment for each year and region has been collected as follows:

Table D 2-23 BMLWE level of treatment by year.

Supply by treatment level (m³/day)	2016	2017	2018	2019	2020
Water delivered with Chlorination	287,388	287,388	287,388	287,388	287,388
Water delivered with conventional treatment	309,675	309,675	309,675	314,675	314,675
Water delivered with advanced treatment	-	-	4,000	4,000	4,000

Table D 2-24 BMLWE level of treatment by region in 2020.

Supply by treatment level (m³/day)	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
Water delivered with chlorination	68,085	35,839	31,912	16,462	14,854	76,395	6,093	37,748	287,388
Water delivered with conventional treatment	5,000	35,175	33,000	70,000	13,000	60,000	90,000	8,500	314,675
Water delivered with advanced treatment	-	4000	-	-	-	-	-	-	4,000

Using the daily production and billing data provided, non-revenue water can be calculated for each year, if cannot be accurately calculated by region either due to uncertainty over water export quantities from one region to another, or due to billing estimates being higher than actual consumption and sometimes higher than production.

Table D 2-25 BMLWE non-revenue water by year.

Quantity (m³/day)	2016	2017	2018	2019	2020
Production	521,559	561,272	553,313	613,526	607,723
Billing	519,160	530,170	534,234	545,746	554,749
Billing with metering	139,591	143,722	148,755	152,236	155,126
Billing without metering	379,569	386,448	385,479	393,510	399,623
Non-Revenue water	2,399	31,102	19,079	67,780	52,974

An updated count was made of supply systems, reservoirs, and pump stations as follows:

Table D 2-26 BMLWE transmission system components.

Length of mains (km)	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
Pumping stations capacity (kW)	10,323	8,815	20,876	3,088	3,832	8,408	5,583	13,286	74,211

The storage capacity for raw water (dams) and treated water was also updated as follows:

Table D 2-27 BMLWE storage capacity.

Storage capacity m³	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Total**
Raw water storage capacity	1,092,000	0	0	0	0	9,300,000	0	408,000	10,800,000
Treated water storage capacity	160,085	64,715	44,860	46,050	32,205	106,984	20,885	38,066	513,850

And the pumping power capacity was given as follows:

Table D 2-28 BMLWE pumping power capacity.

Length of mains (km)	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Total**
Pumping stations capacity (kW)	10,323	8,815	20,876	3,088	3,832	8,408	5,583	13,286	74,211

As well as the length of mains divided into transmission and distribution:

Table D 2-29 BMLWE length of mains.

Length of mains (km)	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Total**
Mains length total	3,384	889	540		1,351	1,550	627	1,142	9,484
Transmission main	848	77	77		260	312	72	176	1,823
Distribution main	2,536	812	463		1,090	1,238	555	966	7,661

Network extensions for 2019 and 2020 showed a significant length of pipe added to the network in both years which amounted to approximately 2% for each of these years.

Table D 2-30 BMLWE new network extensions.

Network extensions	**Aley**	**Baabda**	**Beirut N.**	**Beirut S.**	**Jbeil**	**Keserwan**	**Metn C.**	**Metn U.**	**Total**
2,019	71,161	16,477	-	1,403	44,931	31,800	3,110	11,359	182,260
2,020	29,523	150	-	32	50,149	132,503	3,148	107	217,632

The number of bulk meters and other measuring instrumentation was given as follows:

Table D 2-31 BMLWE instrumentation.

Measuring devices	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
System flow meters (total)	151	151	86	58	240	151	151	89	1,077
District flow meters	0	0	15	0	0	15	12	23	65
Pressure meters	0	59	4	16	4	37	28	27	175
Water level meters	3	54	4	16	0	41	27	24	169
On-line water quality instruments	0	0	0	0	0	0	0	0	0

Information about the level of automation was collected. main facilities units were considered as the total number of plants to be automated and connected to SCADA. Automation refers to both when local and remote automation. The number of main facilities was estimated using the number of individual power panels and therefore may be underestimated for neglecting the yet unpowered facilities where reservoirs and main valves are located.

Table D 2-32 BMLWE facility automation.

Control and SCADA	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
Main facilities	858	165	43	26	360	229	67	94	1,842
Automated facilities	496	116	36	21	191	122	49	57	1,088
Remotely controlled facilities	0	35	5	16	0	26	28	10	120

The number of isolating valves was also collected and updated, giving the total number as well as the main valves at facilities.

Table D 2-33 BMLWE system valves.

Measuring devices	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
Isolating valves	5,099	5,129	195	2,853	3,244	3,462	3,063	2,618	25,663
Plant isolating valves	1,059	650	195	83	595	901	294	495	4,272

D. 2.2.2 Operation and Maintenance

A detailed sheet was given for working vehicles in each region.

Table D 2-34 BMLWE working vehicles.

Vehicles	Central	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
2021	17	26	7	6	9	11	3	6	1	86

Detailed maintenance cases such as failures, preventive maintenance and corrective maintenance work orders were not available. The plants department kept information that is several years old on spreadsheets yet this has not been practiced for more than five years.

D. 2.2.3 Water Quality

Table D 2-35 BMLWE water quality tests and compliance by year.

Scope	Variable	2016	2017	2018	2019	2020
Total	Water quality tests carried out	22,143	22,601	20,885	20,048	5,114
	Wastewater quality tests carried out	3,792	3,791	3,791	3,791	3,792
Performed	Treated water quality tests carried out*	22,143	22,601	20,885	20,048	5,114
	Aesthetic tests carried out	1,982	2,348	2,433	2,641	392
	Microbiological tests carried out	18,179	17,905	16,019	14,766	4,330
	Physical-chemical tests carried out	1,982	2,348	2,433	2,641	392
	Radioactivity tests carried out	0	0	0	0	0
Required by standard	Water quality tests required*	24,204	24,204	24,204	24,204	24,204
	Aesthetic tests required	648	648	648	648	648
	Microbiological tests required	22,908	22,908	22,908	22,908	22,908
	Physical-chemical tests required	648	648	648	648	648
	Radioactivity tests required	576	576	576	576	576
In compliance with standard	Compliance of water quality tests	22,143	22,601	20,885	20,048	5,114
	Compliance of aesthetic tests	1,982	2,348	2,433	2,641	392
	Compliance of microbiological tests	18,179	17,905	16,019	14,766	4,330
	Compliance of physical-chemical tests	1,982	2,348	2,433	2,641	392
	Compliance of radioactivity tests	0	0	0	0	0

** NB: Quality tests are the tests carried out for different parameters required according to Lebanese standards in water quality testing.*

The figures given for the required quality tests is based on an exercise done in 2016 and has not been updated since then with the new production capacities and new numbers of facilities.

Table D 2-36 BMLWE water quality tests and compliance by region for 2020.

Scope	Variable	Aley	Baabda	Beirut and Metn C.	Jbeil	Keserwan	Metn U.	Total
Total	Water quality tests carried out	0	0	0	0	0	0	5,114
	Wastewater quality tests carried out	84		3,708				3,792
Performed	Treated water quality tests carried out	70	36	3,422	703	454	429	5,114
	Aesthetic tests carried out	0	6	236	43	42	65	392
	Microbiological tests carried out	70	24	2,950	617	370	299	4,330
	Physical-chemical tests carried out	0	6	236	43	42	65	392
	Radioactivity tests carried out	0	0	0	0	0	0	0
Required by standard	Water quality tests required	2,832	2,688	11,076	2,928	2,712	1,968	24,204
	Aesthetic tests required	168	108	168	60	108	36	648
	Microbiological tests required	2,496	2,472	10,740	2,808	2,496	1,896	22,908
	Physical-chemical tests required	168	108	168	60	108	36	648
	Radioactivity tests required							576
In compliance with standard	Compliance of water quality tests	70	36	3,422	703	454	429	5,114
	Compliance of aesthetic tests	0	6	236	43	42	65	392
	Compliance of microbiological tests	70	24	2,950	617	370	299	4,330
	Compliance of physical-chemical tests	0	6	236	43	42	65	392
	Compliance of radioactivity tests	0	0	0	0	0	0	0

The numbers listed as being in compliance are the same as the tests performed. This has been explained as each test listed being representative of a process of evaluation that may involve more than one test. If the first test is outside the acceptable range, actions are taken and the test is repeated until the issue has been resolved.

D.2.3 CUSTOMER SERVICE

D. 2.3.1 Subscribers

2.3.1.1 Subscription Reports

BMLWE provided the system output summaries for the number of subscribers in each regional department, and the number of metered subscribers by year

Table D 2-37 BMLWE subscribers.

Subscribers	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Total
2018	50,799	47,307	27,917	44,656	18,920	54,796	80,231	48,878	373,504
2019	52,504	48,524	28,301	45,062	19,509	55,689	81,730	49,987	381,306
2020	54,025	49,125	28,399	45,245	20,088	56,476	82,392	51,413	387,163

The total number of metered subscribers was given. It was reported that only 12007 of them in Keserwane in specific are being metered and billed according to metering.

Table D 2-38 BMLWE metered subscribers.

Year	Meters
2016	19,163
2017	19,700
2018	20,544
2019	21,143
2020	21,756

In detail, the distribution of metered subscribers in 2019 was also provided, showing the 12007 operational customer meters in Keserwane.

Table D 2-39 BMLWE metered subscribers by region.

Metered subscribers	Aley	Baabda	Beirut N.	Beirut S.	Jbeil	Keserwan	Metn C.	Metn U.	Grand Total
2021	498	925	1586	4012	457	12007	1184	474	21143

D. 2.3.2 Service coverage

BMLWE reported full coverage with the exception of the following locations being operated by local municipalities:

Table D 2-40 Locations operated by local municipalities.

#	Name of the locality
1	Aammatour
2	Aaynab
3	Ain Zhalta
4	Arsoun
5	Baaqline
6	Bdadoun
7	Beit Ed Din
8	Blaybel
9	Bsous
10	Chabaniyeh
11	Damour
12	Deir el Qamar
13	Deir Qoubel
14	Faraya
15	Fraydis (Chouf)
16	Hammana
17	Haret Jandal
18	Houmal

#	Name of the locality
19	Jbaa (Chouf)
20	Jeblaya
21	Jouret arsoun
22	Kfar Dibiane
23	Kfar Selouane
24	Kherbet Bisri
25	Khreibeh
26	Moukhtara
27	Niha (Chouf)
28	Ouadi ed Deir
29	Qmatiyeh
30	Qomayel
31	Qraiyeh
32	Richmaya
33	Safa
34	Saoufar
35	Sarhmoul
36	Tarchich

D. 2.3.3 Quality of Service

2.3.3.1 Distribution department complaints and actions

The monthly numbers of complaints and were given representing a collection of complaints and reports.

Table D 2-41 BMLWE monthly complains.

Clains	Clain 2017	Clain 2018	Clain 2019	Clain 2020
January	583	937	775	1092
February	772	1156	956	835
March	427	1045	908	821
April	1039	882	927	541
May	1355	1155	1248	922
June	1539	1052	1580	1367
July	2626	1532	1944	1537
August	2073	1236	1438	1323
September	1341	1300	1402	1948
October	2242	1801	1373	1309
November	1511	1001	1061	1100
December	1072	897	1126	1166
Total	**16,580**	**13,994**	**14,738**	**13,961**

Additionally, BMLWE keeps a number of work orders, or actions implemented.

Table D 2-42 BMLWE monthly responses to complaints.

Actions	2017	2018	2019	2020
January	583	935	771	855
February	772	1152	947	520
March	427	1043	904	635
April	1039	877	908	314
May	1355	1151	1227	596
June	1539	1049	1549	975
July	2626	1524	1910	768
August	2068	1227	1386	518
September	1340	1287	1276	849
October	2239	1739	1159	392
November	1506	952	876	572
December	1070	824	578	568
Total	16,564	13,760	13,491	7,562

In summary, an estimate of the percentage of addressed complaints can be estimated.

Table D 2-43 BMLWE claims and actions.

Year	Claims	Actions	% addressed
2017	16580	16564	99.9%
2018	13994	13760	98.3%
2019	14738	13491	91.5%
2020	13961	7562	54.2%

A general issue that affects complain data is that subscriber grievances are not usually resolved through the call centre complaint channels but through direct contacts. Also, it is expected that the use of the call centre will be more prevalent in the city than in villages. Given the data collected, the following issues are observed:

- Numbers of claims do not differentiate between complaints and reports such as reporting leaks or thefts.
- Numbers of complaints received by the call centre do not represent complaints on the service.
- Type of complaint or report is not specified.
- Response time and job completion time are not specified.

D. 2.3.4 Supply Continuity

2.3.4.1 Production Department

Water supply schedules were provided for most of the service area for some seasons of 2019. The current levels or supply are reportedly in constant decrease due to power availability issues.

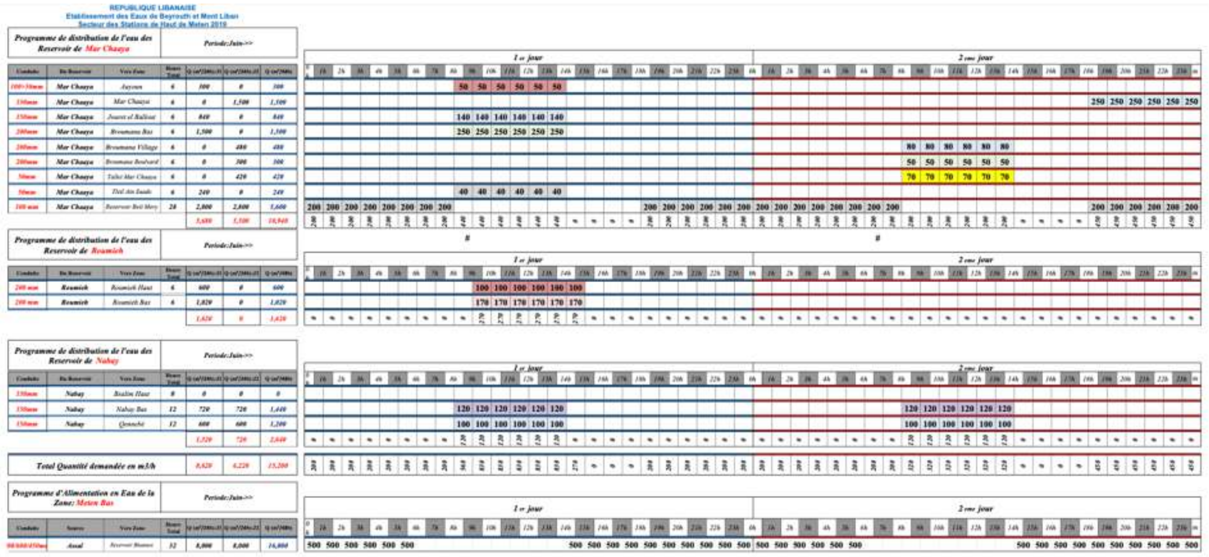

Figure D 2-11 An example of supply schedule for BMLWE showing hours of supply and estimated hourly flow rate within a two-day supply cycle

BMLWE provided detailed schedules for almost the entire system. Based on the hours listed for each network and duration of supply days, we calculated the supply continuity indicator for each regional department and for BMLWE as a whole in the summer of 2019.

Table D 2-44 BMLWE extracted supply continuity in 2019.

Region	Avg. supply duration	Avg. supply quantity	Listed number of networks	Network with 24h h/day or more	Estimated customers with continuous supply
Unit	h/day	m³/day	No.	No.	%
Aley		70,381			
Jbeil	18.0	26,789	127	16	13%
Keserwan	17.2	137,586	110	24	22%
Costal Metn	14.9	94,728	55	8	15%
Upper Metn	13.6	46,739	98	8	8%
South Beirut	9.5	102,150	13	2	15%
Baabda	5.2	75,983	22	2	9%
North Beirut (Achrafieh only)	21.7	59,171	16	13	81%
BMLWE	14.8	613,526	441	73	17%

The 2019 supply schedule represented the month of June and for 80% of BMLWE. The data represented is also an estimate given that the supply hours and the flow rate supplied at each hour are planned and not actual, the reliability is therefore affected further.

For the purpose of reliably monitoring supply continuity, the available information comes with following issues:

- The tables are primarily designed for printing and not for computational purposes.

- The tables are provided in a mix of Excel spreadsheets and PDFs. Not all original Excel files could be located.
- The supplied quantities are presented in estimated allocations even when the actual flow rate is metered.

The goal of using this data is to calculate the performance level for the WE and deviation from benchmark and observe variations over the time and regions. The data was therefore processed to allow calculating the average supply hours for each regional department and for BMLWE overall. Ideally, the base for averaging the individual supply hours should be the number of subscribers or number of connections. However, this would have been problematic since:

- The number of customers are defined at the level of the billing area which does not directly map onto the distribution network.
- The number of current illegal users who are potential future legal users is not proportional to the number of customers in each network.

Therefore, and to ensure consistency of results, the weighted-average calculations were performed on the flow quantities listed for each network.

D.2.4 ECONOMIC AND FINANCIAL DATA

D. 2.4.1 General

For the purpose of the financial performance diagnosis, key data encompassing technical, commercial and financial pieces of information was collected from BMLWE. BMLWE provided the requested data for the period between 2016 to 2020 from the following financial and accounting data sources:

- The tariffs
- Revenues, operating costs and collection rates
- Trial balance
- Financial statements

The objective is then to combine these data, produce some relevant ratios for displaying a clear picture of the situation of the WE.

In the following, a summary of economic and financial key figures is given for BMLWE's total service area.

D. 2.4.2 Operational Expenditures

Expenses covers mainly cost of operation and maintenance that were extracted from the Trial Balance, account number 5, and sorted by type. It is to be noted that a number of Opex are not correctly registered, or not registered at all, in the accounting of BMLWE (See Sub-Section A. 0.5.3). Theses expenditure are recorded under *"Resource accounting"* in the account № 14 of the assets (Trial Balance) sum after BMLWE's Board and MoEW approvals.

Expenses include variables costs as energy and consumables while fixed costs cover the human resources, maintenance of the network, the equipment and the buildings, administrative and office expenditures, Water Purchase, since BMLWE operates a number of private wells leased from the private sector, and financial expenses.

Variable costs are those for Energy and Consumables expenditures.

- Energy is provided from two different sources:
  EDL (invoices partly paid by BMLWE)
  Generators (sensitive to availability/price of fuel)
- Consumables is an account under which are all expenditures that could not fit in other labelled account. Which means that it may contains fixed and variable costs. BMLWE did not provide more details about this account.

Fixed Costs are all costs that do not fall under variable Costs.

- Human resources
  Human Resources are broken-down into Permanent and Non-Permanent staff. Non-permanent personnel are workers hired by private contact.
- Maintenance of the network, the equipment and the buildings,
- Administrative and office expenditures.
- Water Purchase
  BMLWE operates a number of private wells, leased from the private sector
- Financial

The following table shows the overall expenses costs broken-down by type for the period between year 2016 up to year 2020.

Table D 2-45 BMLWE Opex for 2016 to 2020 (Source: BMLWE General Ledger)

	(LBP)				
Year	**2016**	**2017**	**2018**	**2019**	**2020**
Human resources	39,204,792,810	34,505,061,944	47,674,671,921	45,715,298,363	40,487,406,744
Est. Energy (EDL & Generators)*	19,899,277,000	23,682,504,000	21,731,104,000	26,485,618,000	24,884,961,000
Consumables (chlorine and gasoline)	783,073,000	958,386,000	740,642,000	983,362,000	830,126,000
Maintenance	21,950,933,000	15,311,060,000	10,070,963,000	12,297,928,000	9,318,283,000
Admin	3,506,015,760	4,088,352,254	3,631,470,000	3,663,758,000	3,967,916,827
Total Operating cost (excl. Donors input)	**85,344,091,570**	**78,545,364,198**	**83,848,850,921**	**89,145,964,363**	**79,488,693,571**

It can be noted that a number of opex were not assigned correctly and others were not included. The 3 main components of the costs structure are the Human resources, the Energy and the maintenance with respectively in average 50%, 28% and 16% of the total Opex. The total of these components represent 94% of the total O&M costs. Administrative and consumables costs are around 6% in average of the O&M costs.

D. 2.4.3 Revenues

Revenues are generated from water pricing, including water subscription, maintenance services and others services:

Table D 2-46 BMLWE Revenues for 2016 to 2019 (Source: BMLWE General Ledger)

	2016	2017 (LBP)	2018	2019
Water subscription	119,330,197,496	117,092,570,559	118,642,297,322	122,846,508,131
Maintenance	20,962,778,877	21,076,148,996	21,644,880,797	19,015,130,239
Admin & Subscription fees	4,815,363,227	4,157,089,829	4,073,432,631	2,563,952,822
Other services (IT)	1,285,989,068	1,254,617,517	1,309,434,589	1,159,496,238
Grand Total	**146,394,328,668**	**143,580,426,901**	**145,670,045,339**	**145,585,087,430**

Revenues from water pricing, which include Subscription and Maintenance, generate on average 96% of the total recurring revenues of BMLWE. Other revenues come from fees for new subscriptions, fines and penalties.

D. 2.4.4 Tariffs

Different tariff grids are in force at BMLWE: Residential, Commercial and farming, and in particular areas special tariffs ruled by Decree № 8088/1952

2.4.4.1 Residential tariffs

Table below shows the water tariffs in force at BMLWE, which calls for the following comments:

- Non-metered subscribers
  Are charged a yearly lump sum based on a nominal 1 m³/day consumption

- Metered subscribers
  Subscribers are charged:
  - A fixed rate for water subscription, water meter maintenance, automation, connection to the sewer, and automation.
  - A variable amount depending on the metered volume

Presently, these tariffs apply for parts of Keserouan district, namely Aintoura, Ain Rihani, Shaile, Ballouneh, and Ajaltoun. It is expected, in the coming year, to be extended to Achrafyeh and a number of localities in the middle Matn under a USAID funded project), for the following cities/villages.

Table D 2-47 BMLWE residential tariff (2019)

TARIFF for Regular subscriptions (LBP/year)				
	Not connected to WW		Connected to WW	
	Metered	Gauged	Metered	Gauged
Yearly Water subscription for 1 m³/day	321,000	275,000	321,000	275,000
Maintenance	50,000	10,000	50,000	10,000
IT	3,000	3,000	3,000	3,000
Wastewater Subscription	25,000	25,000	40,000	40,000
	399,000	**313,000**	**414,000**	**328,000**
VAT (11%)	43,890	34,430	45,540	36,080
Stamp	1,000	1,000	1,000	1,000
Rounding	110	570	460	920
Bill /Year	**444,000**	**349,000**	**461,000**	**366,000**

2.4.4.2 *Industrial/irrigation tariffs*

There are several tariffs for irrigation, whether the abstraction is by gravity or pumped and a tariff for industrials as shown on Table D 2-48 below.

Table D 2-48 BMLWE water tariff for Industrials and farmers (2019)

	Industrial	Irrigation		
		By Gravity	Lump sum	Pumping
Water subscription	100,000	80,000	100,000	60,000
Maintenance	0	0	0	0
Automation	3,000	3,000	3,000	3,000
Wastewater	0	0	0	0
Fines	0	0	0	0
VAT (11%)	11,330	9,130	11,330	6,930
Stamp	1,000	1,000	1,000	1,000
Rounding	670	870	670	70

2.4.4.3 *Special tariffs based on Decree 8088/1952*

Several water prices are set for specific villages, these prices had been authorized by decree 8088 in 1952, as shown on Table D 2-49 below.

Table D 2-49 BMLWE water tariff for areas covered by Decree 888/1952

(LBP/year)						
	Nabaa el Assal system		**Hrajel**		**Fradis (Barouk)**	
	Metered	**Gauged**	**Metered**	**Gauged**	**1st m^3**	**2nd m^3**
Water subscription	241,000	207,000	281,000	241,000	91,667	366,667
Maintenance	10,000	10,000	10,000	10,000	10,000	10,000
Automation	3,000	3,000	3,000	3,000	-	-
Wastewater	25,000	25,000	25,000	25,000	25,000	50,000
VAT (11%)	30,690	26,950	35,090	30,690	13,934	46,934
Stamp	1,000	1,000	1,000	1,000		
Rounding	310	50	910	310	-	-
Bill /Year	**311,000**	**273,000**	**356,000**	**311,000**	**140,601**	**473,601**

D. 2.4.5 Billing

- The rate of billing is yearly for subscriber with Gauge and per semester for those metered.
- For the billing method, there is an internal software developed by BMLWE.
- There is a data base of billing and updated number of subscribers developed by BMLWE.

D. 2.4.6 Collection

- Method of collection: There is a BMLWE centre in each district where subscriber can pay cash, or they can use OMT service for money transfer. BMLWE has also a team dedicated to indoor collection.
- The number of subscriber and the rate of collection per district for the BMLWE are given in Table D 2-50 below.

Table D 2-50 BMLWE collection rates 2018 to 2020

	Jbeil	Keserwane	Upper Metn	Coastal Metn	South Beirut	North Beirut	Baabda	Aaley Chouf
2018 Subscribers	18 920	54 796	48 878	80 231	44 656	27 917	47 307	50 799
Collection (%)	81	70	81	75	90	88	64	70
2019 Subscribers	19 509	55 689	49 987	81 730	45 062	28 301	48 524	52 504
Collection (%)	66	67	69	69	79	79	70	57
2020 Subscribers	20 088	56 476	51 413	82 392	45 245	28 399	49 125	54 025
Collection (%)	61	60	63	61	68	60	57	47

D. 2.4.7 Capital expenditure

Data in relation with Capex were collected from chapter 2 of the administrative budget of BMLWE. The Capex's data given by BMLWE are for the period from 2016 to 2019. It can be observed that Capex has declined considerably from 35.9 MLBP in year 2016 to 6.7 MLBP in year 2019, presumably in relation to the current financial crisis. However, it is to be noted that this drop in investment spending is to some extent offset by subsidies from a certain number of donors covering sensitive sectors.

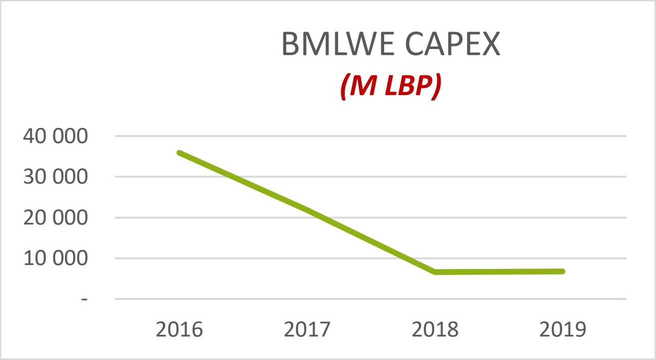

Figure D 2-12 BMLWE Capex

Table D 2-51 below shows the Capex data relating to years 2016 to 2020, as provided by BMLWE.

Table D 2-51 BMLWE Capex

	2016	2017	2018	2019
		(LBP)		
Works	7,952,938,000	12,093,698,000	1,007,503,000	318,819,000
Acquisition	10,857,249,000	66,400,000	1,066,004,000	1,638,332,000
Network	7,122,971,000	573,323,000	533,998,000	272,919,000
Equipment	3,506,851,000	2,725,726,000	846,217,000	230,838,000
Studies and supervision	1,524,894,000	1,413,327,000	1,661,207,000	2,620,791,000
Assets network	2,974,570,000	2,346,644,000	761,955,000	502,415,000
Assets for water	1,432,222,000	2,056,681,000	571,758,000	597,477,000
Administrative Assets	187,109,000	107,335,000	148,386,000	362,859,000
Irrigation				198,634,000
Reservoir	300,240,000	247,959,000	17,167,000	-
Wastewater		185,900,000		-
Grand Total	**35,877,044,000**	**21,816,993,000**	**6,614,195,000**	**6,743,084,000**

Unsurprisingly, it can be observed that Capex has declined considerably from 35.9 MLBP in year 2016 to 6.7 MLBP in year 2019, presumably in relation to the current financial crisis. However, it is to be noted that this drop in investment spending is to some extent offset by subsidies from a certain number of donors covering sensitive sectors. These subsidies, in the form of supplies and consumables (never in cash), are recorded as a lump sum in the general balance account 140 "Materials", and therefore do not appear in the administrative budget.

D. 2.4.8 Assets valuation and depreciation

There is no evaluation of the assets depreciation.

D. 2.4.9 Income statement

BMLWE is due to release a yearly income statement. The following table present the income statement for year 2016 to 2019.

Table D 2-52 BMLWE income statement for year 2016 to 2019

Revenues and Collection	**2016**	**2017**	**2018**	**2019**
	(M LBP)			
Rights arising from various subscriptions, fees and imports	169,018	165,019	165,682	189,444
Recycled rights from previous years	134 459	86,251	94,652	91,266
New releases from previous years	5,426	3,928	9,006	6,966
Funds credited or cancelled	61,732	2,711	16,511	4,825
Total Revenue Receivable	**247,172**	**252,487**	**252,830**	**282,852**
Taken from reserve money				
to feed budget items				
to recover previous budget	86,526	94,736	97,184	94,431
Total Taken from reserve money	**86,526**	**94,736**	**97,184**	**94,431**
Total revenues under collection, including those taken from the reserve money	**333,697**	**347,223**	**350,014**	**377,282**
Arrears since 31-12-2005	86,251	94,652	91,266	121,162
Collected Revenues, including those taken from the reserve money	**247,447**	**252,571**	**258,748**	**256,121**
Expenditures				
Total expenditure - Part 1	74,180	74,448	81,625	85,114
Total expenditure - Part 2	116,063	111,370	98,007	93,798
Total expenditures	**190,243**	**185,818**	**179,632**	**178,913**
Balance				
Balance between Revenues and Expenditure transferred to Reserve money	**57,204**	**66,754**	**79,115**	**77,208**

D. 2.4.10 Financial KPI

No financial data have been provided by the WE.