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

NLWE

North Lebanon Water Establishment

REVISED EDITION

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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
EBITDA	Earnings Before Interest, Tax, Depreciation & Amortization
EDL	Electricité Du Liban
EDK	Electricité De Kadischa
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. This 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 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 NLWE.

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. NLWE provided good insights over data management issues.

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 2019 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 endeavor surely requires, as a prerequisite, the fortification of the Establishment in the following – but not only – fields :

- Strategic vision

  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 a strategic vision.

  NLWE does not have a declared, clear, development strategic vision for the upcoming years, with objectives to reach and a tentative timeframe to reach them.

  This must be defined and the means for its implementation sought.

- Establishment's structure

  The first step is to revise the structure of the WE and set up a new organizational structure in order to support 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 hire; and if so, the official wage scale has become too low to attract applicants. Therefore, the human resources of WEs are slowly depleting.

  The establishment has to be able to retain its human resource by being allowed to hire and to raise the wages to an attractive level.

- 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 endeavor 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 with 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 sewage, the standards of the effluent, storm water disposal, among others, should be attended to by the concerned stakeholders as they fall beyond the mandate of the WEs, but do impact directly on the treatment process.

- Irrigation

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

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

There is 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 and maintenance.

- <u>Water Establishments sustainability</u>

  Water establishments in Lebanon are still non-sustainable.

  All efforts should be invested to transform the establishments into sustainable enterprise within a midrange period. From what has been studied until to date, NLWE 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. NLWE GENERAL OVERVIEW

NLWE serves a geographic area of approximately 1,950 Km² divided, for service and management purposes, into three potable water distribution departments as shown on Figure A 2-1 below. Irrigation services are limited.

The supplied population is around 1,279,800 (2020) with approximately 270 000 housing units, out of which approximately 48% (2020) are subscribed to the water supply service.

The water supply sources of NLWE consist of a combination of 69 wells, 79 pumping stations, 3 treatment plants and 153 springs. The length of the network is 6,000 km with 67,500 connections.

NLWE has the authority and responsibility to provide sewage collection and treatment services. This was traditionally under the responsibility of the municipalities until the enforcement of law 221/2000. However, NLWE is refusing taking over any WWTPs and receiving the ownership of wastewater assets. Therefore, municipalities are still managing the collection networks. CDR has erected a number of wastewater networks and WWTPs and is still operating them for NLWE, which is quite reluctant to take over.

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

Table A 2-1 NLWE overview (2020)

Population	
Estimated population served	1 279 000
Nbr of municipalities	457
Nbr of Housing Units	270 000
Nbr of connections	67 500
Housing units per connection	4
Subscribers (2019)	
Metered subscriber	60 979
Gauged subscribers	67 804
Total subscribers	**128 783**
Rate of metered subscribers	47%
Water production	
Volume produced (Million m^3/Y)	94
Collection rate (%)	50%
Est. NRW rate (%)	48%
Water Resources & Infrastructures	
Nbr of Water Treatment Plants	3
Nbr of Pumping Stations	79
Nbr of Wells	69
Nbr of Springs	153
Nbr of Dams	0
Est. length of the water networks (km)	6 000
Wastewater	
Nbr of Major WWTP in NLWE jurisdiction	
In service (to date all operated by CDR)	4
Under constructio/rehabilitation (by CDR)	5
	9
Length of existing sewer	Not Known
Staffing	
Nbr of actual employees (Permanent + On demand)	604

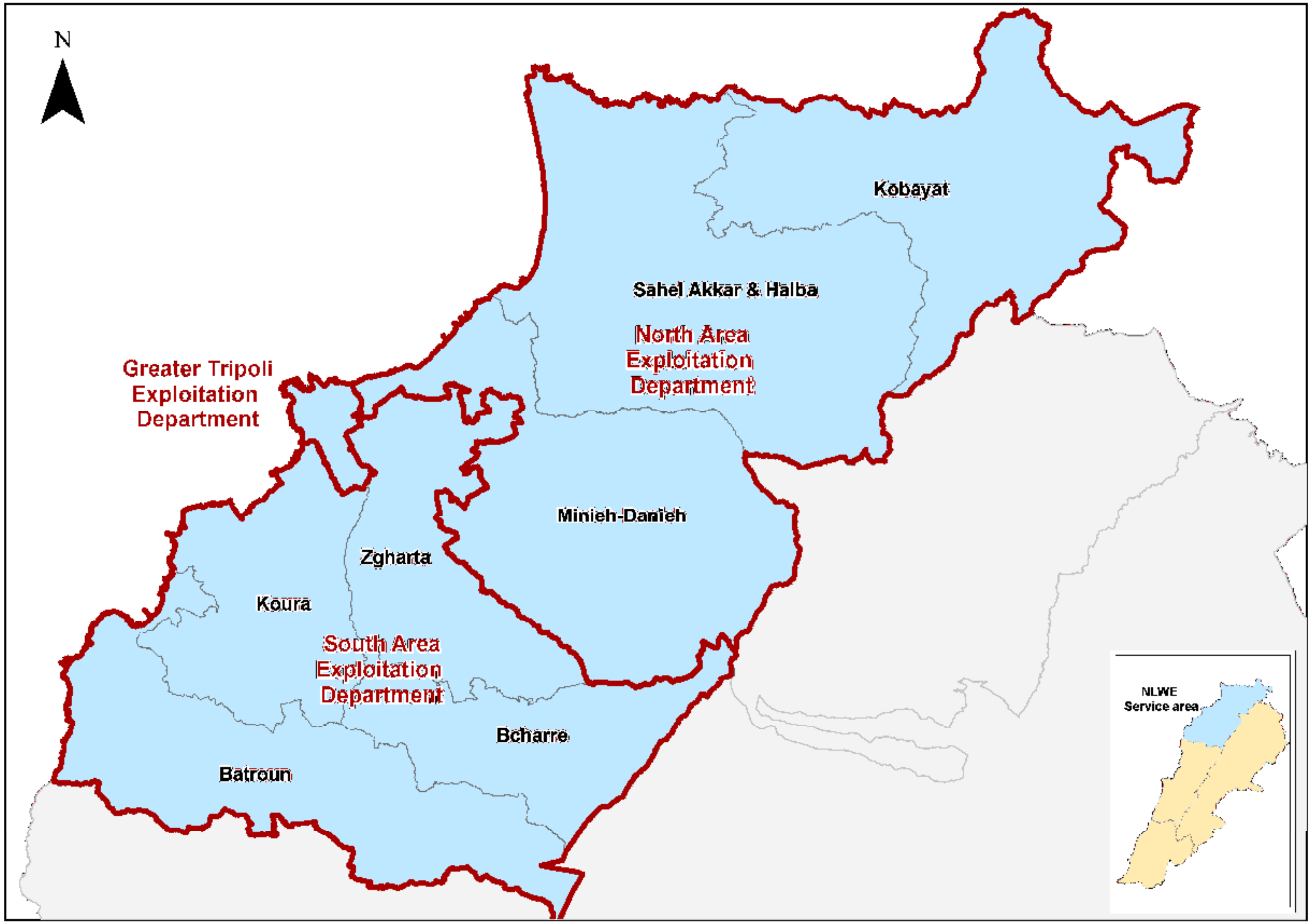

Figure A 2-1 NLWE service are

A.3. PERFORMANCE DIAGNOSIS SUMMARY

A.3.1 HUMAN RESOURCES

3.1.1.1 Legal organisation Chart – Vacant positions

Figure A 3-1 below shows NLWE's organization chart as specified by Bylaw 14913/5 of July 2005 (*The Organisation of North Lebanon Water Establishment and the Specification of its employees, grades, salary scale, and hiring conditions*)

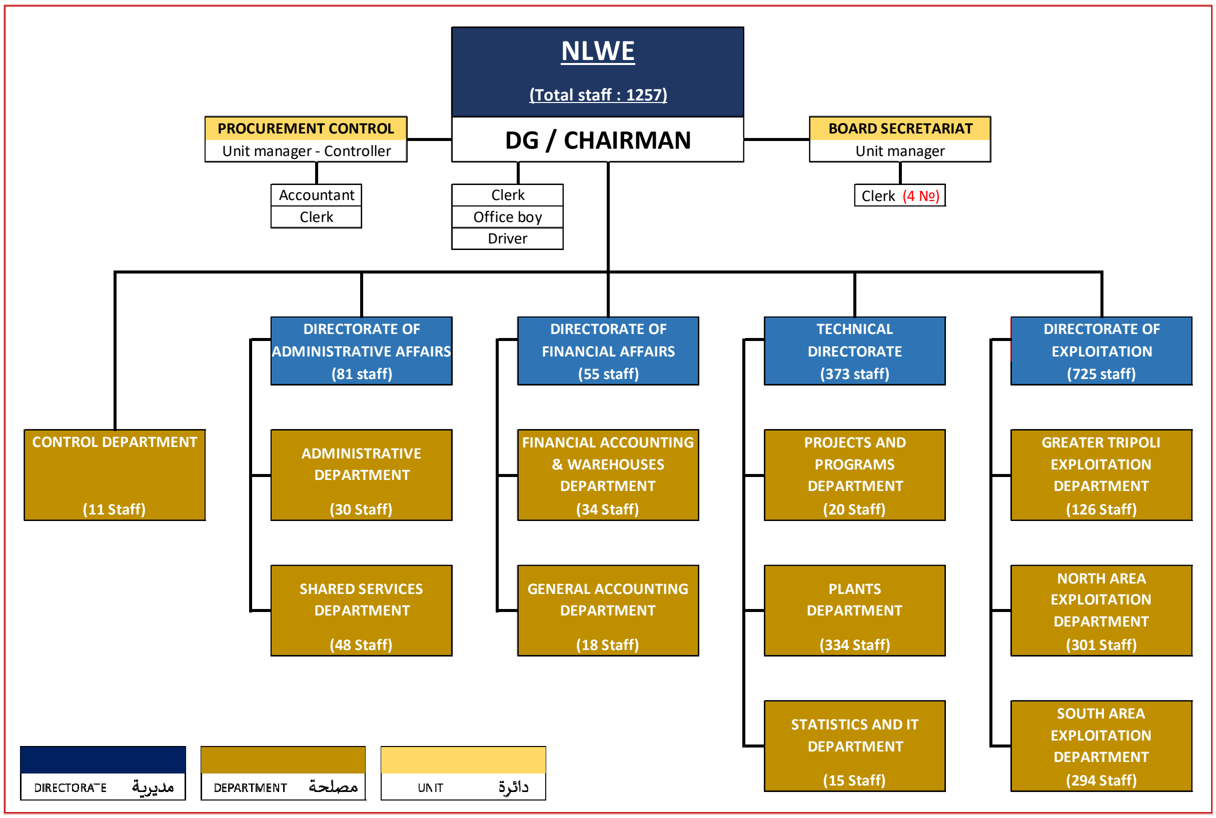

Figure A 3-1 NLWE General Organigram as per By-Law № 14913/5 of July 2005

Detailed Organization charts by department are provided under *Section D.*

Total employees number should be 1257, of which only 246 positions are presently (2021) filled, which amounts to 80% vacancy.

Article 21 of law 46/2017 provides for a ban of employment in all public institutions and establishments. To circumvent this ban, NLWE (like all other WEs) hires on-demand staff to fill mainly the operational positions, in order to provide its core missions and ended up with 363 (2021) on-demand personnel representing 60% of the total 604 (246 + 363) present staff.

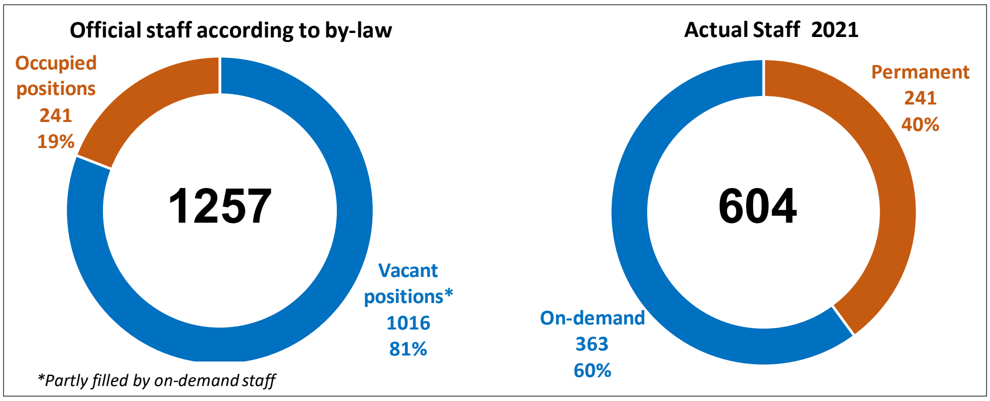

Figure A 3-2 Staff allocation (2021)

On the other hand, due to the deteriorating economic situation and the devaluation of the national currency, NLWE is facing high rate of departures of experienced employees and is risking the loss of their knowledgebase.

3.1.1.2 Assessment of staff productivity

The estimated total number of connections in NLWE's jurisdiction is 68 000, and the benchmark for a performing water utilities is 5 employees per 1000 service connection[1]

Figure A 3-3 below shows the number of staff per 1000 connections.

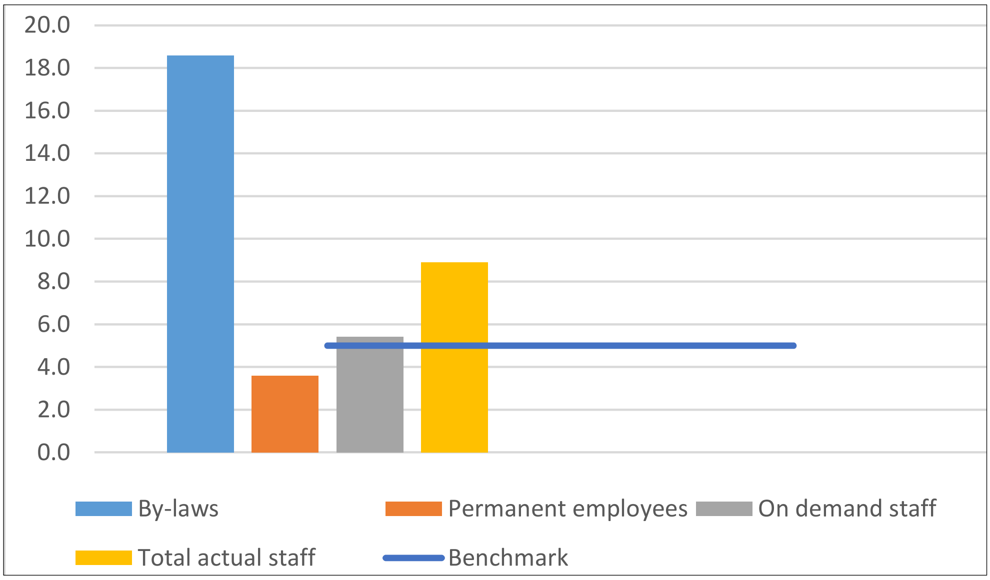

Figure A 3-3 NLWE's staff per 1000 connections

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[1] Tynan & Kingdom - 2002

It can be seen that :

- The number of staff required by the by-law is exaggerated. This is an indication that (i) either the number of connections is highly under-estimated, (ii) or the legally foreseen staff is indeed over-estimated.
- NLWE is not understaffed, thanks to 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.

However, since the establishment manages to provide minimum acceptable services with half the legally foreseen staff, this is another indicator that the organization chart must be reviewed.

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 NLWE are known by region from 2017 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 NLWE, 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 46%. 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 6%. 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 shows that NLWE 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

Despite the construction of multiple WWTPs in North Lebanon by the CDR, the water quality is facing hardship as a result of the sanitation sector; the wastewater and hazardous contaminants from cities, villages and industries are often pumped into rivers or seas without appropriate treatment, leading to water pollution and posing a threat to the health of ecosystems and people.

Legally, the wastewater sector in full (collection networks and treatment facilities) is under the responsibility of the WEs. However, NLWE is reluctant to take over this sector, 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, NLWE is refusing to operate any 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 Number of wastewater facilities in NLWE.
(All operated by CDR)

WWTP	Design Capacity (m³/day)
<u>In Service</u>	
Selaata (Batroun)	3,200
Chkika	2,600
Ejbaa	3,200
Aintourine	1,800
<u>Under rehabilitation</u>	
Tripoli	135,000
<u>Under Construction</u>	
Aabdeh	39,000
Bchaali	500
Bcharreh	3,500
Kfar Hilda	3,500
Michmich	8,000

A.4. FINANCIAL DIAGNOSIS SUMMARY

A.4.1 KEY FIGURES

Table A 4-1 below summarizes the financial key figures of NLWE.

Table A 4-1 NLWE Financial Key figures

``		2017	2018	2019	2020
		(year ends December 31)			
Subscribers, production, NRW					
Total number of customers		121,280	124,793	127,603	129,559
of whom water meters (but not read)		56,878	56,266	59,110	60,979
Volume produced entering into the system	m³/year	73,730,000	95,049,000	96,557,000	94,494,000
Volume billed/subscribed	m³ /year	41,759,016	47,599,650	48,781,520	49,628,685
Estimated NRW rate		43,4%	49,9%	49,5%	47,5%
Revenues; Collection rate; Operating cost					
Accrued revenues	LBP	28,902,482,330	31,706,208,005	32,522,098,112	32,342,529,527
Actual revenues	LBP	17,204,227,361	18,361,753,587	16,608,263,209	16,250,661,214
Annual collection rate		60%	58%	51%	50%
Operating cost	LBP	24,003,338,803	31,710,215,773	29,781,462,051	28,863,979,752
Operating result, EBITDA					
EBITDA in case 100% collection rate	LBP	4,899,143,527 (17%)	-4,007,768 (-0%)	2,740,636,061 (8%)	3,478,549,775 (11%)
Actual EBITDA considering actual collection rate	LBP	-6,799,111,442 (-40%)	-13,348,462,186 (-73%)	-13,173,198,842 (-79%)	-12,613,318,538 (-78%)
Cash situation					
Cash situation	LBP				
Account Receivables	LBP	108,297,966 647	117,083,719,692	128,016,265,889	139,202,568,328
Estimated Amortization					
Rates for 1 m³					
Nominal selling price (based on accrued revenues)	LBP/m³	692	666	667	652
Actual selling price (based on actual collection)	LBP/m³	412	386	340	327
Nominal operating cost (based on volume produced)	LBP/m³	326	334	308	305
Actual operating cost (based on volume billed)	LBP/m³	575	666	611	582

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 (Earnings Before Interest, Tax, Depreciation

& Amortization) which reflects the profitability of the business together with the capacity to produce sufficient cash-flow.

Generally speaking, NLWE is in a bad financial situation as revenues do not meet O&M costs, leaving the WE without the capacity to replace worn-out assets and the situation has deteriorated after 2019 due to the financial crisis.

Operating result in 2019 is a profit amounting 11% of the accrued revenues with a positive EBITDA. While considering the collection rate, which is 50% In average, the gross margin becomes negative. Due to the low collection rate, the accounts receivables are accumulating. In 2020, Accounts receivables by the end of the year are 4 times the annual turnover and the trend is not favorable. On the long run, such accumulation of bad debts will require a provision for unpaid bill.

Major cause for such bad situation is the low level of the tariff with an unchanged tariff while O&M costs are increasing. NLWE is in in a situation where the official tariff level is higher than the O&M cost. While considering the 50% collection rate the O&M cost becomes higher than the collected price of m3. Such situation is not sustainable and must be addressed urgently.

A.4.3 OPEX COST RECOVERY

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

In 2019, energy costs were 27% of the total Opex, against 55% for labour, and 13% for maintenance cost. With a total of 82%, energy and staff costs had the greatest impact on Opex (confirming the *Pareto Principle* 80/20!).

However, in 2022, the cost of energy became preponderant, exceeding 50% of the Opex while labor is now less than 20%.(Figure A 4-1 below).

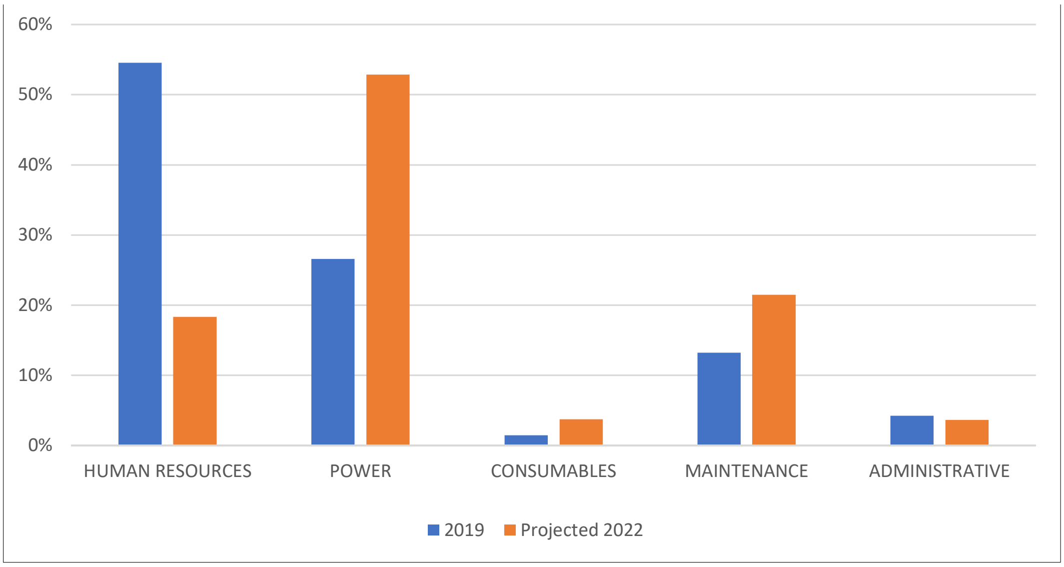

Figure A 4-1 Opex distribution : 2019 v/s 2022

Presently, the situation has worsened with the rising inflationary pressures, the devaluation of the Lebanese Pound and the rise in energy prices. NLWE now barely covers 6% of the operational costs compared to 51% prior to economic meltdown (with the tariff in force in 2021).

The required tariff to balance the estimated 2022 Opex is around 4.5 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 : 32,522 M LBP			Cash Flow : 16,608 M LBP			Total OPEX : 32,687 M LBP		
Financial Indicators (Base value - 2019)			**Collection rate assessment**			**OPEX Breakdown**		
Exchange Rate :	1,500	LBP/USD	Revenues :	32,522	M LBP	HR	17,828	M LBP
Diesel	850	LBP/l	Collected :	16,608	M LBP	Power	8,687	M LBP
gazoline	25,000	LBP/20 l	Collection Rate	**51%**		EDL	7,728	M LBP
transportation	8,000	LBP/day	Cost recovery	51%		Generators	763	M LBP
EDL/Gen. %	92%	EDL				Donations	196	M LBP
EDL increase factor :	1.00		**Subscriptions rate assessment**			Consumables	476	M LBP
CPI :	115		Volume Produced	96,577	K m^3	Paid by WE	476	M LBP
Salaries increase factor :	1.00		Volume Billed	48,782	K m^3	Donations	0	M LBP
Including new WWTPs :	No		Technical losses	6%	(ILI = 8)	O&M	4,319	M LBP
			Revenue Water	**54%**		Paid by WE	1,729	M LBP
Tariff increase factor :	1.00		Potential invoicing	60,357	M LBP	Donations	2,590	M LBP
Bill amount for 1 m^3 subscription (gauged not connected) : 279 000 LBP)						Administrative	1,377	M LBP

Operational Revenues : 32,522 M LBP			Cash Flow : 16,608 M LBP			Total OPEX : 263,149 M LBP		
Financial Indicators (Typical 2022)			**Collection rate assessment**			**OPEX Breakdown**		
Exchange Rate :	20,000	LBP/USD	Revenues :	32,522	M LBP	HR	45,058	M LBP
Diesel	19,700	LBP/l	Collected :	16,608	M LBP	Power	139,428	M LBP
gazoline	375,000	LBP/20 l	Collection Rate	**51%**		EDL	107,624	M LBP
transportation	64,000	LBP/day	Cost recovery	6%		Generators	27,265	M LBP
EDL/Gen. %	92%	EDL				Donations	4,538	M LBP
EDL increase factor :	13.00		**Subscriptions rate assessment**			Consumables	11,186	M LBP
CPI (base = 115) :	700		Volume Produced	96,577	K m^3	Paid by WE	11,186	M LBP
Salaries increase factor :	2.00		Volume Billed	48,782	K m^3	Donations	0	M LBP
Including new WWTPs :	Yes		Technical losses	6%	(ILI = 8)	O&M	59,096	M LBP
			Revenue water	**54%**		Paid by WE	29,254	M LBP
Tariff increase factor :	1.00		Potential invoicing	60,357	M LBP	Donations	29,841	M LBP
Bill amount for 1 m^3 subscription (gauged not connected) : 279 000 LBP)						Administrative	8,382	M LBP

A.4.4 BILLING, COLLECTION, SUBSCRIBERS

Such 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 slight increase in the overall water subscriptions between 2017 and 2020 before slowing down in 2020 due to the economic downturn. The number of subscribers increased at a 4% compound annual rate during 3 years, from 130,410 in 2018 to 135,969 at the end of 2020 (according to values provided by the exploitation directorate)

The annual collection efficiency decreased slowly from 61% in 2017 to 58 % in 2018 and reached 50% in 2020 due to the turbulence and the deteriorating economic conditions that started in 2019. In fact, the lack of official collectors and incentives and the reliance on contractual collectors are critical issues that prevent NLWE 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.1*, key recommendations are grouped and sorted by priority.

A.5.1 MASTER PLAN / STRATEGY

As a general strategy, it is necessary to assess the relevance of existing Master Plans by:

- Reviewing existing Master Plans and proposing required amendments.
- Set up a list of required infrastructure projects in order to improve distribution coverage and water balances.

Estimated duration: 24 Months

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.
  Propose a new Organization Chart including job description and qualification requirements for each staff member down to the level of first line supervisors
- 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.
- Eventually, set up a staff's performance monitoring body/system based on specific targets to achieve and performance indicators.

A.5.3 DIGITALISATION

Until recently, NLWE were using X7 accounting system, but have now migrated to ERP. On the other hand, a GIS system is used for storing and managing technical data. 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 RESOURCES

Presently, the water production is not adequately monitored due to the lack of flow measurement equipment in most of the water sources NLWE is tapping. Production figures given by the WE are based on operators' *best estimate*. Moreover, the eventually available water resources the WE can rely on for planning of future demand are barely known.

Therefore it is necessary to :

- Carry out a general survey of all water sources presently in service and 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 a central production datacentre.
  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.
- Carry out – for the purpose of planning future water demand - required studies to identify existing water resources and their potential capacity.

A.5.5 WATER DISTRIBUTION

Except for some very limited distribution zones, distribution networks are not organized into DMAs, and there is no flow measurement at the level of the distribution centres or reservoirs. Here again, the distributed flow given by the WE is an operator's *best estimate*.

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 datacentre.
  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 datacentre; 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, a pilot area to convert into DMA and carry out within this area detailed studied 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.
- Hire a sewage treatment expert seconded to the WE in order to oversee the execution of these contracts.

A.5.9 TARIFF STUDIES

Tariffs 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 NLWE.

A.5.10 O&M MANAGEMENT SYSTEM

In order to enhance efficiency and reduce the cost of O&M, it is necessary design a modern preventive/corrective maintenance system, and implement it in the view of eventually coupling it to the 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 50% (Figure A 4-1 above). NLWE's should set up and implement a strategy for reducing production cost by the use of 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

NLWE is reluctant to take over the wastewater sector for reasons detailed under Sub-section A.3.5 above.

In the meantime, financing must be provided from sources other than NLWE 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 NLWE applies (partially) water metering in parts of Tripoli and elsewhere.

However, based on lessons learned from past experiences in NLWE and the other WE, it appears that this is not a top priority 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 qualities 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 WEs 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:

1. 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 of office building with multiple units.
2. 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 why 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.
3. 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.
4. 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:

1. The total number as per the WE organisation by-laws.
2. The number of employees.
3. The number of contracted staff.
4. 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.

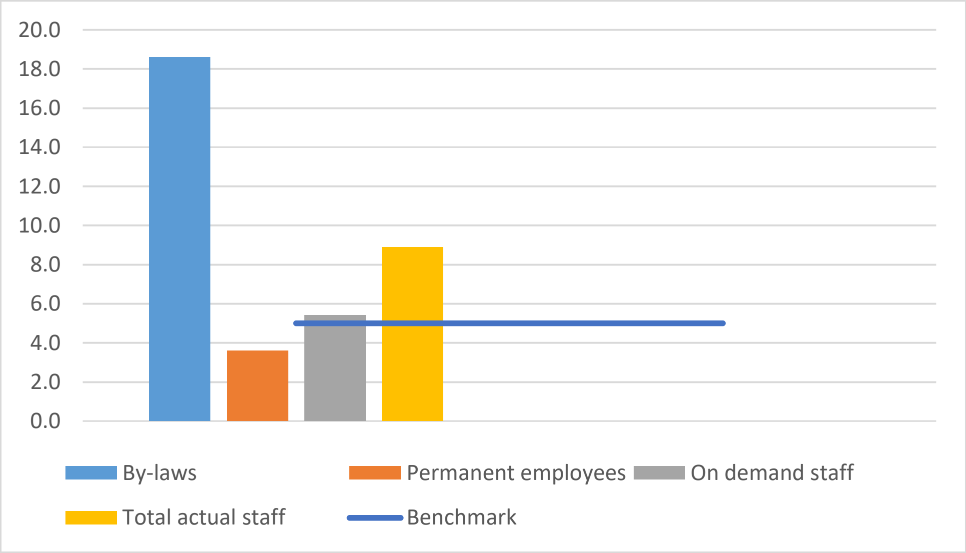

Figure B 1-1 Personnel per 1000 connections.

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 find that for the case of NLWE the results are lower than the benchmark, and the total actual (Employee + Contracted) is also lower than the benchmark, yet the number assigned by the by-laws exceeds and is almost 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 customers.

Acknowledging that the number of subscribers does not size the service area, and that the number of illegal users, the previous conclusion could therefore be misleading. Assessing the total number of potential subscribers, we use the number of units as demonstrated below. Having better estimations is priority for many areas of analysis and planning.

Table B 1-1 Approximate system size assumptions used.

Variable	Unit	NLWE
Connections	1000 No.	68
Subscribers	1000 No.	130
Units	1000 No.	270
% Subscribed	%	48%
Implied population	M No.	1.4

Using the number of units instead of the number of current customers a clear picture is formed; while the decreed number of staff for NLWE is relatively high, the WE fall well within the benchmark.

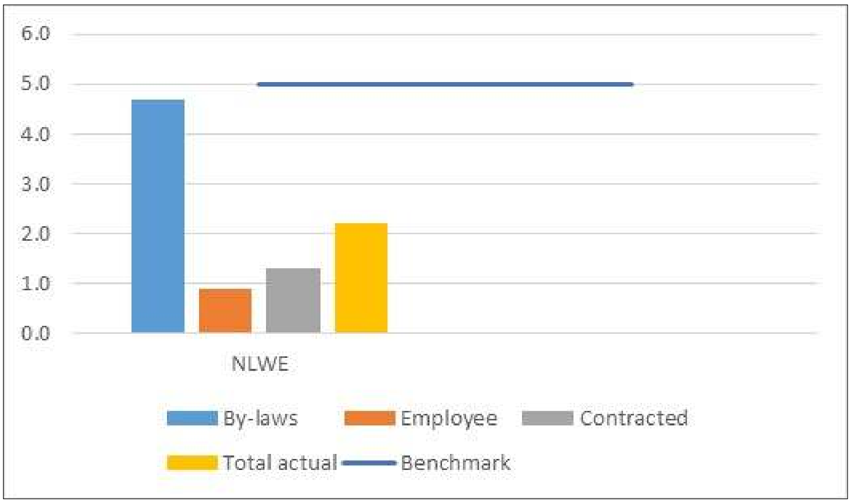

Figure B 1-3 Personnel per 1000 units or potential customer

Another used indicator for sizing the total utility staff is by the quantity produced.

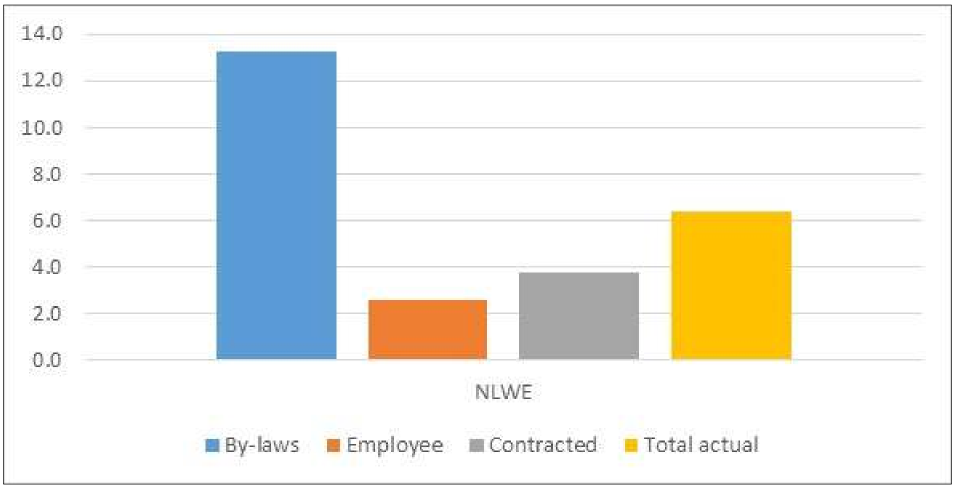

Figure B 1-4 NLWE - Personnel per 1,000,000 m^3 produced.

The comparison with the 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 similar in all WEs.

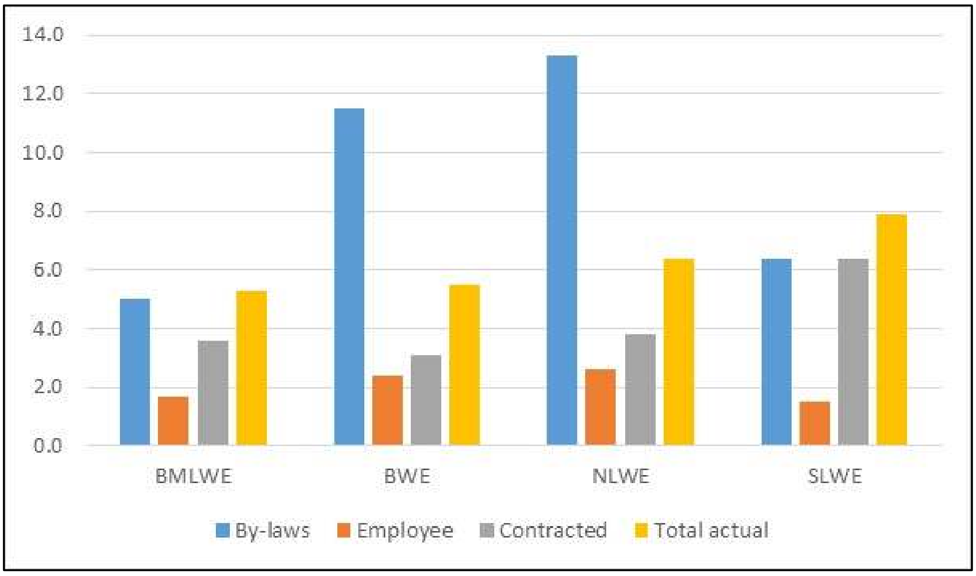

Figure B 1-5 Personnel per 1,000,000 cubic meters produced.

Table B 1-2 Total personnel performance indicators.

Performance indicator	Unit	NLWE		Benchmark
Employees per connection	No./1000 Connections	By-laws	18.6	5 (Tynan and kingdom 2002)
		Employee	3.6	
		Contracted	5.4	
		Total actual	9.0	
Employees per customer	No./1000 Customer	By-laws	9.7	5 drawing from Y&K 2002
		Employee	1.9	
		Contracted	2.8	
		Total actual	4.7	
Employees per customer	No./1000 Units	By-laws	4.7	5 drawing from Y&K 2002
		Employee	0.9	
		Contracted	1.3	
		Total actual	2.2	
Employees per water produced	No./(10^6 m^3)	By-laws	13.3	Comparative
		Employee	2.6	
		Contracted	3.8	
		Total actual	6.4	

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 NLWE.
- Wastewater management units.
- Structure is vertical and complex in NLWE.
- Stores units have a financial counterpart in NLWE.

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	NLWE
Customer service units	No.	0
Distribution units	No.	725
Engineering units	No.	20
Facility units	No.	314
Finance units	No.	66
General units	No.	105
HR units	No.	13
Water quality units	No.	14

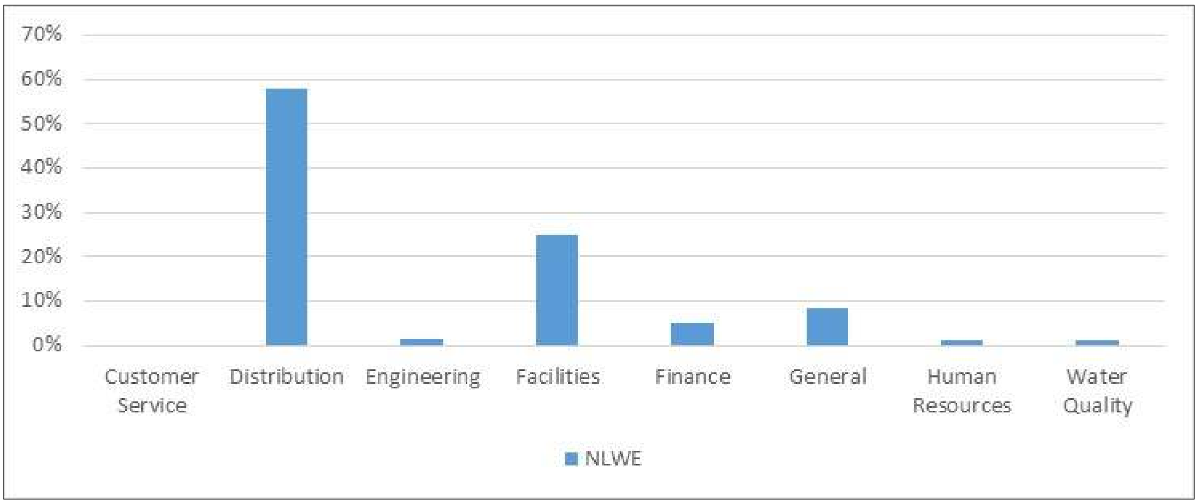

Figure B 1-6 Personnel according to the by-laws under units of different business areas.

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.

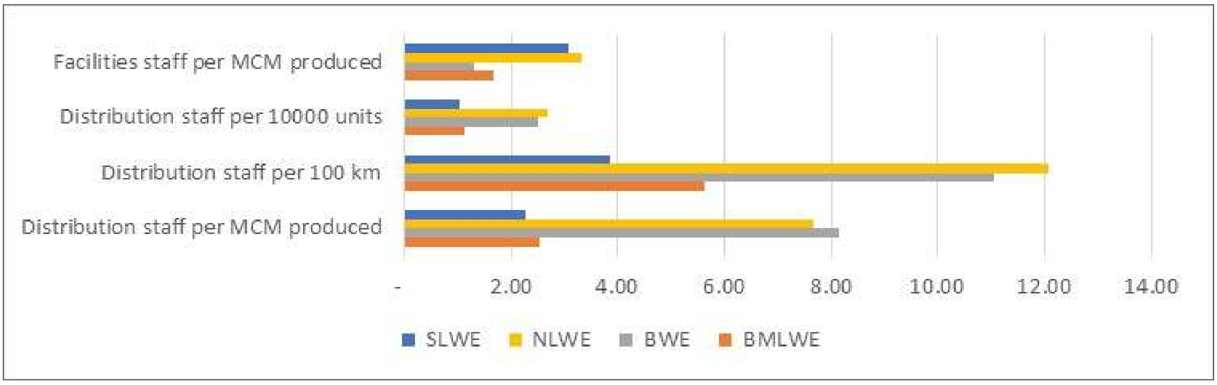

Figure B 1-7 Facilities and distribution personnel performance according to the by-laws under units of different business areas.

The comparison of the four WEs according to facilities and distribution personnel performance marked discrepancy between the number of staff between the four WEs, which promotes the need to revise the organisation 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 WE is being challenged the most and which positions are the most critical. This is limited by the freedom of the WE to choose ideally and therefore should only be seen in terms of general patterns. The analysis is still more limited by the availability of information, for while the detailed information of staff and their current jobs was not completely available for the WE, and similarly for the contracted staff where the needed information was generally sparse. 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	NLWE
Auxiliary - Clerical	No.	75
Auxiliary - Driver	No.	15
Auxiliary - Guard	No.	40
Auxiliary - Office boy	No.	36
Collector/Reader	No.	111
Customer service	No.	38
Financial/Administrative	No.	73
Management	No.	40
Management (Eng.)	No.	49
Technical - Driver	No.	7
Technical - Engineer	No.	30
Technical - Labourer	No.	343
Technical - Other	No.	369
Technical - Water quality	No.	31

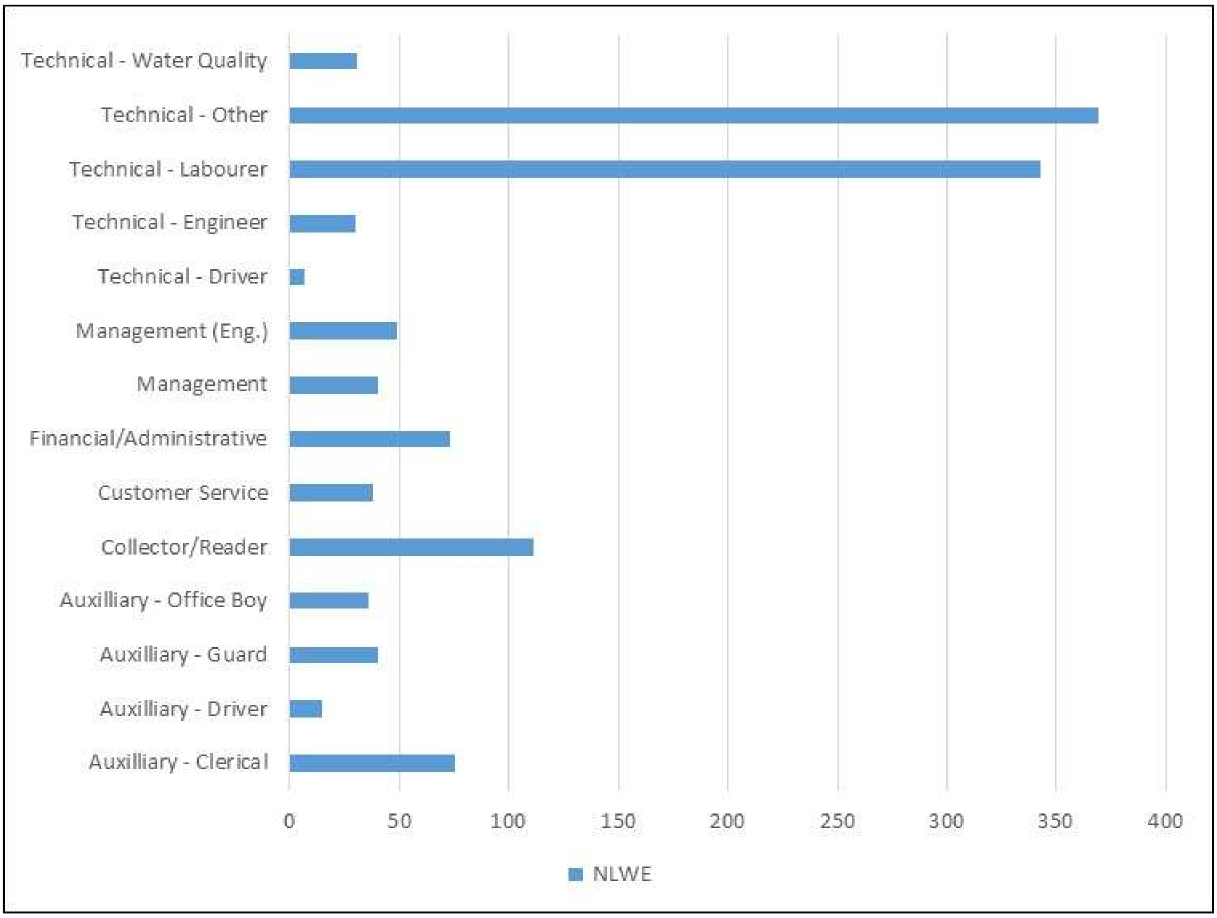

Figure B 1-8 Personnel by job type according to the by-laws.

To calculate the percentage of each job type.

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

Relative size	Unit	NLWE
Auxiliary - Clerical	%	6%
Auxiliary - Driver	%	1%
Auxiliary - Guard	%	3%
Auxiliary - Office boy	%	3%
Collector/Reader	%	9%
Customer service	%	3%
Financial/Administrative	%	6%
Management	%	3%
Management (Eng.)	%	4%
Technical - Driver	%	1%
Technical - Engineer	%	2%
Technical - Labourer	%	27%
Technical - Other	%	29%
Technical - Water quality	%	3%

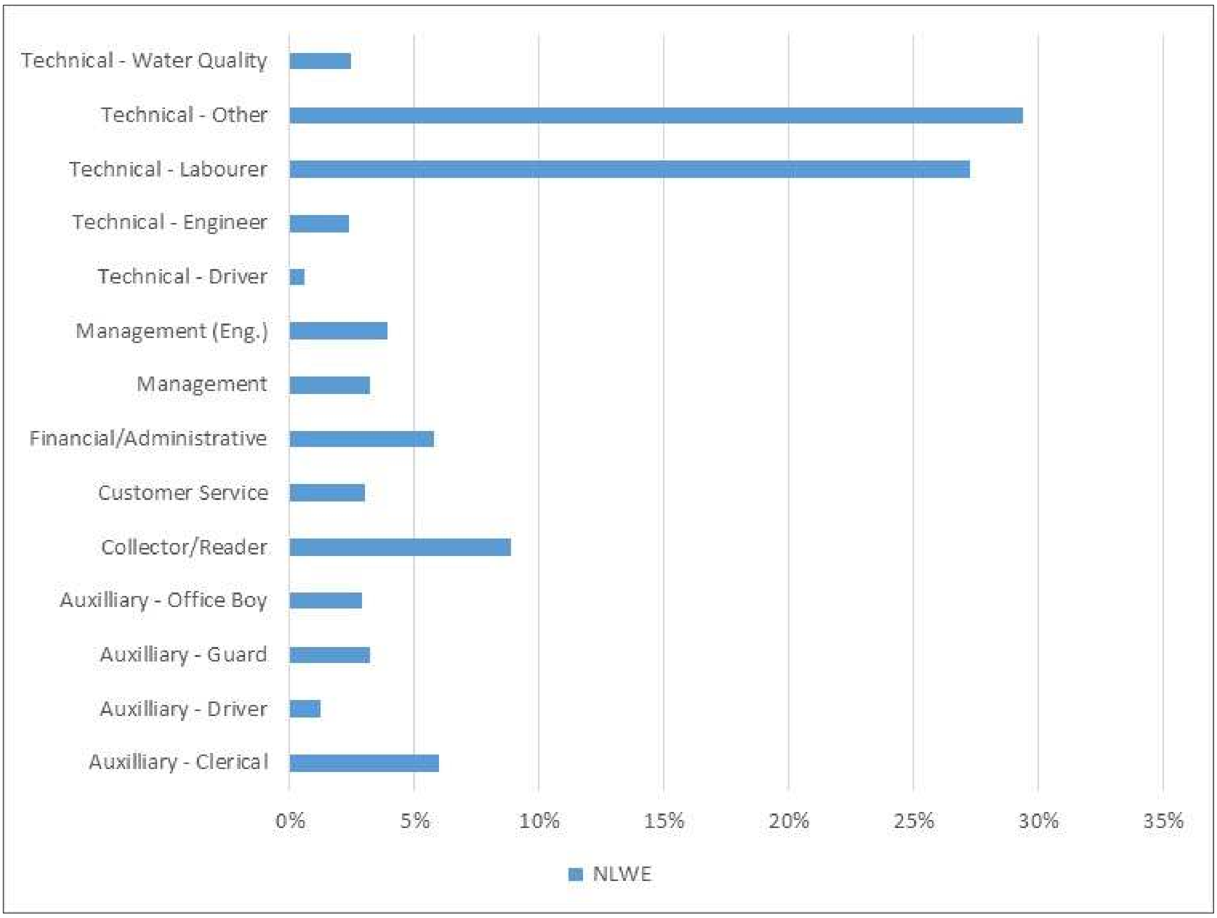

Figure B 1-9 Relative number of each job type according to the by-laws.

It can be clearly seen in the case of NLWE 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 of each WE, 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.

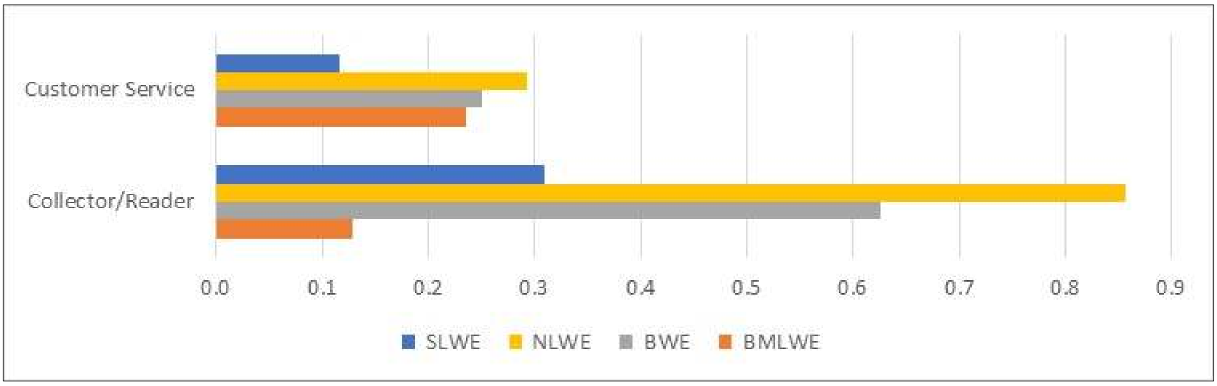

Figure B 1-10 Number of customer service and collection/meter reading staff according to the by-laws per 1000 current subscribers.

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 1-11 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 1-12 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	NLWE
University degree personnel	No.	Employee	76
Basic education personnel	No.		43
Other qualification personnel	No.		122
Unknown	No.		-
University degree personnel	No.	Contracted	3
Basic education personnel	No.		-
Other qualification personnel	No.		357
Unknown	No.		3
University degree personnel	No.	Total	79
Basic education personnel	No.		43
Other qualification personnel	No.		479
Unknown	No.		3

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	NLWE
University degree personnel	%	Employee	32%
Basic education personnel	%		18%
Other qualification personnel	%		50%
Unknown	%		0%
University degree personnel	%	Contracted	1%
Basic education personnel	%		0%
Other qualification personnel	%		98%
Unknown	%		1%
University degree personnel	%	Total	13%
Basic education personnel	%		7%
Other qualification personnel	%		79%
Unknown	%		1%

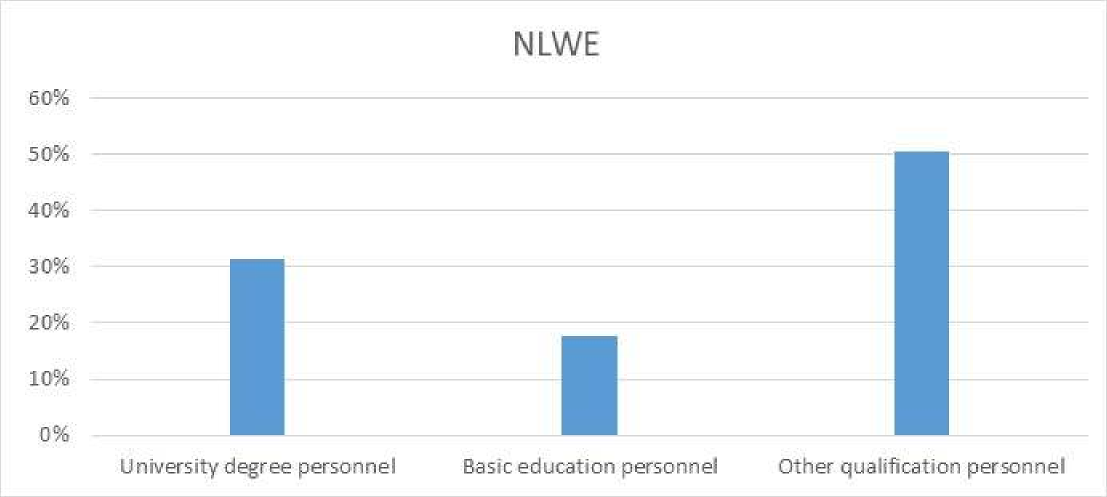

Figure B 1-13 Education level of employees.

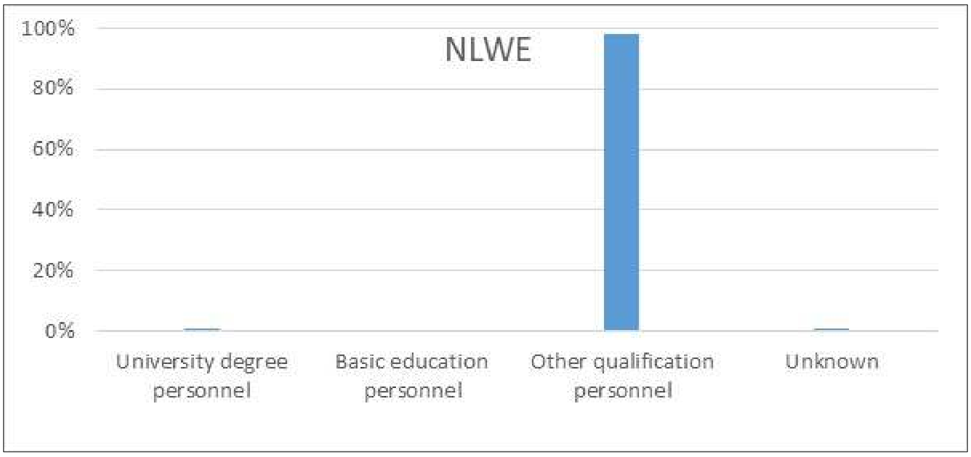

Figure B 1-14 Education level of contracted staff.

B.1.5 Training

No data in relation with the total number of training hours is delivered to the TA from NLWE.

Table B 1-8 Training variables.

Variable	Unit	Type	NLWE
Training	Hours/employee	Employee	

Table B 1-9 Training performance indicators.

Variable	Unit	Type	NLWE
Training	Hours/employee	Employee	

B.1.6 Employee health and productivity

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

Table B 1-10 Training performance indicators.

Variable	Unit	NLWE
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	NLWE
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

1. 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.
2. ERP system allows the integration of an HR model with the payroll as used in other WEs.

Weaknesses

1. No job descriptions, clear assignment of responsibilities, or clear criteria for health and safety.
2. Dysfunctional employee evaluation process.
3. No or outdated or insufficient written procedures increase the demand on the knowledge of key staff members.
4. Higher level positions assigned to employees without expected qualifications.
5. Contracted staff expecting a place in a new WE set up.
6. The scope of training is often restricted to a few employees due to the age of and positions assigned to employees.
7. WE is restricted in investing in personnel improvements given that most functional staff is contracted.

Opportunities

1. Economically and socially attractive job opportunities.
2. Technological opportunities in training and distant learning.

Threats

1. Political environment does not support hiring.
2. Current by-laws do not support WEs in acquiring the needed functions, specialties, and relative number of staff for each.

B.1.8 Recommended actions

This sub-section is about recommended actions for the improvement of performance in personnel management

The shape of reformed water establishments translates directly into its organisation 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 organisation 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 size 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 who have not been officially qualified for the positions. Upon restructuring these individuals may be treated unjustly and may harbour resentment if their service in their assigned roles is was ignored. At the same time, most of the cases found cannot possibly find a normal path to qualify to the jobs currently fill by assignment.

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.
  Propose a new Organization Chart including job description and qualification requirements for each staff member down to the level of first line supervisors
- 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.
- Eventually, set up a staff's performance monitoring body/system based on specific targets to achieve and performance indicators.

B.2. WATER LOSS

The procedure for assessing of 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 authorised consumption during the period. Secondly, estimations are made for each kind of apparent loss, i.e., customer meter under-registration, unauthorised consumption, and data acquisition and handling errors. Starting with the calculation of the total non-revenue water we have the following data from the year 2020:

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

Quantity	Unit	NLWE
Water produced	m^3	94,494,000
Water imported	m^3	-
Water exported	m^3	-
System input volume	m^3	94,494,000

The net system input is the same as the production estimates since NLWE 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 their service areas. Such relationship therefore may be seen as that of water export.

The accuracy of the production quantity is not known. 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 instantaneous flow measured by the estimated operating hours.
- The estimates may not consider all sources or update 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.

For NLWE, bulk metering is used to an extent, but without similar 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 unknowns, an estimate of ±20% uncertainty will be used for NLWE.

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

Quantity	Unit	NLWE
System input volume mean	m^3	94,494,000
Metered	%	-
Uncertainty	%	20%
Uncertainty	m^3	18,898,800
System input volume min	m^3	75,595,200
System input volume max	m^3	113,392,800

Looking at the billed authorised 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	NLWE
Billed authorised consumption	m^3	49,628,594
Billed and metered	m^3	23,213,270
Billed and unmetered	m^3	26,415,324
% quantity "metered"	%	47%
Metered subscribers Avg. consumption for metered	No. m^3/day	60,979 1.04

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 reach 1 cubic meters per day. For NLWE, the value is close in comparison to their average “subscribed” unmetered quantities estimated, 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 for each.

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

Quantity	Unit	NLWE
Avg. consumption for metered	m^3/day	1.04
Estimated residential units	No.	270,000
Total consumption (test)	m^3	102,782,645
Water produced	m^3	94,494,000
Real losses (test)	m^3	(8,288,645)
Plausibility	m^3	Implausible

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 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 practicing 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 on the level of a District Metered Area, (DMA), where the night flowrates provide an estimate of the leakage, and the different pressure values help find the average daily leakage. However, this may not be applicable to the local context because:.

1. Continuously supplyied DMAs only exist in a few areas in Lebanon that are far from representative.
2. 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 Estimating of real losses based on leakage indicators

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

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

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

B.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 is the need for local throttling to ensure higher areas receive water. Network topographies are steep and elevation differences may often reach and exceed the recommended limits such as 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 estimation at one standard deviation, or 30±10 m at 95% confidence limit. Therefore, an average value of ***P = 30 m*** will be adopted for the calculation.

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[1] *Source : IWA*

The length of main is obtained from NLWE's GIS system: ***LM = 6 000 km***.

The number of service connections is calculated based on the estimated total number of housing units in the jurisdiction of NLWE (270 000) and the estimated number of connections per housing unit (4), which gives a ***Nc = 67 500***

Therefore, the UARL can be calculated as follows:

• Average pressure	30 m
• Length of mains	6 000 km
• № of connections	67 500
UARL =	4 860 m^3/day
UARL =	1 773 900 m^3/year

B.2.2.2.2 Estimating the infrastructure leakage indicator (ILI)

The ILI is the choice indicator for real loss benchmarking and making comparisons given 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 3-1 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.

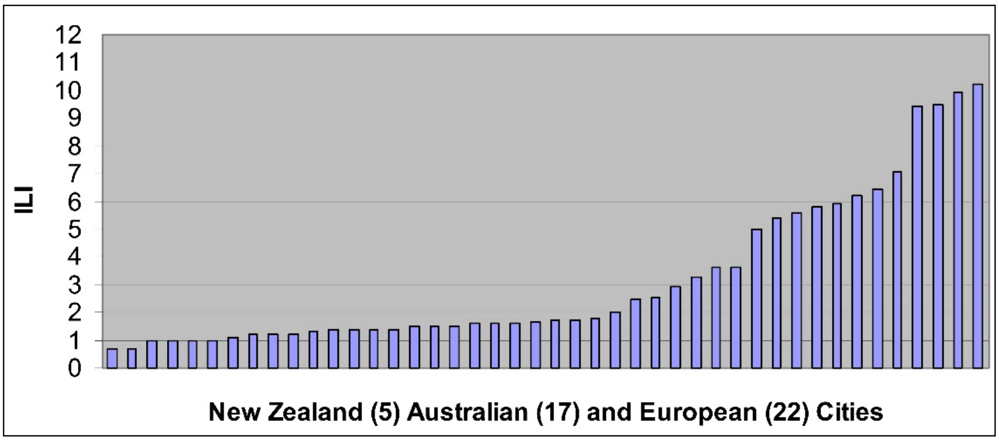

Figure 2-1 Average ILI values for various cities[2]

For 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.

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[2] *Source: A. Lambert & R. Mckenzie.*

B.2.2.2.3 Calculating the Real losses

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

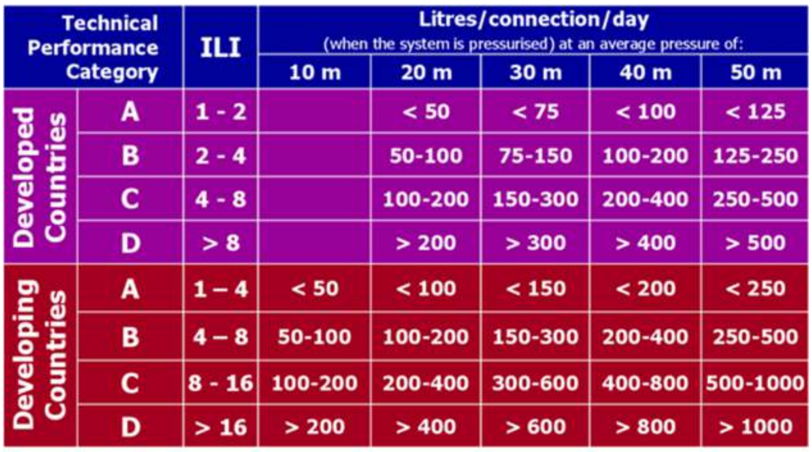
Real losses = UARL x ILI = 1 773 900 x 8 = 14 191 200 m³/year

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: 14 191 200 x 10 / 24 = 5 913 000 m³/year

The yearly production of NLWE being 94 484 000 m³ the real losses amount to 6% of the production.

Assuming supply is continuous, the losses per connection are approximately 600 to 700 l/connection/day. Referring to Figure B 3-2 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 2-2 General guideline for real loss performance levels[3].

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 NLWE when the system is pressurised (w.s.p), which is low.

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[3] *Source: Liemberger, R. and R. Mckenzie. "Accuracy Limitations of the ILI - Is it an Appropriate Indicator for Developing Countries?" (2005).*

Table B 2-5 Estimating the real losses for an ILI of 8 for all NLWE.

Quantity	Unit	NLWE
UARL	m³/y	1,773,900
Supply continuity	Hour	10
ILI	N/A	8
Real losses (test)	m³/y	5,913,000
Real losses	l/c/d	240
Real losses (w.s.p)	l/c/d	576
Real losses	m³/km/day	2.7
Real losses (w.s.p)	m³/km/day	6.5

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 2-6 Estimating the apparent losses for NLWE.

Quantity	Unit	NLWE
System input volume	m³	94,494,000
Real losses	m³	5,913,000
Consumption	m³	88,581,000
Consumption	m³/day	242,688
Consumption per unit	m³/day	0.90
Authorised consumption	m³	42,505,429
Unauthorised consumption	m³	46,075,571
Water loss	m³	51,988,571

The results were found very sensitive to the number of connections, which are estimated to range at 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 need:

- 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, 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 the WE.

Table B 2-7 Estimation uncertainty for the NRW variables.

Variables	Unit	Value	± % Error	Reliability	Est. Err.	Std. Err.	Variance
System input volume	m^3	94,494,000	20%	Low	2.E+07	1.E+07	9.E+13
Billed authorised consumption	m^3	49,628,594	2%	High	1.E+06	5.E+05	3.E+11
Non-Revenue Water	m^3	44,865,406	**42%**	Low	2.E+07	1.E+07	9.E+13

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

Table B 2-8 Estimation uncertainty for the NRW performance indicator.

Performance indicator	Unit	Value	± % Error
Non-revenue Water	%	47%	47%

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.

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

Table B 2-9 NLWE Water loss analysis with accuracy calculation.

Variables	Unit	Value	± % Error	Value min	Value max	Reliability	Est. Err.	Std. Err.	Variance
Length of mains	km	6,000	20%	4,800	7,200	Mid	1.E+03	6.E+02	4.E+05
Units	No.	270,000	10%	243,000	297,000	Low	3.E+04	1.E+04	2.E+08
Units per connection	No./No.	4	33%	3	5	Low	1.E+00	7.E-01	5.E-01
Connections	No.	67,500	40%	40,593	94,407	Low	3.E+04	1.E+04	2.E+08
Avg. Pressure	No.	30	33%	20	40	Low	1.E+01	5.E+00	3.E+01
UARL	m³/day	4,860	55%	2,164	7,556	Low	3.E+03	1.E+03	2.E+06
ILI (assumed)	N/A	8	50%	4	12	Low	4.E+00	2.E+00	4.E+00
Supply continuity	Hour	10	10%	9	11	Low	1.E+00	5.E-01	3.E-01
Real losses	m³/day	16,200	75%	3,993	28,407	Low	1.E+04	6.E+03	4.E+07
System input volume	m³/day	258,888	9%	235,588	282,188	Low	2.E+04	1.E+04	1.E+08
Consumption (SIV-RL)	m³/day	242,688	11%	216,384	268,992	Low	3.E+04	1.E+04	2.E+08
Unit consumption	m³/day	0.90	15%	0.77	1.03	Low	1.E-01	7.E-02	5.E-03
Subscribers	No.	129,559	1%	128,263	130,855	High	1.E+03	7.E+02	4.E+05
Legal consumption	m³/day	116,453	15%	99,240	133,666	Low	2.E+04	9.E+03	8.E+07
Illegal consumption	m³/day	126,234	25%	94,799	157,670	Low	3.E+04	2.E+04	3.E+08
Water loss (RL+AL)	m³/day	142,434	24%	108,712	176,157	Low	3.E+04	2.E+04	3.E+08
Water loss	%	55%	25%	41%	69%	Low	1.E-01	7.E-02	5.E-03
Water losses per connection	l/c/day	2,110	47%	1,114	3,107	Low	1.E+03	5.E+02	3.E+05
Water losses per mains length	m³/km/day	24	32%	16	31	Low	8.E+00	4.E+00	2.E+01
Billed authorised consumption	m³/day	135,969	2%	133,249	138,688	High	3.E+03	1.E+03	2.E+06
Apparent loss index (ALI)	N/A	19	25%	14	23	Low	5.E+00	2.E+00	6.E+00
Real loss per connection (w.s.p)	l/c/day	576	86%	82	1,070	Low	5.E+02	3.E+02	6.E+04
Real loss per mains length (w.s.p)	m³/km/day	6	79%	1	12	Low	5.E+00	3.E+00	7.E+00

B.2.4 Diagnosis of challenges

To assess the factors leading to low performance on in water loss 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

1. Pilot projects have been introduced in NLWE to reduce physical losses using good water distribution practices.

Weaknesses

1. No clear roles for water loss assessment, planning, and reduction at the WE.
2. WE own distribution personnel perform water distribution independently from the best interest of the WE.
3. Distribution network information is largely missing from GIS in many areas.

Opportunities

1. Interest in NRW project funding.

Threats

1. No supervisory or regulatory accountancy by the Ministry on the WE to reduce NRW.
2. With the currency crises the financial feasibility of reducing NRW is diminished.
3. Social resistance against legal subscriptions especially without fair metering.
4. Social resistance against customer metering by high volume consumers.
5. No centralised and consolidated data for parcels, buildings, and units to aid in illegal use management and no recent aerial images.
6. 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 system, regional department, 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, a pilot area to convert into DMA and carry out within this area detailed studied 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 Shifting to metred consumption policy

Metered consumption is the end key for reducing NRW, Opex, and overall water consumption. In fact NLWE applies (partially) water metering in parts of Tripoli and elsewhere.

However, based on lessons learned from past experiences in NLWE and the other WE, it appears that this is not a top priority 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 Estimation of the energy use to calculate the energy use performance indicator .

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

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

Table B 3-2 Energy use performance indicator .

Performance indicator	Unit	NLWE	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. NLWE has adapted their pumping schedules to align best with grid energy availability, and therefore the extent of the problem would not be realised 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 1. Pilot projects for energy generations have been implemented, and projects for energy recovery have been discussed.
Weaknesses 1. No records of energy use at WE requiring EDL/EDK to share this data. 2. No assessment of energy use using local fuel generators. 3. Most pumping lines lack a study for energy reduction potential. 4. Incomplete knowledge of the system and the relationship between pumping locations and the quantities supplied.
Opportunities 1. Interest in energy efficiency project funding.
Threats 1. No supervisory or regulatory accountancy by the Ministry on the WE to improve energy use efficiency. 2. With unpaid EDL/EDK invoices the financial feasibility of reducing energy use is diminished. 3. Mountainous topography and political water availability increases the difficulty for reducing energy use.

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

Therefore, the needed improvements include:

- Identification and continuous update of discrete 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 NLWE generally showed:

- Lack of completion and comprehensiveness.
- Lack of completion 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 completion 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 at the regional departments at each 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	NLWE
Number of water supply systems	No.	
Wells	No.	69
Springs	No.	153
Dams	No.	-
Treatment plants	No.	3

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 NLWE are as follows:

Table B 4-2 Water resource variables.

Variable	Unit	NLWE
Wells daily production capacity	m^3/day	
Springs daily production capacity	m^3/day	
Dams daily production capacity	m^3/day	
Total daily production capacity	m^3/day	336,548
Daily treatment capacity	m^3/day	
Maximum water treated daily	m^3/day	
System input volume	m^3/day	258,888

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

- Technical assessment of current source 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 4-3 Water storage variables.

Variable	Unit	NLWE
Number of transmission and distribution storage tanks	No.	504
Treated water storage capacity	m^3	192,210
Transmission and distribution storage capacity	days	0.74

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 suituation

Presently (2020) there is 60,976 domestic water meters installed in the jurisdiction of NLWE, out of which some 40% in Tripoli city. The rate of metered subscriptions is 47%, which is high relatively to the other WEs.

However, the billing is based on a kind of hybrid gauged/metered method : Subscribers pay the standard gauged subscription for a nominal 1 m³/day (365 m³/year). Only the excess consumption is billed by m³ consumed.

So meters are read quarterly and consumption exceedig 90 m³ (365/4) for the quarter in question is billed separately.

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 4-4 Pumping stations and pumps.

Variable	Unit	NLWE
Pumping stations	No.	79
Pumps	No.	

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

Table B 4-5 Metering base variables.

Variable	Unit	NLWE
Total plants (sources, PSs, TPs, Reservoirs)	No.	
Connections	No.	67,500
Subscribers	No.	129,559

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

Table B 4-6 Metering performance variables.

Variable	Unit	NLWE
Production and transmission meters	No.	
District meters	No.	
Subscriber meters	No.	60,979

Metering is vital for measuring some of the most vital water establishment metrics in NRW and energy use. Given that the 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 strategise about, 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 the 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 SCADA

The evaluation aims at evaluating the level of automation and remote monitoring and control of water facilities. This shall be initiated in NLWE where a number of facilities of concern shall be chosen as a proxy for the number of control units, the level of automation and remote control.

Table B 4-7 SCADA variables.

Variable	Unit	NLWE
Control units	No.	
Automated facilities	No.	
Remotely controlled units	No.	-

At present, SCADA performance indicator is null.

Table B 4-8 SCADA performance indicators.

Performance indicator	Unit	NLWE
Facility automation degree	%	
Facility remote control degree	%	

Ideally, control units should be used to represent points of on the production and transition system such as pump control panels, reservoir inlet and outlet valves, and other critical system valves. To improve the 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 specialised maintenance of SCADA systems.

B.4.5 Diagnosis of challenges

To assess the factors leading to low performance on in water system 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 1. Focus on water resource sufficiency and storage capacity expansion across the WE. 2. Some level of bulk metering in NLWE.
Weaknesses 1. The level of water treatment cannot be assured especially at small disperse sources. 2. WE does not have the capacity to manage large numbers of bulk and customer meters. 3. Information about facilities is rarely updated, highly dubious, and incomplete on GIS. 4. Distribution networks layouts are largely missing. 5. As a rule, small water resources are unmetered, or meters are dysfunctional.
Opportunities 1. Funding opportunities focus on water resources, storage, and associated measurement and control technologies. 2. Investment in customer meter is interesting to funding agencies.
Threats 1. Many small production and transmission facilities increase the complexity of asset management and the cost of SCADA.

B.4.6 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. 4.6.1 Master plan / Strategy

As a general strategy, it is necessary to assess the relevance of existing Master Plans by:

- Reviewing existing Master Plans and proposing required amendments.
- Set up a list of required infrastructure projects in order to improve distribution coverage and water balances.

Estimated duration: 24 Months

B. 4.6.2 Digitalisation

Until recently, NLWE were using X7 accounting system, but have now migrated to ERP. On the other hand, a GIS system is used for storing and managing technical data. 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. 4.6.3 Water production – Available water resources

Presently, the water production is not adequately monitored due to the lack of flow measurement equipment in most of the water sources NLWE is tapping. Production figures given by the WE are based on operators' *best estimate*. Moreover, the eventually available water resources the WE can rely on for planning of future demand are barely known.

Therefore it is necessary to :

- Carry out a general survey of all water sources presently in service and 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 a central production datacentre.
  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.
- Carry out – for the purpose of planning future water demand - required studies to identify existing water resources and their potential capacity.

B. 4.6.4 Water distribution

Except for some very limited distribution zones, distribution networks are not organized into DMAs, and there is no flow measurement at the level of the distribution centres or reservoirs. Here again, the distributed flow given by the WE is an operator's *best estimate*.

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 datacentre.
  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 datacentre; 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. 4.6.5 Production cost optimisation

With the present financial situation, energy has become the major component of production cost, nearing 50%. NLWE's should set up and implement a strategy for reducing production cost by the use of 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. 4.6.6 Taking over the wastewater sector

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

In the meantime, financing must be provided from sources other than NLWE 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. NLWE are in the process of receiving an EU funded mobile system.

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

Table B 5-1 Inspection and calibration performance indicators.

Performance indicator	Unit	NLWE	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 the 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	NLWE
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	NLWE
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	

B.5.3 Vehicles

Vehicle availability is vital for establishing field presence and traversing the service areas to operate and maintain assets. Figures in relation with the number of vehicules were not provided by the WE.

Table B 5-4 Vehicle availability variables.

Variable	Unit	NLWE
Operating vehicles	No.	
Length of mains	km	6,000
Subscribers	No.	129,559

Table B 5-5 Vehicle availability performance indicators.

Performance indicator	Unit	NLWE
Vehicle availability	No./100	
Vehicle availability	No./100	

B.5.4 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 5-6 Customer metering variables in year (2020).

Variable	Unit	NLWE
Customer meter read	No.	
Customers billed based on metering	No.	
Customer meters	No.	60,979

While the data was not available from NLWE, it is expected that metering and billing based on excess quantity is high in Tripoli but low for metered subscribers outside in general.

Table B 5-7 Customer metering performance indicators.

Performance indicator	Unit	NLWE	Benchmark
Customer meter reading efficiency	%	Mid	100%
Customers billed based on metering	%	Mid	100%

B.5.5 Water quality testing

Table B 5-8 Water quality testing variables.

Variable	Unit	NLWE
Required treated water quality tests	No.	
Required aesthetic tests	No.	
Required microbiological tests	No.	
Required physical-chemical tests	No.	
Required radioactivity tests	No.	
Required water quality tests carried out	No.	
Aesthetic tests carried out	No.	
Microbiological tests carried out	No.	
Physical-chemical tests carried out	No.	
Radioactivity tests carried out	No.	

Table B 5-9 Water quality testing performance indicators.

Performance indicator	Unit	NLWE
Aesthetic tests carried out	%	
Microbiological tests carried out	%	
Physical-chemical tests carried out	%	
Radioactivity tests carried out	%	

B.5.6 Diagnosis of challenges

To assess the factors leading to low performance on 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

1. Experience in and attempt at designing or acquiring maintenance management and quality management systems at NLWE.

Weaknesses

1. 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.
2. Difficulty in narrowing down the assets requiring preventive maintenance, inspection, or calibration and the required maintenance for each asset.
3. Difficulty in assessing the sampling and quality testing of sources and networks according to the Lebanese standards.
4. Maintenance information is often lacking, and when available focus to major contracted works at facilities.
5. No records of network failures that may aid in assessing the condition of network assets.
6. WE has no capacity to perform acceptable levels of regular maintenance.

Opportunities

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

Threats

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

B.5.7 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:

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

2. Completion of and standardisation of maintenance forms for NLWE, review of existing systems, and planning revisions and development of capable maintenance management system upgrade and the integration with mobile applications for field functions.
3. Study of and update of the water sampling and testing needs for NLWE. This will also help develop the needs of staffing and vehicles for the WE.
4. 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.
5. 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 develop the needs of staffing and vehicles for the WE.
6. 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 minimises pipe replacement before all attempts at maintenance have been taken, and where replacement proves to be a more cost-effective solution.

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

Variable	Unit	NLWE
Units	No.	270,000
Subscribers	No.	129,559
Unit supplied legally by WE	No.	129,559
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	NLWE
Service coverage	%	
Unit supply coverage legally by WE	%	48%
Unit supply coverage by other entities	%	
Unit supply coverage by illegal connections	%	52%

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 the WE, the issue of continuity has often remained in the background. The resulting hours of supply are still not known, and previous estimates focused more on source operating hours not distribution supply hours.

Table B 6-3 Supply continuity variables.

Variable	Unit	NLWE
Avg. supply duration	h/day	
Listed number of networks	No.	
Network with 23 h/day or more	No.	
Estimated customers with continuous supply	%	

The resulting performance can not be therefore calculated for NLWE. Given the importance of this key performance indicator, supply continuity was estimated for the other WEs as 40% as an initial figure, based on an average of approximately 10 hours per day.

Table B 6-4 Supply continuity performance indicators.

Variable	Unit	NLWE	Benchmark
Supply continuity	%	~ 40%	100%
Population receiving continuous supply	%	Low	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 not provided by NLWE.

Table B 6-5 Water quality compliance base variables.

Variable	Unit	NLWE
Treated water quality tests carried out	No.	
Aesthetic tests carried out	No.	
Microbiological tests carried out	No.	
Physical-chemical tests carried out	No.	
Radioactivity tests carried out	No.	

Data was not provided by NLWE for the water quality tests nor the compliance level of these tests. 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	NLWE
Quality of supplied water	No.	
Aesthetic tests compliance	No.	
Microbiological tests compliance	No.	
Physical-chemical tests compliance	No.	
Radioactivity tests compliance	No.	

The resulting compliance levels therefore were not calculated. These complaince levels can 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	NLWE	Benchmark
Quality of supplied water	%		100%
Aesthetic tests compliance	%		100%
Microbiological tests compliance	%		100%
Physical-chemical tests compliance	%		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	NLWE	Benchmark
Average response time to customer complaints	Hours		48
New connection establishment time	days		14
Time to install a customer meter/gauge	days		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	NLWE
Billing complaints and queries	No.	
Service complaints	No.	423
Pressure complaints	No.	-
Continuity and interruption complaints	No.	3
Water quality complaints	No.	17

And the results show that NLWE has low recorded number of complaints compared to other WE. Therefore the customer complaints performance indicators in NLWE can be calculated as follows:

Table B 6-10 Customer complaints performance indicators.

Performance indicator	Unit	NLWE
Billing complaints and queries	No./1000 customer	
Service complaints per connections	No./1000 customer	3.3
Pressure complaints	No./1000 customer	
Continuity and interruption complaints	No./1000 customer	0.0
Water quality complaints	No./1000 customer	0.1

NLWE has initiated one or more systems of documenting complaints over the years, with some of them being integrated with the ERP syetm. However, common issues are seen such as:

- 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
1. Expected high levels of service coverage, if precluded by prevalence of illegal connection to the network in NLWE.
Weaknesses
1. No sufficient capacity for responding to all customer complaints. 2. Large volumes of customer complaints remain to be processed outside of official channels.
Opportunities
1. Mobile applications provide a technological solution for saving cost and staff needed to achieve wider communication with customers. 2. Relaunching of WE with new campaigns, while maintaining good performance, may help establish trust and cooperation with users.
Threats
1. Other than Tripoli, water users have not developed the habit of contacting the call centre to report service complaints. 2. Power shortages keep supply continuity an unachievable goal.

B.6.7 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 standardise if not necessarily centralised customer application that allows for:
    - 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 23/7 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 state 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 legal consumption as well as the illegal use 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.

Appendix Table 1 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.

Appendix Table 2 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 tables below.

Appendix Table 3 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	%

Appendix Table 4 IWA performance indicators in the area of physical systems.

Code	Area	Performance indicator	days
Ph1	Treatment	Treatment plant utilisation	%
Ph2	Storage	Raw water storage capacity	days
Ph3		Transmission and distribution storage capacity	days
Ph4	Pumping	Pumping utilisation	%
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	%

Appendix Table 5 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	m^3/connection
Op24		Water losses per mains length	m^3/km/day
Op25		Apparent losses	%
Op26		Apparent losses per system input volume	%
Op27		Real losses per connection	l/c/d (w.s.p)
Op28		Real losses per mains length	l/c/d (w.s.p)
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 table below.

Appendix Table 6 Proposed water loss performance indicators.

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

Appendix Table 7 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.

Appendix Table 8 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.

Appendix Table 9 Proposed performance indicators in the area of O&M

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.

Appendix Table 10 Proposed 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 waterpoints 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.

Appendix Table 11 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 needed 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:

- ✓ 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.
- ✓ 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.

- ✓ 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.
- ✓ 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 authorised 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.
- ✓ 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.
- ✓ 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 manage to 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 committees.

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 has 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 upon two main chapters:

- The first chapter presents a financial analysis 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

Book keeping 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 (BWE) not recording some key expenditures (Energy, taxes, out-sourced activities etc.). The same applies to subsidies which are included or not into the revenues.

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

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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

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 the “Audit Court” 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	m^3/year
Volume billed/subscribed	m^3/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/m^3	LBP
Average collected /m^3	"
Operating cost /m^3	"

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 of NLWE

C. 2.3.1 Opinion on quality, accuracy and consistency of data collected

Seems there is some reluctances to dispatch the information for confidentiality reasons although the TA is deemed to assist the WE. Major data regarding the balance sheet were not made available. All data highlighted in yellow colour 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 NLWE for the period between the year 2017 and the year 2020.

The key figures as collected from NLWE 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 below 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 figures for NLWE

		2017	2018	2019	2020
Nbr. of customers	Nbr	121,280	124,793	127,603	129,559
Of whom wr meters	"	56,878	56,266	59,110	60,979
Volume produced & entering into the	m^3/year	73,730,000	95,049,000	96,557,000	94,494,000
Volume billed/subscribed (incl.	m^3/year	41,759,016	47,599,650	48,781,520	49,628,685
Est. NRW rate	%	43,4%	49,9%	49,5%	47,5%

Accrued revenues (including Irrigation)	LBP	28,902,482,330	31,706,208,005	32,522,098,112	32,342,529,527
Annual collection rate	%	59.53%	57.91%	51.07%	50.25%
Actual revenues of the year	LBP	17,204,227,361	18,361,753,587	16,608,263,209	16,250,661,214
Operating cost	"	24,003,338,803	31,710,215,773	29,781,462,051	28,863,979,752
Operating result (EBITDA)	"	4,899,143,527	-4,007,768	2,740,636,061	3,478,549,775
EBITDA in %	%	17%	0%	8%	11%

Operating result while taking the collection rate(EBITDA)	LBP	-6,799,111,442	-13,348,462,186	-13,173,198,842	-12,613,318,538
EBITDA in % while taking the collection rate	%	-40%	-73%	-79%	-78%

Cash situation end of the year	LBP				
Receivables end of the year	"	108,297,966 647	117,083,719,692	128,016,265,889	139,202,568,328
Est. Amortization					

Average selling price/m^3	LBP	692	666	667	652
Average collected /m^3	"	412	386	340	327
Operating cost / m^3	"	575	666	611	582

C. 2.3.3 Comments on key figures

Table C 2-5 Situation of NLWE

	NLWE year 2020	
	Accrued	**Actual**
Turn over	32,342,529,527	
Subsidies		
Total actual revenues		16,250,661,214
Other Operating cost	-11,618,301,824	
Personnel	-17,245,677,928	
EBITDA	**3,478,549,775**	-12,613,318,538
Amortization	Not available	
Operating result		
Other revenues/expenditures	Not available	
Cost of debt	Not available	
Net result		

Generally speaking, the NLWE is in a bad financial situation whereas revenues actually collected not meeting even the cost of personnel and the situation is deteriorating.

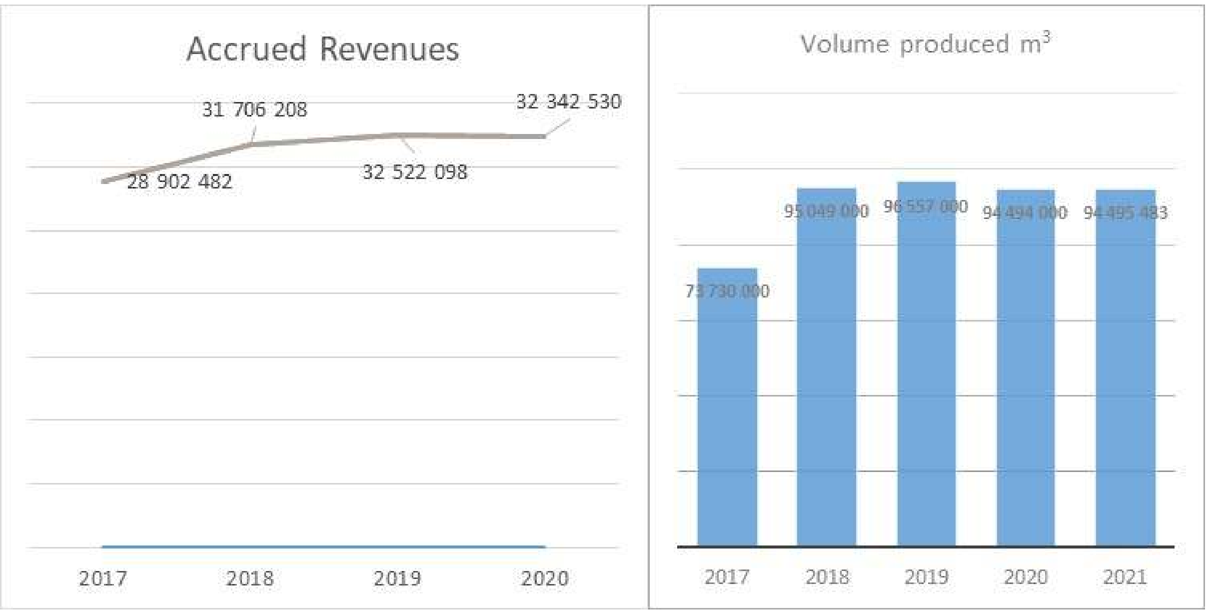


Figure C 2-1 Accrued revenues in LBP & Volume produced

The collection rate remains low.

Although we were not given the possibility to make an in-depth exploration there is a high likelihood that the WE is suffering from treasury difficulties.

Not surprisingly, the same occurs for account receivables which are accumulating year after year as shown here under. In 2020 outstanding accounts receivables represents more than four times the accrued turn over.

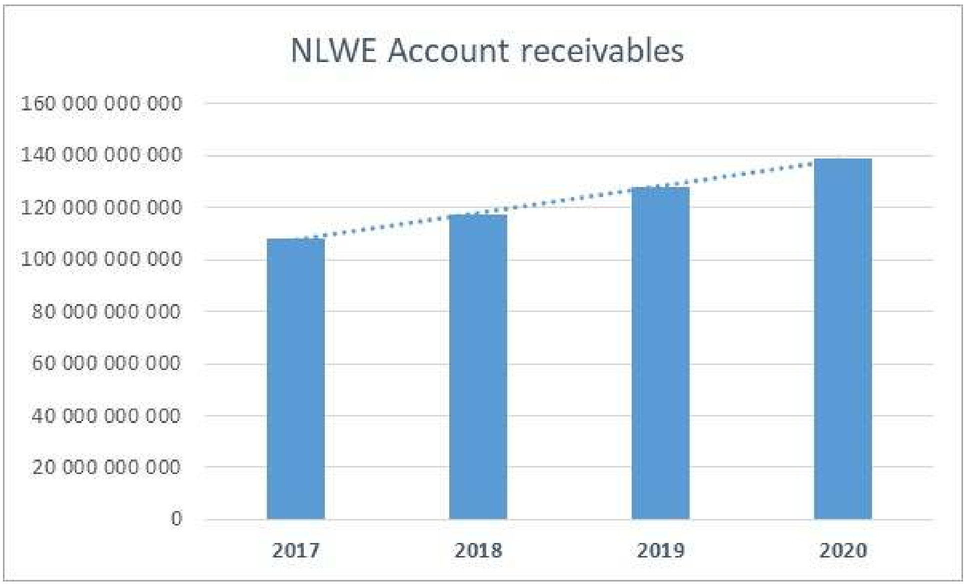


Figure C 2-2 Account receivables in NLWE

As far as cost, price of m3 the picture hereunder is self-explanatory with O& M cost higher than official price.

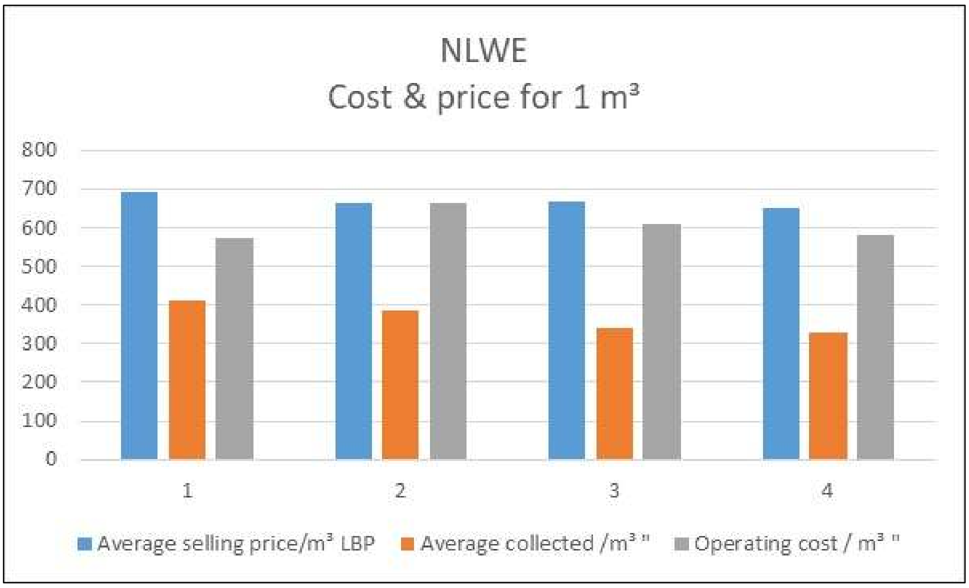


Figure C 2-3 NLWE price & cost for 1 m³

In the absence of a comprehensive balance sheet:

- No info regarding the outstanding debt of NLWE.
- 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.

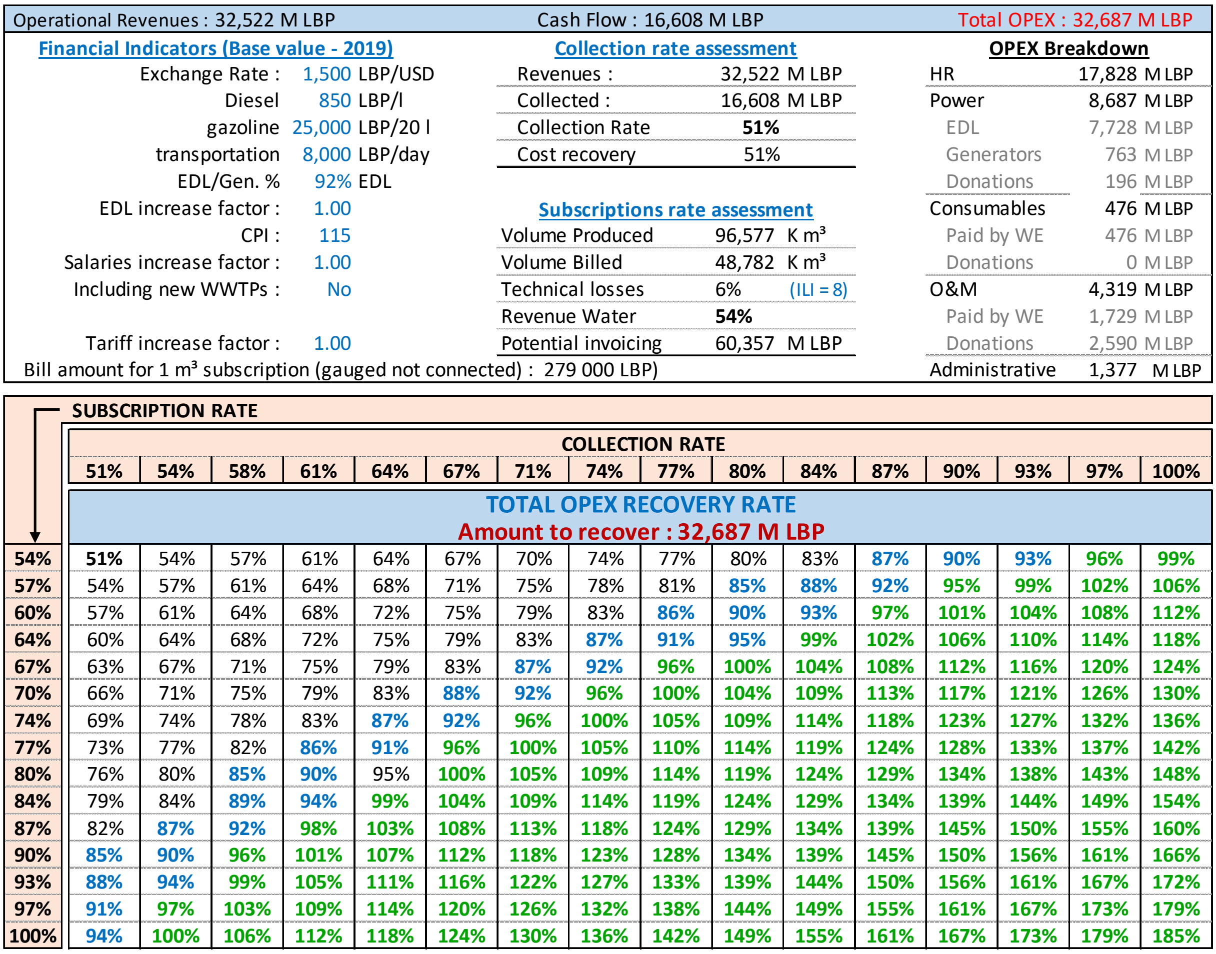
Therefore, in this study by *Cost Recovery* it is meant *Opex Cost recovery*.

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 NLWE was achieving 51% Opex recovery. Opex balance would have been achieved if the Collection and the Revenue Water rates were brought up to 75%.

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



Operational Revenues : 32,522 M LBP | Cash Flow : 16,608 M LBP | Total OPEX : 32,687 M LBP

Financial Indicators (Base value - 2019)

Exchange Rate :	1,500	LBP/USD
Diesel	850	LBP/l
gazoline	25,000	LBP/20 l
transportation	8,000	LBP/day
EDL/Gen. %	92%	EDL
EDL increase factor :	1.00	
CPI :	115	
Salaries increase factor :	1.00	
Including new WWTPs :	No	
Tariff increase factor :	1.00	

Bill amount for 1 m³ subscription (gauged not connected) : 279 000 LBP)

Collection rate assessment

Revenues :	32,522 M LBP
Collected :	16,608 M LBP
Collection Rate	**51%**
Cost recovery	51%

Subscriptions rate assessment

Volume Produced	96,577	K m³
Volume Billed	48,782	K m³
Technical losses	6%	(ILI = 8)
Revenue Water	**54%**	
Potential invoicing	60,357	M LBP

OPEX Breakdown

HR	17,828	M LBP
Power	8,687	M LBP
EDL	7,728	M LBP
Generators	763	M LBP
Donations	196	M LBP
Consumables	476	M LBP
Paid by WE	476	M LBP
Donations	0	M LBP
O&M	4,319	M LBP
Paid by WE	1,729	M LBP
Donations	2,590	M LBP
Administrative	1,377	M LBP

SUBSCRIPTION RATE

COLLECTION RATE

TOTAL OPEX RECOVERY RATE

Amount to recover : 32,687 M LBP

SUBSCRIPTION RATE	51%	54%	58%	61%	64%	67%	71%	74%	77%	80%	84%	87%	90%	93%	97%	100%
54%	**51%**	54%	57%	61%	64%	67%	70%	74%	77%	80%	83%	87%	90%	93%	96%	99%
57%	54%	57%	61%	64%	68%	71%	75%	78%	81%	85%	88%	92%	95%	99%	102%	106%
60%	57%	61%	64%	68%	72%	75%	79%	83%	86%	90%	93%	97%	101%	104%	108%	112%
64%	60%	64%	68%	72%	75%	79%	83%	87%	91%	95%	99%	102%	106%	110%	114%	118%
67%	63%	67%	71%	75%	79%	83%	87%	92%	96%	100%	104%	108%	112%	116%	120%	124%
70%	66%	71%	75%	79%	83%	88%	92%	96%	100%	104%	109%	113%	117%	121%	126%	130%
74%	69%	74%	78%	83%	87%	92%	96%	100%	105%	109%	114%	118%	123%	127%	132%	136%
77%	73%	77%	82%	86%	91%	96%	100%	105%	110%	114%	119%	124%	128%	133%	137%	142%
80%	76%	80%	85%	90%	95%	100%	105%	109%	114%	119%	124%	129%	134%	138%	143%	148%
84%	79%	84%	89%	94%	99%	104%	109%	114%	119%	124%	129%	134%	139%	144%	149%	154%
87%	82%	87%	92%	98%	103%	108%	113%	118%	124%	129%	134%	139%	145%	150%	155%	160%
90%	85%	90%	96%	101%	107%	112%	118%	123%	128%	134%	139%	145%	150%	156%	161%	166%
93%	88%	94%	99%	105%	111%	116%	122%	127%	133%	139%	144%	150%	156%	161%	167%	172%
97%	91%	97%	103%	109%	114%	120%	126%	132%	138%	144%	149%	155%	161%	167%	173%	179%
100%	94%	100%	106%	112%	118%	124%	130%	136%	142%	149%	155%	161%	167%	173%	179%	185%

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 3-2 Opex recovery analysis (2020 financial situation)

Operational Revenues : 32,522 M LBP	Cash Flow : 16,608 M LBP	Total OPEX : 263,149 M LBP

Financial Indicators (Typical 2022)

Exchange Rate :	20,000	LBP/USD
Diesel	19,700	LBP/l
gazoline	375,000	LBP/20 l
transportation	64,000	LBP/day
EDL/Gen. %	92%	EDL
EDL increase factor :	13.00	
CPI (base = 115) :	700	
Salaries increase factor :	2.00	
Including new WWTPs :	Yes	
Tariff increase factor :	1.00	

Bill amount for 1 m³ subscription (gauged not connected) : 279 000 LBP)

Collection rate assessment

Revenues :	32,522	M LBP
Collected :	16,608	M LBP
Collection Rate	**51%**	
Cost recovery	6%	

Subscriptions rate assessment

Volume Produced	96,577	K m³
Volume Billed	48,782	K m³
Technical losses	6%	(ILI = 8)
Revenue Water	**54%**	
Potential invoicing	60,357	M LBP

OPEX Breakdown

HR	45,058	M LBP
Power	139,428	M LBP
EDL	107,624	M LBP
Generators	27,265	M LBP
Donations	4,538	M LBP
Consumables	11,186	M LBP
Paid by WE	11,186	M LBP
Donations	0	M LBP
O&M	59,096	M LBP
Paid by WE	29,254	M LBP
Donations	29,841	M LBP
Administrative	8,382	M LBP

SUBSCRIPTION RATE	COLLECTION RATE															
	51%	**54%**	**58%**	**61%**	**64%**	**67%**	**71%**	**74%**	**77%**	**80%**	**84%**	**87%**	**90%**	**93%**	**97%**	**100%**
	TOTAL OPEX RECOVERY RATE **Amount to recover : 263,149 M LBP**															
54%	**6%**	7%	7%	8%	8%	8%	9%	9%	10%	10%	10%	11%	11%	12%	12%	12%
57%	7%	7%	8%	8%	8%	9%	9%	10%	10%	11%	11%	11%	12%	12%	13%	13%
60%	7%	8%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%	13%	13%	14%
64%	7%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%	13%	14%	14%	15%
67%	8%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%	13%	14%	14%	15%	15%
70%	8%	9%	9%	10%	10%	11%	11%	12%	12%	13%	14%	14%	15%	15%	16%	16%
74%	9%	9%	10%	10%	11%	11%	12%	12%	13%	14%	14%	15%	15%	16%	16%	17%
77%	9%	10%	10%	11%	11%	12%	12%	13%	14%	14%	15%	15%	16%	16%	17%	18%
80%	9%	10%	11%	11%	12%	12%	13%	14%	14%	15%	15%	16%	17%	17%	18%	18%
84%	10%	10%	11%	12%	12%	13%	14%	14%	15%	15%	16%	17%	17%	18%	19%	19%
87%	10%	11%	11%	12%	13%	13%	14%	15%	15%	16%	17%	17%	18%	19%	19%	20%
90%	11%	11%	12%	13%	13%	14%	15%	15%	16%	17%	17%	18%	19%	19%	20%	21%
93%	11%	12%	12%	13%	14%	14%	15%	16%	17%	17%	18%	19%	19%	20%	21%	21%
97%	11%	12%	13%	13%	14%	15%	16%	16%	17%	18%	19%	19%	20%	21%	21%	22%
100%	12%	12%	13%	14%	15%	15%	16%	17%	18%	18%	19%	20%	21%	21%	22%	23%

The financial situation of NLWE – 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. Table C 3-3 below shows the required tariff for Opex recovery, for various scenarios.

Table C 3-3 Required tariff revision

IMPACT OF TARIFF INCREASE ON COST RECOVERY RATE														
Assuming unchanged Collection and Subscriptions rates														
Cost recovery rate	6%	14%	21%	28%	35%	42%	50%	57%	64%	71%	78%	86%	93%	100%
Tariff increase factor	1	2.14	3.28	4.43	5.57	6.71	7.85	8.99	10.14	11.28	12.42	13.56	14.70	15.84
Required bill amount for 100% Cost recovery : 4 420 000 LBP														
Assuming 100% Collection; Subscriptions unchanged														
Cost recovery rate	12%	19%	26%	33%	39%	46%	53%	60%	66%	73%	80%	87%	93%	100%
Tariff increase factor	1	1.55	2.09	2.64	3.18	3.73	4.27	4.82	5.36	5.91	6.45	7.00	7.55	8.09
Required bill amount for 100% Cost recovery : 2 260 000 LBP														
Assuming 100% Collection and Subscriptions														
Cost recovery rate	23%	29%	35%	41%	47%	53%	59%	64%	70%	76%	82%	88%	94%	100%
Tariff increase factor	1	1.26	1.52	1.78	2.03	2.29	2.55	2.81	3.07	3.33	3.58	3.84	4.10	4.36
Required bill amount for 100% Cost recovery : 1 220 000 LBP														

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 3-1 below gives a possible (and plausible) progress that NLWE 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	51%	46.80%	52% (+5%)	57% (+5%)	62% (+5%)	67% (+5%)	72% (+5%)
Subscriptions rate	54%	54%	58% (+4%)	62% (+4%)	66% (+4%)	70% (+4%)	74% (+4%)
Tariff increase factor	1.00	1.00	5.38 (+438%)	6.45 (+20%)	7.74 (+20%)	8.96 (+16%)	10.30 (+15%)
Bill amount (for 1 m³/day, gauged)	**279,000 LBP**	**279,000 LBP**	**1,500,000 LBP**	**1,800,000 LBP**	**2,160,000 LBP**	**2,500,000 LBP**	**2,875,000 LBP**
2019 Revenue increase factor	1.00	1.00	6.39	8.99	12.50	16.59	21.68
Cost Recovery	51%	4.30%	27%	39%	54%	71%	93%
Cash flow/Opex Balance	**-16,079 M LBP** (-10.7 M$)	**-338,621 M LBP** (-16.9 M$)	**-256,545 M LBP** (-12.8 M$)	**-216,969 M LBP** (-10.8 M$)	**-163,586 M LBP** (-8.2 M$)	**-101,371 M LBP** (-5.1 M$)	**-23,906 M LBP** (-1.2 M$)
Cash flow/Opex Balance in case unchanged collection and subscription rates	**-16,079 M LBP** (-10.7 M$)	**-338,621 M LBP** (-16.9 M$)	**-272,012 M LBP** (-13.6 M$)	**-255,646 M LBP** (-12.8 M$)	**-236,007 M LBP** (-11.8 M$)	**-217,459 M LBP** (-10.9 M$)	**-197,001 M LBP** (-9.9 M$)

	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	92% EDL	92% EDL
EDL increase factor :	1	25.0 x 2019 rate
CPI	115	700
Salaries increase factor :	1	1.5 x 2019 rate
OPEX		**353,841 M LBP**

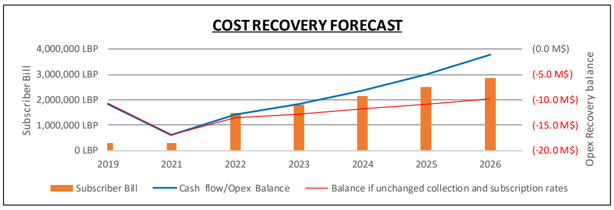


Figure C 3-1 Plausible gradual improvement in order to achieve Opex balance

C. 4 MAJOR RECOMMENDATIONS

In 2021 in the context of hyperinflation, the picture has deteriorated 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 WEs 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.

- Tariff level adjustment should target the operating cost while accounting for collection rate and NRW.
- Such tariff adjustment should also include an automatic adjustment formula that would not require a formal authorization/clearance from the Ministry for being applied. Such formula should take into account (among others) the cost of energy, the cost of chemicals and other consumables.
- An urgent review for the provision of increase of the tariff level for matching the O & M cost. Such review is to be made through a quick review of the 2021 financial statements. Such action can be made either through the TA or appoint a specific consultant for that particular purpose. The key issue being; the process has to be quick and accepted by the Ministry and WEs.
- Introduce a task force within the WE for addressing the key issue of declining collection rates for corrective action starting with information campaigns and ending with disconnections threats.
- 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.
- 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.
- Hire a sewage treatment expert seconded to the WE in order to oversee the execution of these contracts.
- 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 NLWE.

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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LIST OF TABLES

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D. 1 BASIS OF PERFORMANCE DIAGNOSIS

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	kVar
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)	m³
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 وتبويمها.		
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:

- <u>The income statement</u>
  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 is 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 in 2005 for NLWE as follows:

- 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

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 14931

Bylaw 14913/5 July 2005 (T*he Organisation of North 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.

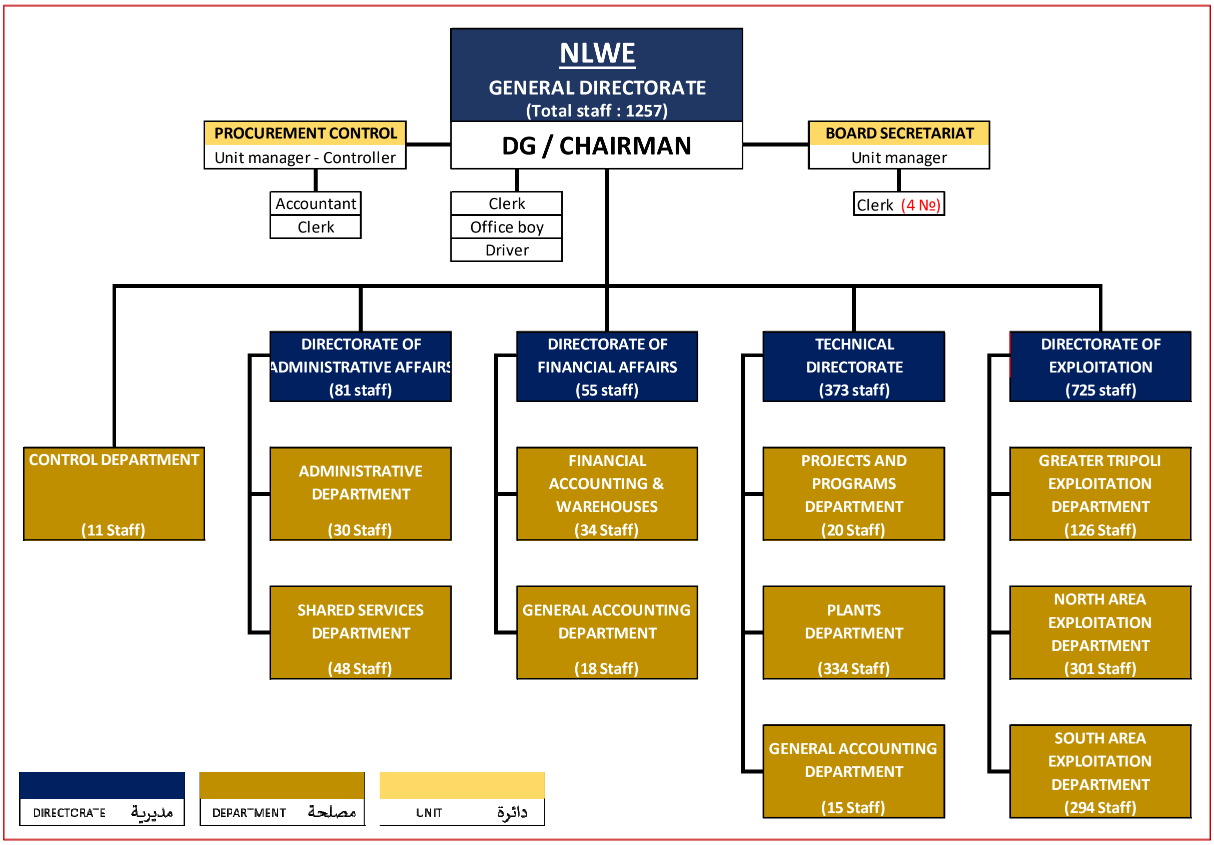

Figure D 2-1 NLWE General Organigram

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 following tables extracted from the by-law, where the title and number of each position are provide

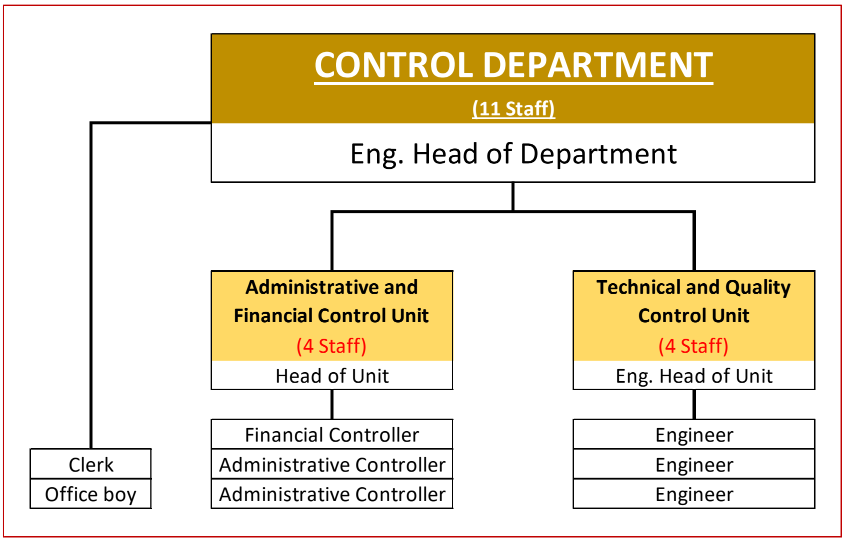

Figure D 2-2 Control department Organigram

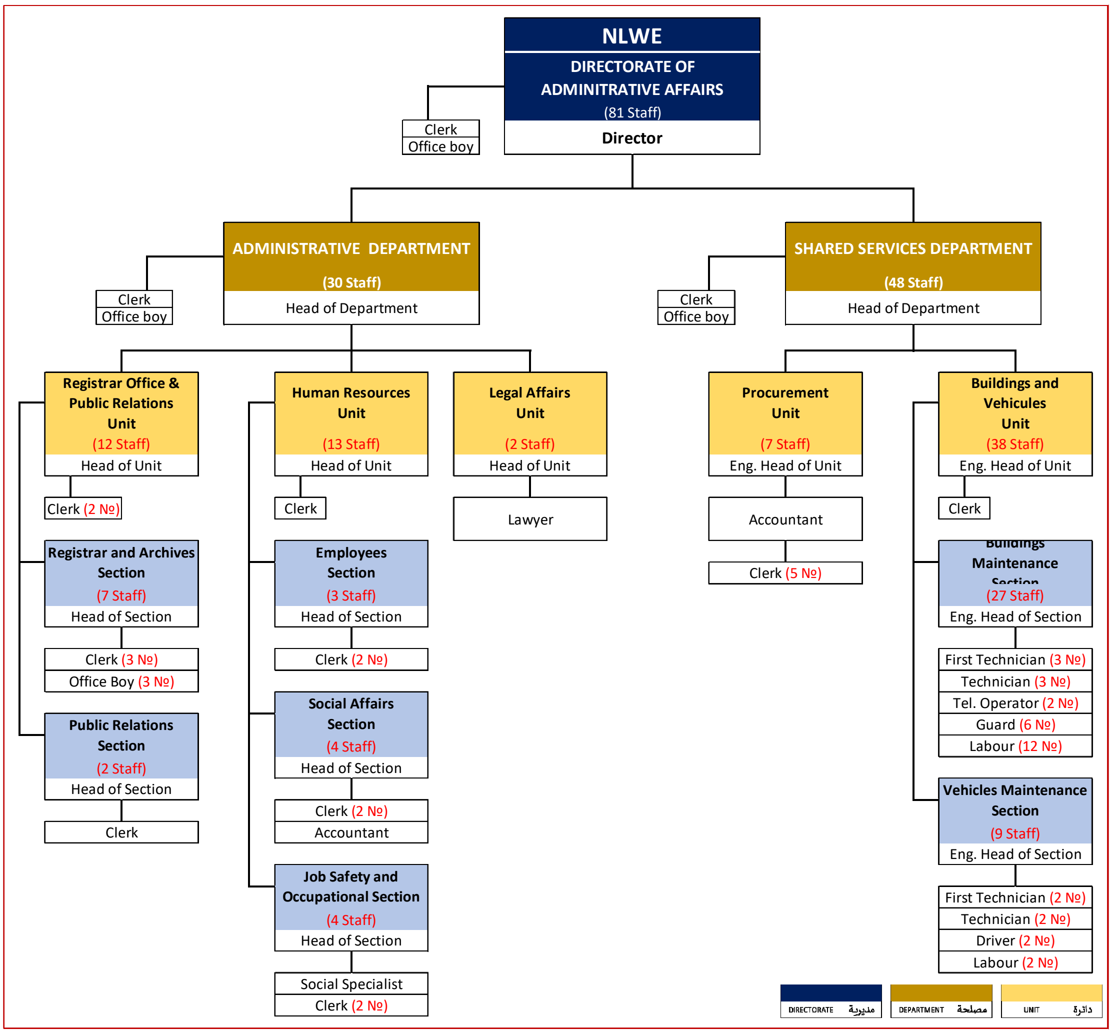

Figure D 2-3 Directorate of administrative affairs Organigram

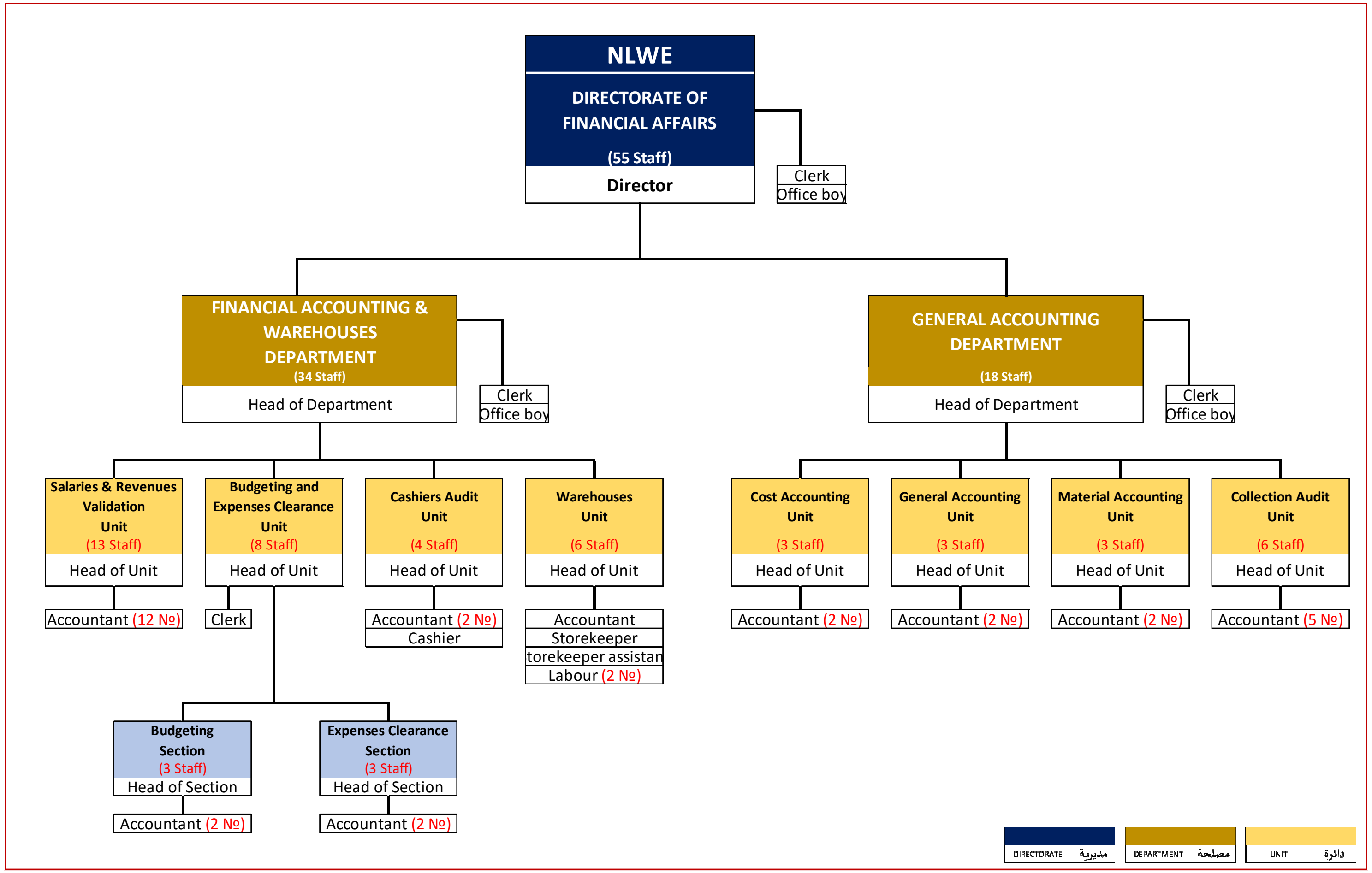

Figure D 2-4 Directorate of financial affairs Organigram

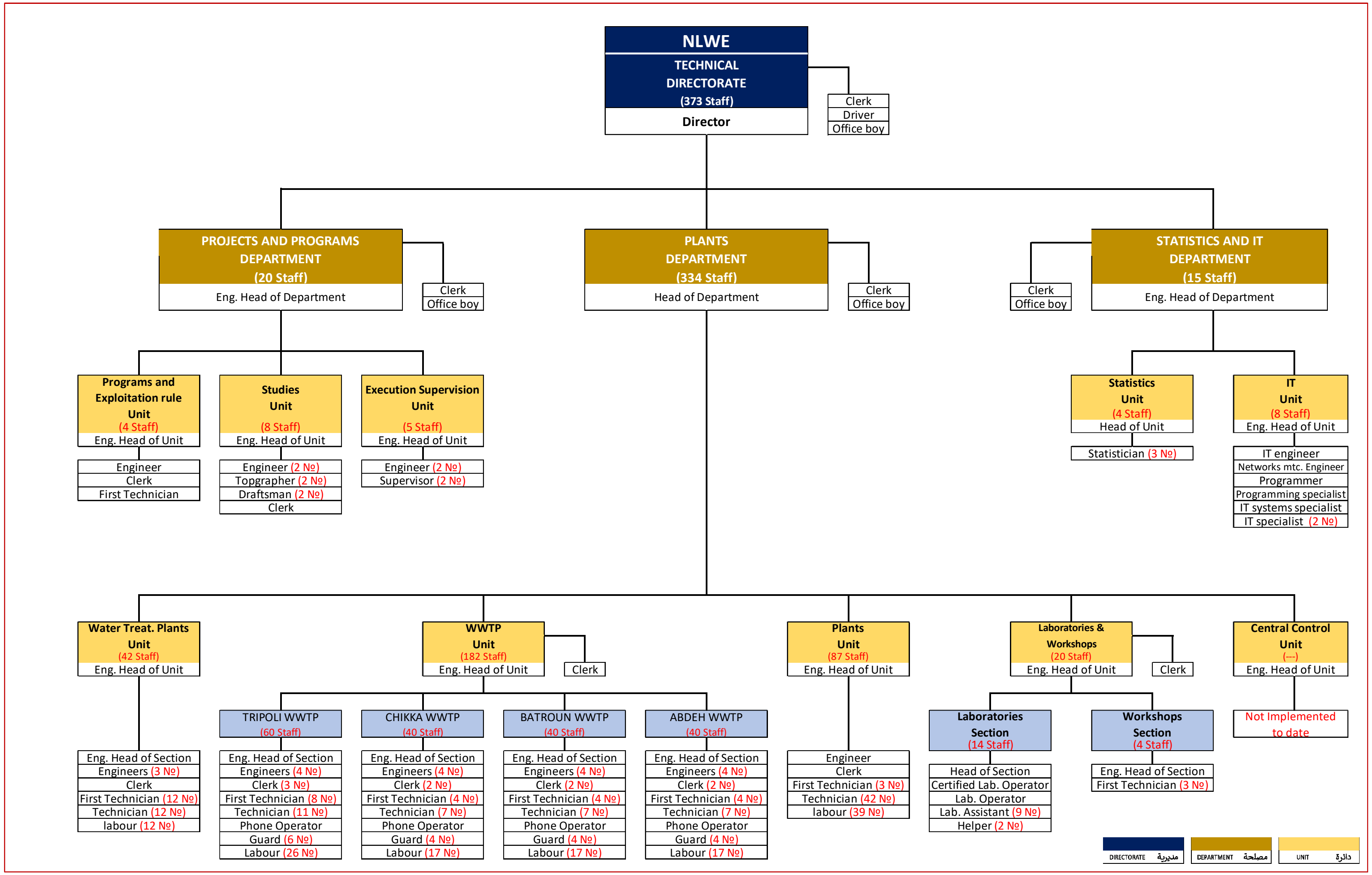

Figure D 2-5   Technical Directorate Organigram

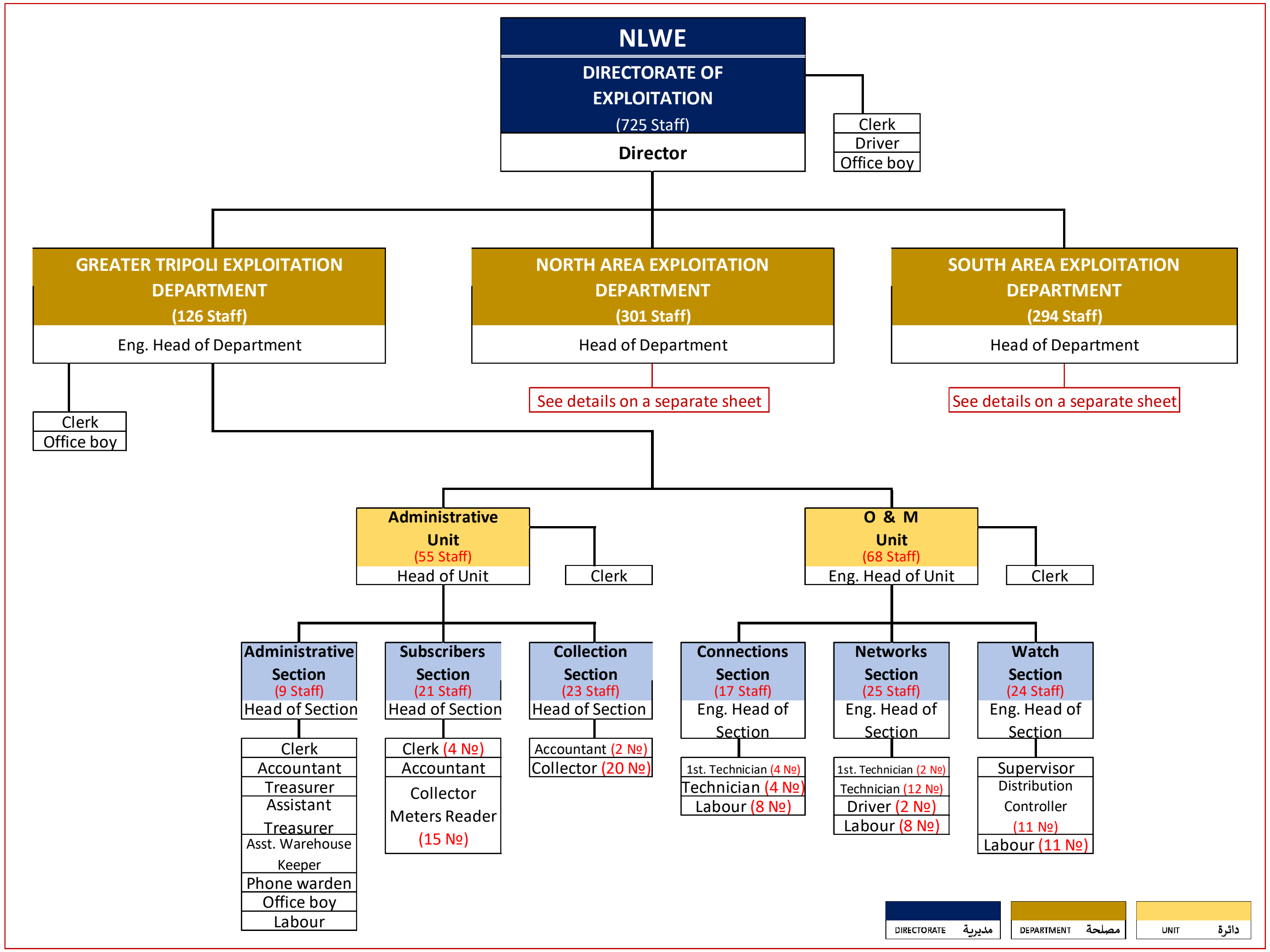

Figure D 2-6 Exploitation Tripoli Organigram

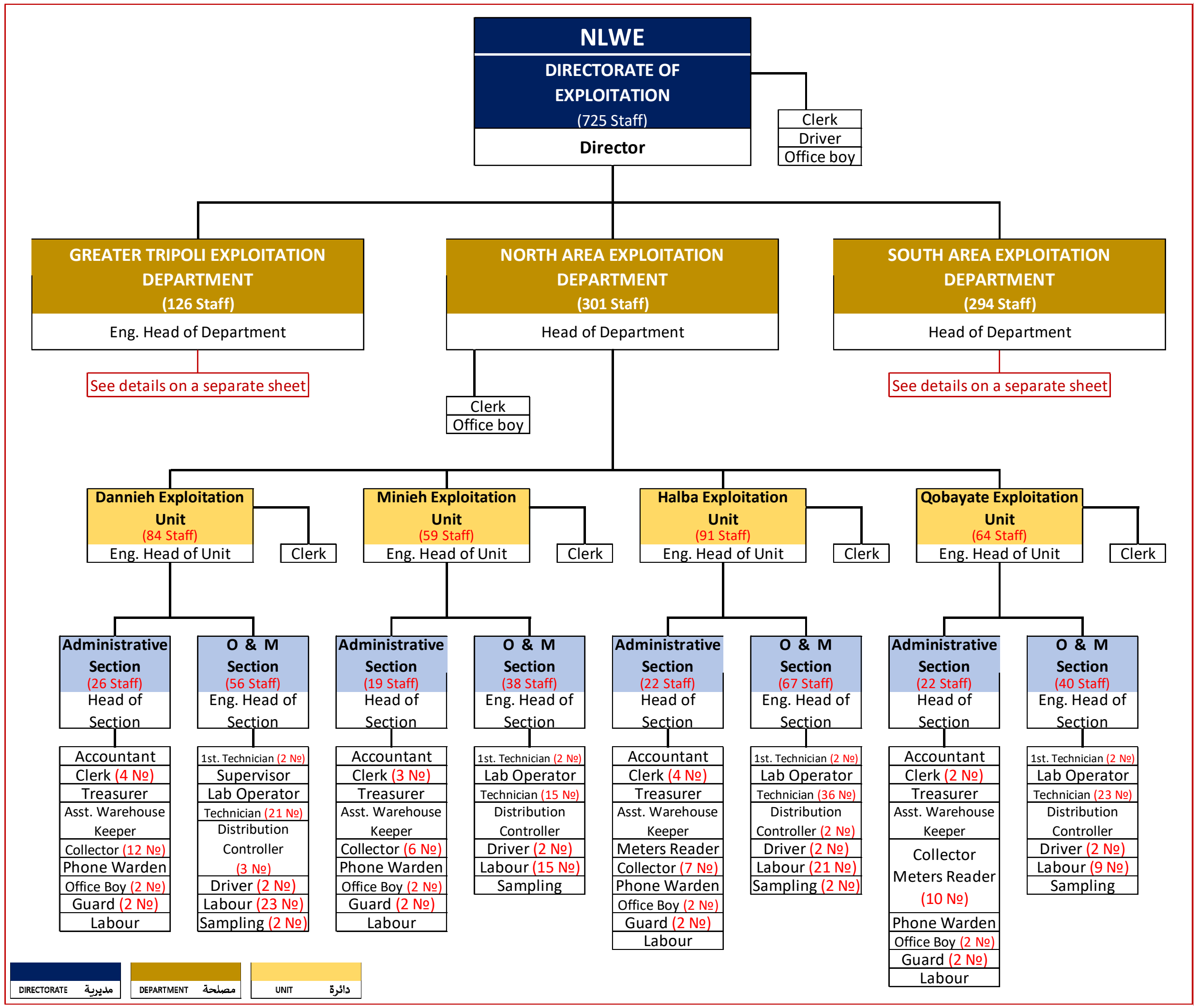

Figure D 2-7 Exploitation North Organigram

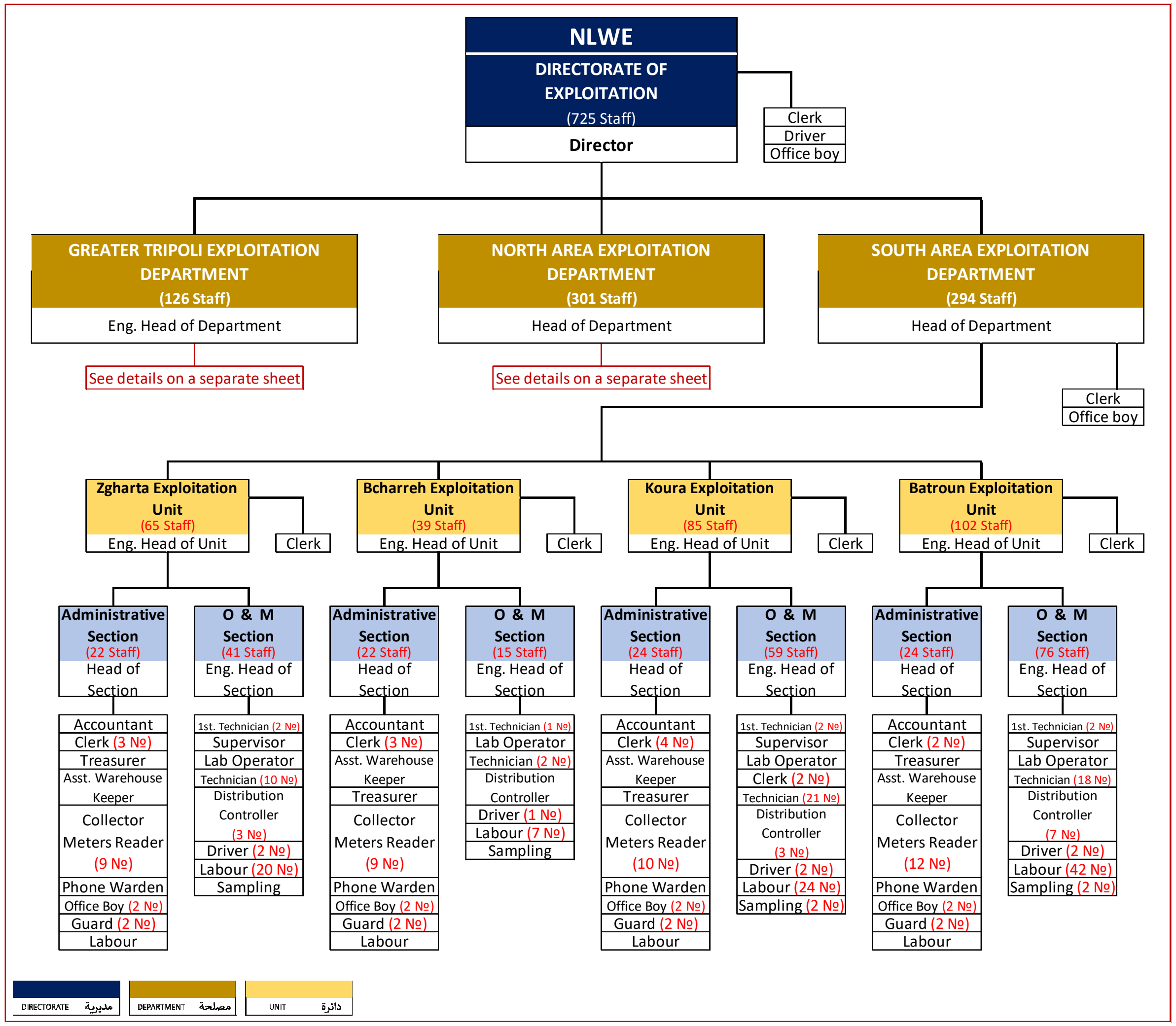

Figure D 2-8 Exploitation South Organigram

Table D 2-1 NLWE Staff distribution by business area according to NLWE organizational by-laws

	Central	Batroun	Bcharreh	Dannieh	Halba	Koura	Minieh	Qobayat	Tripoli	Zgharta	Total
Customer Service											
Distribution	10	102	39	84	91	85	59	64	126	65	725
Engineering	20										20
Facilities	134	40			40	40			60		314
Finance	66										66
General	105										105
HR	13										13
Water quality	14										14
Grand Total	362	142	39	84	131	125	59	64		65	1257

Table D 2-2 NLWE Staff Distribution by job type. according to NLWE organizational by-laws

	Central	Batroun	Bcharreh	Dannieh	Halba	Koura	Minieh	Qobayat	Tripoli	Zgharta	Total
Auxiliary - Clerical	48	4	1	1	4	6	1	1	8	1	75
Auxiliary – Driver	5	1	1	1	1	1	1	1	2	1	15
Auxiliary – Guard	6	6	2	2	6	6	2	2	6	2	40
Auxiliary – Office boy	18	2	2	2	2	2	2	2	2	2	36
Collector/Reader		12	9	12	8	10	6	10	35	9	111
Customer Service		3	4	5	5	5	4	3	5	4	38
Financial / Administrative	42	3	3	3	3	3	3	3	7	3	73
Management	28	1	1	1	1	1	1	1	4	1	40
Management (Eng.)	24	3	2	2	3	3	2	2	6	2	49
Technical - Driver		1		1	1	1	1	1	0	1	7
Technical - Engineer	14	4			4	4			4		30
Technical - Labourer	69	60	8	24	39	42	16	10	54	21	343
Technical - Other	97	39	4	27	51	38	18	26	53	16	369
Technical - Water quality	11	3	2	3	3	3	2	2	0	2	31
Grand Total	362	142	39	84	131	125	59	64	186	65	1257

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 all of NLWE.

D.2.1.2 Human Resources as collected from NLWE

Different data was provided by NLWE's personnel when approached by the consultant:

2.1.2.1 Staff Table provided by NLWE (Jun 1st 2021)

A detailed table of employees was provided by NLWE showing the current assignment as well as the original position and job assignment for each employee. Two employees were indicated to have been assigned to a job while also serving at their original position. We applied the information at the level of each employee and matched it with the positions as indicated in the bylaws enabling us to find the number of employees by departmental business area as well as by job type. One staff member had comments indicating that they have been terminated in 2019.

Table D 2-3 Number of employees by business area.

Business Area	No.
Distribution	180
Engineering	4
Facilities	8
Finance	24
General	20
HR	3
Water quality	2
Grand Total	241

Table D 2-4 Number of employees by job type.

Job Type	No.
Auxiliary - Clerk	14
Auxiliary - Guard	2
Auxiliary - Office boy	5
Auxiliary - Phone operator	2
Collector/Reader	21
Financial / Administrative	34
Management	23
Management (Eng.)	17
Technical - Engineer	1
Technical - Other	113
Technical - Water quality	9
Grand Total	241

2.1.2.2 Table summary of on-demand personnel

A scanned document shows the 2021 number of on-demand contracted staff as follows:

Table D 2-5 2021 number of on-demand contracted staff as given by NLWE.

Position	No.
Engineer	3
Public relations	1
Administrative assistant	4
Data entry - Communication	4
Laboratory technician	28
Plants technician - plumber	68
Driver, guard, sampler , labourer, etc.	255
Total	363

Given the limited information, only an attempt was made at job types as follows:

Table D 2-6 Number of on-demand contracted personnel by job type

Job Type	No.
Auxiliary - Clerical	4
Auxiliary - Driver	
Auxiliary - Guard	
Auxiliary - Office boy	
Collector/Reader	
Customer Service	4
Financial / Administrative	1
Management	
Management (Eng.)	
Technical - Driver	
Technical - Engineer	3
Technical - Labourer	
Technical - Other	68
Technical - Water quality	28
Unknown	255
Grand Total	363

2.1.2.3 NLWE presentation 2021

A presentation given by NLWE gave the number of employees by general job type, as well as the number of on-demand contract as follows:

Table D 2-7 Number of employees by job type

Positions	2018	2019	2020
Total Employees	265	254	246
Engineers	19	18	17
BA Holders	63	63	63
BT/TS Holders	38	37	37
Skilled Labour	32	31	31
Unskilled Labour	113	105	98

Table D 2-8 Number of on-demand contracted personnel by job type

Positions	2018	2019	2020
Total On-demand	340	360	370
Engineers	3	3	3
BA Holders	0	0	0
BT/TS Holders	0	0	0
Skilled Labour	107	107	107
Unskilled Labour	230	240	250

D.2.2 TECHNICAL

D.1.1.1System information

2.2.1.1 GIS export file

A GIS export of different asset layers provides the main source of data for system information. Most fields had a significant number of unpopulated records and therefore technical details cannot be extracted in a representative way across the entire system. Moreover, the extent to which the NLWE GIS covers the entire network is variable depending on where major investments were made and where GIS documents were provided from the contractors working on these investments. Almost all of the entries for facilities were dated as part of the 2017 asset survey with the LWP project. The network details are largely absent with some exceptions such as the transmission mains of most parts. The remaining network information is being prepared for an update.

Table D 2-9 Well information according to GIS

Well condition	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Total
Average	3	1	5	8	7	3	11	8	23	69
Good	12		1	4	12	7	5	6	3	50
Non-Operational				1	1		2	3		7
Poor	5			3	11	3	6	6	4	38
Grand Total	20	1	6	16	31	13	25	24	32	168
Assumed operational	20	1	6	15	30	13	23	21	32	161

Table D 2-10 PS information according to GIS

PS condition	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Total
(Blank)			2	1	1			1		5
Average	6	1	3	4	2	4	3	4	6	33
Good	6	3	1	6		2	3	6	5	32
Poor	1	1	1	1	3		2			9
Grand Total	13	5	7	12	6	6	8	11	11	79
Assumed operational	13	5	7	12	6	6	8	11	11	79

Table D 2-11 Springs information according to GIS

PS condition	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	and Total
(Blank)	4	8	24	6	1		6	1	19	69
Average	1	1	3	1		2	1		7	16
Good		1				1		1		3
Non-Operational						1				1
Poor			2						1	3
Grand Total	5	10	29	7	1	4	7	2	27	92
Assumed operational	5	10	29	7	1	3	7	2	27	91

Table D 2-12 Reservoirs information according to GIS

Reservoir condition	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
(Blank)			5	1			6	2	1	15
Average	52	11	44	54	19	6	58	4	39	287
Good	40	4	9	29	20	5	6	10	7	130
Non-Operational	3	1		1	4		6			15
Poor	10	7	6	11	15	4	6	4	9	72
Grand Total	105	23	64	96	58	15	82	20	56	519
Assumed operational	102	22	64	95	54	15	76	20	56	504

Table D 2-13 Transmission mains lengths by material according to GIS

Trans. Line Material	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
(Blank)	146,562	54,092	147,340	69,135	105,756	2,918	182,426		68,108	776,337
DI	2,058			70730			7173			79,962
GRP				4670						4,670
HDPE							19736			19,736
PE				907						907
Grand Total	**148,621**	**54,092**	**147,340**	**145,442**	**105,756**	**2,918**	**209,335**		**68,108**	**881,612**

Table D 2-14 Transmission mains lengths by status according to GIS

PS condition	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
(Blank)	142671	13575	6742	1401	73674	2918	107		19736	260824
Future project							10266			10266
Kobayat							2698			2698
Needs renovation	5949	40517	140598	17753	32082		71396		48372	356668
New project				97878			50804			148682
New project 2017							34289			34289
Old project							3510			3510
Ongoing project				28410			36266			64676
Grand Total	148621	54092	147340	145442	105756	2918	209335		68108	881612

Table D 2-15 Transmission mains lengths by method of operation according to GIS

Trans. Line delivery	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
Gravity	131947	53132	136978	72393	63663	42	153677		57422	669253
Pumping	16674	960	10362	73049	42093	2876	55658		10686	212358
Grand Total	148621	54092	147340	145442	105756	2918	209335		68108	881612

2.2.1.2 Tripoli Network spreadsheet

Information about different Tripoli network segments of different projects were provided as a spreadsheet.

Table D 2-16 Tripoli network lengths by material and by diameter

AC	167,830
AG	10,237
DI	29,635
CI	80,070
GRP	8,729
HDPE	101,140
PVC	3,345
(blank)	140,502
Grand total	**541,488**

Diameter	Grand Total
<100	103,290
100-300	372,892
>300	55,897
(blank)	9,409
Grand Total	541,488

2.2.1.3 Technical directorate information sheet

A scanned document was provided by the technical directorate included the quantity supplied and a list of resources.

The document contrasts production quantities with subscriptions and quantity subscribed in each region for 2020. Since the subscriptions do not include Tripoli their summation would not be of value.

Table D 2-17 Number of resources by type

Asset	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
Springs	2	8	6			2			7	
Wells	20	1	8			9			24	
Total	22	9	14	11	28	11	12	0	31	138

Table D 2-18 Production v/s Subscriptions

Value (m^3/day)	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
Production	30882	4123	21345	27073	28210	14910	4538		15349	146430
Subscribed Quantity	12801	4123	11941	12023	17551	5067	4244		10921	
Subscriptions	11579	3581	8396	11618	14949	4329	4183		10482	

2.2.1.4 Billing system report

The billing system output for the years 2018-2020 was provided were the numbers of customers and subscribed quantity were provided.

Table D 2-19 Quantity of meters billed by type

Year	Subscribed (m³/day)	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
2018	Gauge	10,521	4,110	10,998	2,187	14,726	3,985	1,980	12,718	10,639	71,864
	Inactive								768		768
	Meter	1,648		371	8,655	2,302	933	2,161	41,702	7	57,778
	Grand Total	12,169	4,110	11,369	10,842	17,028	4,918	4,141	55,188	10,646	130,410
2019	Gauge	10,502	4,114	11,115	1,449	14,763	4,033	1,838	12,761	10,872	71,447
	Inactive								760		760
	Meter	1,939		590	10,111	2,622	957	2,309	42,907	7	61,441
	Grand Total	12,441	4,114	11,705	11,560	17,385	4,990	4,147	56,427	10,879	133,648
2020	Gauge	10,822	4,123	11,309	1,449	14,877	3,922	1,436	12,759	10,921	71,618
	Inactive								753		753
	Meter	1,979		632	10,575	2,674	1,145	2,808	43,779	7	63,598
	Grand Total	12,801	4,123	11,941	12,024	17,551	5,067	4,244	57,290	10,928	135,969

2.2.1.5 NLWE presentation 2021

A presentation given by NLWE gave the monthly production in each region as follows:

Table D 2-20 Monthly production

Region	Springs	Wells	Total
Batroun	527,642	401,345	928,986
Bcharreh	226,320	2,400	228,720
Denniyeh	550,440	89,910	640,350
Halba		739,893	739,893
Koura	494,973	562,073	1,057,045
Minieh	104,400	342,900	447,300
Qobayyat		151,517	151,517
Tripoli	2,026,824	914,144	2,940,967
Zgharta	441,733	190,241	631,974
Inactive	4,372,332	3,394,423	7,766,751

Where assuming a 30 day month estimate was used as verified by listed total daily rates, the following annual amounts can be estimated:

Table D 2-21 Annual production

Region	Springs	Wells	Total
Batroun	6,419,644	4,883,031	11,302,663
Bcharreh	2,753,560	29,200	2,782,760
Denniyeh	6,697,020	1,093,905	7,790,925
Halba	-	9,002,032	9,002,032
Koura	6,022,172	6,838,555	12,860,714
Minieh	1,270,200	4,171,950	5,442,150
Qobayyat	-	1,843,457	1,843,457
Tripoli	24,659,692	11,122,085	35,781,765
Zgharta	5,374,418	2,314,599	7,689,017
Grand Total	53,196,706	41,298,814	94,495,483

The presentation also lists their own estimate, while also listing the production and regional water storage capacities as follows:

Table D 2-22 Annual production capacity

Production	2018	2019	2020	2021
Daily (m^3/d)	130,410	133,648	135,969	138,837
Annual (1000 m^3/year)	95,049	96,557	94,494	94,400
Capacity (1000 m^3/year)	123,560	125,525	122,840	122,720

Table D 2-23 Storage capacity

Region	Storage
Batroun	19,890
Bcharreh	4,900
Denniyeh	16,945
Halba	46,955
Koura	13,490
Minieh	2,335
Qobayyat	13,975
Tripoli	59,440
Zgharta	14,280
Grand Total	192,210

NLWE did not provide any further explanation on the method of calculation or estimation of these figures.

D.1.1.2 Energy

A scanned table was provided that showed 91 generators, their KVA rating, and their locations. Fuel consumption and energy used were not provided.

Table D 2-24 Number of generators

Value	Central	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
Number of generators	2	7	1	5	9	10	8	8	30	11	91

D.1.1.3 Water Quality

2.2.1.6 Annual Report Draft 2019 – Laboratory section

Passing results of different water quality tests were provided in form of images in a draft for the annual report. The data itself or the official report were not provided. There was no evidence to whether the passing rates refer to potable or raw water or both, or if they reflect test results that are required for compliance or not.

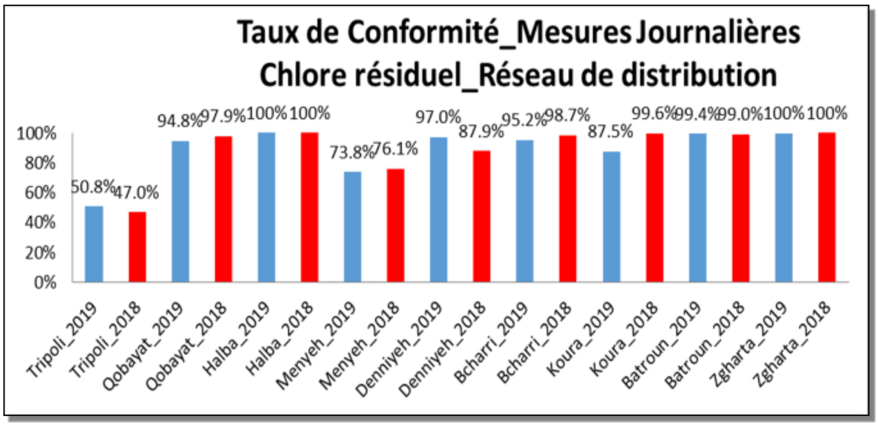

Figure D 2-9 An example of water quality test passing rates reported by NLWE.

2.2.1.7 Regional laboratory reports 2021

Detailed and comprehensive results of sampling and laboratory tests that span aesthetic, physical-chemical, as well as microbiological tests were provided. The exact number of tests conducted on each sample and the reference standard are also provided with a summary for each month on the passing rate. The reported results were not in a database form and significant work is needed to consolidate them. Also, these reports only cover the first half of 2021, and there is no way to evaluate the compliance of these tests with the sufficient number of samples and tests.

المديرية الفنية
دائرة المختبرات والمشاغل - مختبر البترون

نتائج التحاليل الفيزيوكيميائية للمتابعة اليومية لمياه محطة كفرحلدا المعلجة خلال شهر حزيران 2021

الرقم	تاريخ الإعتيان	رمز العينة	نقطة الإعتيان	الكلور الحر	العكارة	couleur	Ph	الموصلية	ملاحظات
1	01/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.33	0.79	<5	7.56	469	المعالجة بغسيل الفلاتر عند الحاجة
2	02/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.34	0.89	<5	7.48	461	
3	03/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.33	0.97	<5	7.49	458	
4	04/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.33	0.69	<5	7.51	470	
5	07/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.31	0.95	<5	7.63	463	
6	08/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.30	0.87	<5	7.60	461	
7	09/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	0.91	<5	7.52	460	
8	6/10/21	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	0.94	<5	7.44	470	
9	11/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.31	0.70	<5	7.48	472	
10	14/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.30	0.85	<5	7.57	459	
11	15/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	1.02	<5	7.52	461	
12	16/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	0.56	<5	7.49	470	
13	18/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.31	0.51	<5	7.53	471	
14	21/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.30	0.41	<5	7.51	477	
15	22/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.33	0.33	<5	7.46	471	
16	23/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.34	0.38	<5	7.49	472	
17	24/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	0.39	<5	7.51	468	
18	25/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	0.38	<5	7.56	467	
19	28/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.33	0.47	<5	7.54	475	
20	29/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.32	0.41	<5	7.44	471	
21	30/06/2021	OA-PR-B1	نبع الدلة والفواويط المعالج	0.31	0.52	_	_	_	
			طريقة الإختبار والتحليل	Methode colorimétrique	Methode néphelométrique	Spectrophotométrie	Electrode		
			عدد التحاليل المحللة للمياه المعالجة N.E analysés d'eaux traitees	21	21	20	20	20	
			عدد التحاليل المطابقة للمياه المعالجة N.E conformes d'eaux traitees	21	21	20	20	20	
			نسبة التطابق المئوية Taux de conformité	100.00%	100.00%	100.00%	100.00%	100.00%	
			الحد الأقصى المسموح به في المياه الصالحة للشرب	0.5mg/l	<5 N.T.U	<15 Pt co	6.5-8.5	200-1500 us/cm	

Figure D 2-10 A sample of lab report

NLWE has provided some of the most complete water quality testing reports yet only for six months of 2021.

D.2.3 CUSTOMER SERVICE

D.1.1.4Subscribers

2.3.1.1 Billing system report

The scan of a billing system detailed output report for the years 2018-2020 was provided were the number of customers and subscribed quantity were provided and summarised as follows:

Table D 2-25 Potable water subscribers.

Year	Subscribers (No.)	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
2018	Gauge	9,848	3,575	7,552	2,149	13,661	3,347	1,955	15,389	10,240	67,716
	Inactive								811		811
	Meter	1,182		299	8,319	823	839	2,119	42,681	4	56,266
	Total	**11,030**	**3,575**	**7,851**	**10,468**	**14,484**	**4,186**	**4,074**	**58,881**	**10,244**	**124,793**
2019	Gauge	10,047	3,574	7,692	1,433	13,851	3,407	1,821	15,424	10,452	67,701
	Inactive								792		792
	Meter	1,225		484	9,728	917	844	2,251	43,657	4	59,110
	Total	**11,272**	**3,574**	**8,176**	**11,161**	**14,768**	**4,251**	**4,072**	**59,873**	**10,456**	**127,603**
2020	Gauge	10,337	3,581	7,875	1,433	13,942	3,311	1,421	15,422	10,482	67,804
	Inactive								776		776
	Meter	1,242		521	10,185	1,007	1,018	2,762	44,240	4	60,979
	Total	**11,579**	**3,581**	**8,396**	**11,618**	**14,949**	**4,329**	**4,183**	**60,438**	**10,486**	**129,559**

Table D 2-26 Subscribed potable water quantities.

Year	Subscribed (m³/day)	Batroun	Bcharreh	Denniyeh	Halba	Koura	Minieh	Qobayyat	Tripoli	Zgharta	Grand Total
2018	Gauge	10,521	4,110	10,998	2,187	14,726	3,985	1,980	12,718	10,639	71,864
	Inactive								768		768
	Meter	1,648		371	8,655	2,302	933	2,161	41,702	7	57,778
	Total	**12,169**	**4,110**	**11,369**	**10,842**	**17,028**	**4,918**	**4,141**	**55,188**	**10,646**	**130,410**
2019	Gauge	10,502	4,114	11,115	1,449	14,763	4,033	1,838	12,761	10,872	71,447
	Inactive								760		760
	Meter	1,939		590	10,111	2,622	957	2,309	42,907	7	61,441
	Total	**12,441**	**4,114**	**11,705**	**11,560**	**17,385**	**4,990**	**4,147**	**56,427**	**10,879**	**133,648**
2020	Gauge	10,822	4,123	11,309	1,449	14,877	3,922	1,436	12,759	10,921	71,618
	Inactive								753		753
	Meter	1,979		632	10,575	2,674	1,145	2,808	43,779	7	63,598
	Total	**12,801**	**4,123**	**11,941**	**12,024**	**17,551**	**5,067**	**4,244**	**57,290**	**10,928**	**135,969**

The report also shows the number of agricultural subscribers and quantities subscribed, either in donum or faddan.

Table D 2-27 NLWE number of irrigation subscribers.

Year	Batroun	Denniyeh	Minieh	Zgharta	Grand Total
2018	249	5,361	1,721	96	7,427
2019	249	5,356	1,761	96	7,462
2020	254	5,361	1,755	96	7,466

Table D 2-28 NLWE irrigation subscription quantities in different units.

Year	Unit	Batroun	Denniyeh	Minieh	Zgharta	Grand Total
2018	Donum	771		3,357		4,128
	Faddan		9,695	2,949	233	12,877
2019	Donum	773		3,435		4,207
	Faddan		9,687	2,975	233	12,895
2020	Donum	794		3,390		4,184
	Faddan		9,689	2,919	226	12,833

2.3.1.2 NLWE presentation 2021

A presentation given by NLWE listed the number of subscriptions by type as well as the quantities distributed by region.

Table D 2-29 Number of subscriptions by type.

Customers	2018	2019	2020
Gauge	67,716	67,701	67,804
Meter	56,266	59,110	60,979
Water right	811	792	776
Total	124,793	127,603	129,559

Table D 2-30 Billed quantities by region.

Region	2018	2019	2020	2021
Batroun	4,441,685	4,540,965	4,672,365	4,770,943
Bcharreh	1,500,150	1,501,610	1,504,895	1,536,645
Denniyeh	4,149,685	4,272,325	4,358,465	4,450,420
Halba	3,956,965	4,219,218	4,388,578	4,481,168
Koura	6,215,220	6,345,525	6,406,115	6,541,271
Minieh	1,795,070	1,821,350	1,849,455	1,888,475
Qobayyat	1,511,465	1,513,655	1,549,060	1,581,742
Tripoli	20,143,529	20,595,946	20,910,941	21,352,120
Zgharta	3,885,790	3,970,835	3,988,720	4,072,874
Grand Total	47,599,559	48,781,429	49,628,594	50,675,657

D.1.1.5Quality of Service

A scanned table provided by the Operations Department listed the number of complaints for each type. The scope covers Tripoli only, and given the low numbers the level of data upkeep and adherence to recording each case encountered cannot be determined.

Table D 2-31 Tripoli operations recorded issues and complaints.

Tripoli	2016	2017	2018	2019	2020
Burst	791	664	556	542	357
Meter dysfunction	5	0	5	5	2
Water interruption at building	36	12	11	2	3
Survey of subscription	171	128	148	97	44
Water quality	38	35	46	21	17
Illegal tapping	5	4	3	0	0
Low water pressure	4	0	1	0	0
Total issues	**1,050**	**843**	**770**	**667**	**423**

D.1.1.6Service Coverage

A presentation given by NLWE in 2021 showed the current and future coverage rate of units by subscriptions. The presentation also lists a population of approximately 1.5 million Lebanese with 270,000 households, in addition to 500,000 refugees.

Coverage	2018	2019	2020
Coverage by NLWE	47.4%	47.6%	47.5%

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

The economic and financial data was collected, cleared and reconsolidated from the administrative budget of NLWE for year 2017 to 2020. Data for 2015 and 2016 is not available because the ERP is still under construction, as stated by NLWE.

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

D.2.4.2 Operational Expenditures

Expenses covers mainly cost of operation and maintenance that were extracted from the administrative account, and sorted by type. It is to be noted that accuracy is not detailed as in the trial balance. Moreover, a number of Opex are not correctly registered, or not registered at all, in the accounting of NLWE (See Sub-Section A. 0.5.3).

The OPEX information were collected from the administrative account of NLWE for the period between 2017 and 2020.

Table D 2-32 NLWE Opex from 2017 to 2020

(LBP)	2017	2018	2019	2020
HR	14,342,109,375	18,795,862,820	18,175,634,921	17,245,677,928
Operation & maintenance	7,131,536,000	8,842,874,000	8,505,142,256	8,157,392,360
Other expenditures	1,467,502,887	2,826,170,953	1,777,529,921	1,441,826,338
Fuel for Power generation	670,126,379	1,242,709,000	660,967,415	1,284,658,401
EDL	392,064,162	2,599,000	662,187,538	734,424,725
Grand Total	**24,003,338,803**	**31,710,215,773**	**29,781,462,051**	**28,863,979,752**

Nb: *Source: Budget expenditures account*

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 energy expenditures. NLWE relies on 4 sources for power supply

- Energy from Generator subscription, referring to outsourced power supply;
- Energy produced by WE generator (sensitive to availability/price of fuel).
- Power supply from EDL
- Power supply from *La Kadischa*[1]

It is to be noted that NLWE do not account electrical bills from La Kadischa and EDL. The values of these dues, which represent almost 30 % of the total Opex, have been reintegrated to get a real figure of the cost of water production and distribution.

Fixed costs are all costs other than energy, out of which the Human Resources cost amounts to 88 %.

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[1] *La Kadischa, Société anonyme d'électricité du Liban Nord* – SAL. A subsidiary of EDL for part of North Lebanon

D.2.4.3 Tariffs

Table D 2-33 below shows the water tariffs in force at NLWE, which calls for the following comments:

- Non-metered subscribers
  Are charged a yearly lump sum based on a typical 1 m^3/day consumption (i.e. 365 m^3 / year)
- Metered subscribers
  Are charged the same yearly lump sum as for non-metered subscribers.
  Over and above the typical lump sum for non-metered subscriptions (paid yearly), additional charges for extra consumption are calculated and invoiced as follows:
  Meters are read every three months. Consumption exceeding 90 m^3 (i.e. 365 m^3/4) during these three months, if any, is recorded and invoiced separately on a quarterly basis, at the unit rate of 750 LBP for residential subscriptions and 1,500 LBP for the industrial / touristic ones
- Connection to the wastewater collection networks
  Subscribers connected to the sewer are charged 20 000 LBP a year, while those not connected are charged 10 000 LBP.

Table D 2-33 NLWE water tariff

TARIFF for Regular subscriptions (LBP/year)				
	Not connected to WW		**Connected to WW**	
	Metered*	**Gauged**	**Metered***	**Gauged**
Yearly Water subscription for 1 m^3/day	219,000	228,000	219,000	228,000
Maintenance	24,000	12,000	24,000	12,000
IT				
Wastewater Subscription	10,000	10,000	20,000	20,000
	253,000	**250,000**	**263,000**	**260,000**
VAT (11%)	27,830	27,500	28,930	28,600
Stamp	1,000	1,000	1,000	1,000
Rounding	170	500	70	400
Bill /Year	**282,000**	**279,000**	**293,000**	**290,000**
New bill if tariff multiplied by 1 :	282,000.00	279,000.00	293,000.00	290,000.00

* Total VAT is 11% of the 3 preceding items, out of which 10% of the yearly subscription (item 1) are paid directly to the municipality and the remaining to the Ministry of Finance.

D.2.4.4 Revenues

Revenues are generated from water pricing, maintenance services and others services, as shown on Table D 2-34, NLWE provided the revenues for the period from year 2018 to the year 2021.

Table D 2-34 NLWE revenues for 2018 to 2020

Revenues	2017	2018	2019	2020
Grand Total	28,902,482,330	31,706,208,005	32,522,098,112	32,342,529,527

Source: Cut off the budget revenues of NLWE

Revenues from water, which include water subscription and water maintenance, generate on annual average 75% of the total recurring revenues.

D.2.4.5 Billing

2.4.5.1 Billing rate

NLWE issues the water bills on yearly basis, these bills are divided into different categories based on the subscription type as follows:

- Irrigation customers
- Non-metered customers
- Metered customers (residential, industrial, touristic, etc…)

إيصال قبض
نسخة خاصة بالمشترك

مؤسسة
مياه لبنان الشمالي

رقم الإيصال	
تاريخ الإصدار	
سنة التحقق	
الفصل	

رقم التسجيل في الـ TVA 173939-601

معلومات عن الاشتراك

اسم المشترك			
رقم الاشتراك			
المصلحة/الدائرة			
كمية الاشتراك		نوع الاشتراك	
البلدة		الشارع	
رقم العقار		رقم المقسم	
البناية/ الطابق			

تفاصيل قراءة العداد

رقم العداد			
التأشيرة الحالية		التأشيرة السابقة	
الكمية المستهلكة		كمية الزيادة	

تفاصيل البدلات والرسوم بالليرة اللبنانية

بدل الاشتراك السنوي	
بدل صيانة العداد/ العيار	
بدل الصرف الصحي	
بدل زيادة الاستهلاك	
بدل صيانة التمديدات الفرعية	
بدل غرامة التأخير (2%)	
الضريبة على القيمة المضافة (11%)	
تدوير كسر الألف إلى 1000 ل.ل	
رسم الطابع المالي	
المجموع بالليرة اللبنانية	
البقايا السابقة	

اسم الجابي/ أمين الصندوق
توقيع الجابي/ أمين الصندوق

فقط

مع الاحتفاظ بجميع الحقوق السابقة غير المسددة وحق المطالبة بها في أي وقت

Figure D 2-11 Sample of NLWE's water bill

2.4.5.2 Billing method

Existing data base of billing and updated number of subscribers for the last three years are as follows:

Table D 2-35 Breakdown of number of subscribers

Description	2018	2019	2020
Non-metered Costumers	68,527	68,493	68,580
Metered Costumers	56,266	59,110	60,979
Irrigation	7,427	7,462	7,466
Total	**132,220**	**135,065**	**137,025**

D.2.4.6 Collection

2.4.6.1 *Collection options*

Water invoices may be paid in 1, 2 or 4 instalments, directly to the bill collectors, or at NLWE cashiers, or by a domiciliation at a bank active in Lebanon.

2.4.6.2 *Collection rate*

- Rate of collection during the last years is as per the below table:

Table D 2-36 NLWE collection rates for 2018-2020

Description	**2018**	**2019**	**2020**
Billed revenues (LBP)	31,706,208,005	32,522,098,112	32,342,529,527
Collected revenues (LBP)	18,361,753,587	16,608,263,209	16,250,661,214
Percentage (%)	57.91%	51.07%	50.25%

D.2.4.7 ERP System

The ERP System is under construction by NLWE, at this moment the operation of migration is under process at all the exploitation units and NLWE financial department is expected to supply financial statement once the ERP is ready.

D.2.4.8 Capital expenditure

Capital expenditure are registered in the administrative accounting system in chapter 2. But, this chapter contains several items, Studies and Legal expenditures, that cannot be considered as capex.

Table D 2-37 NLWE Capex

Capex	**2018**	**2019**	**2020**
Fixed Assets for potable Water		309,444,296	254,650,362
Fixed Assets for Irrigation			
Fixed Assets Wastewater			
Fixed Assets administrative		123,379,195	44,677,369
Transport (assets)			
Studies		51,964,500	22,274,750
Network and equipment		283,642,401	146,316,233
Legal Expenditure	9,990,000		
Total	**9,990,000**	**768,430,392**	**467,918,714**

A major gap in the data collected in the recorded capital Expenditure, is that there is no recorded data in the accounting system were we have an exhaustive detailed list of all investments realized in NLWE, especially if it has been financed by donors. Not all the expenditures financed and paid by donors are registered in the accounting.

D.2.4.9 Asset's valuation and depreciation

No assets evaluation or depreciation have been found in the accounting system of NLWE.

D.2.4.10 ERP System

An ERP System is under construction by NLWE, and NLWE financial department is expected to supply financial statement once the ERP is ready.

D.2.4.11 Financial KPI

There is no financial ratio calculated by NLWE.