REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER

NATIONAL WATER SECTOR STRATEGY UPDATE - 2020

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FOREWORD

The present volume is part of the ***National Water Sector Strategy Update – 2020***, which includes the following volumes:

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PREAMBLE

The Ministry of Energy and Water prepared and adopted the Lebanese National Water Sector Strategy (NWSS) in 2010 which, in turn, was endorsed by the Government of Lebanon in 2012 (Resolution No.2, Date 09/03/2012).

Since then, the Ministry has been implementing plans and projects identified in the strategy and, in parallel, the CDR and the Water Establishments have prepared regional water resources allocation plans, and national and regional groundwater resources studies for the catchment, treatment and distribution of water to all areas of Lebanon. In addition, regional plans for the collection and treatment of wastewater were prepared.

Seven years through, time has come to review what has been realized from the original roadmap and update the Water & Wastewater strategies of 2012 by revisiting the water allocation and supply plans, wastewater collection and treatment plans, water storage / dams master plans, and irrigation plans.

OBJECTIVE OF THE CONSULTANCY

The national water sector strategy of 2012 has put an end to a phase and started a new phase for developing a wide and comprehensive vision and confirming the general principles of the national water policies on the short, medium and long terms.

The updated strategy maintains the main strategic principles of the water policies adopted by the Government of Lebanon in 2012, but reassesses the then set priorities in light of today's actual context. This update also merges the National Water and Wastewater strategies of 2012 into one consolidated strategy that we shall call "Updated National Water Sector Strategy 2020", taking into account studies and projects completed between 2012 and 2019 in both fields.

The objective of the Consultancy is to merge the National Water and Wastewater strategies of 2012 into one consolidated strategy, and will take into account studies and projects that were completed between 2012 and 2019 in both fields.

DATA COLLECTION

The first phase of the consultancy services is the Data Collection.

All available data and necessary information were collected from the relevant stakeholders such as MoEW, the four Water Establishments, the Litani River Authority, the CDR, relevant Ministries such as MoE and MoA, the Council of the South, Donors involved in the water sector, UN Agencies, local and international NGOs, and else.

This information covers all what is available to date about

- Water governance and tariffs of the four WEs.
- Available updated data about rainfall, population count and growth, water needs
- Available water resources and water balance by sector, for each WE

- Status of the production, treatment, conveying and distribution systems for drinking and irrigation water
- Status of the collection, conveying, and treatment of sewage
- Implemented and planned projects,
- Status of large scale projects in progress such as dams, hill lakes, treatment plants, big water conveyors, …
- Conducted hydrogeological and hydrological studies and other relevant studies,
- Available regional water, wastewater, and irrigation master plans,

It needs to be pointed out that at the present stage the collected data is not comprehensive and some information such as the construction dates and the conditions of the existing infrastructure (and else) is scarcely available. However, it gives an overall picture of the present status of the subjects covered under this report.

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LIST OF ACRONYMS

Bm^3	Billion cubic meter
BMLWE	Beirut and Mount Lebanon Water Establishment
BWE	Bekaa Water Establishment
CDR	Council for Development and Reconstruction
CM	Customer Management
EIB	European Investment Bank
EU	European Union
HR	Human resources
IFRS	International Financial Reporting Standards
IWMI	International Water Management Institute
l/c/d	Liters per capita per day
l/sec	Liters per second
LBP	Lebanese Pound
m^3/d	Cubic meter per day
m^3/h	Cubic meter per hour
masl	Meters above sea level
MCM	Million cubic meter
MENA	Middle East and North Africa region
Mm^3	Million cubic meter
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
NGO	Non-Governmental Organization
NLWE	North Lebanon Water Establishment
NRW	Non Revenue Water (unaccounted for water)
NWSS	National Water Sector Strategy
ONL	Office National du Litani

SLWE	South Lebanon Water Establishment
UFW	Unaccounted for Water
UN	United Nations
WE	Water Establishment
WEs	Water Establishments
WES	Water Establishments

I 1 COMPREHENSIVE VISION AND OBJECTIVES

I 1.1 TOWARDS A SUSTAINABLE AND INTEGRATED MANAGEMENT OF THE WATER SECTOR

The updated NWSS is aligned with the national water sector strategy of 2012. It takes into account adoption of the Water Code (law 77/2018) and its structuring principles, which are in turn in line with the water sector structure as defined by Law 221/2000 and its amendments.

Developed in the context of the new Sustainable Development Goals, and in particular Goal 6, which aims to ensure access to water and sanitation for all, the updated NWSS is based on the following targets:

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all;

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all, paying special attention to the needs of women and girls and those in vulnerable situations;

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally;

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity;

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate;

6.6 By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

In order to meet these ambitious objectives, the structuring vision of the strategy is based on strengthening integrated water resources management.

Integrated Water Resources Management is a process that promotes the coordinated development and management of water, in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. It takes into account the large water cycle and the interdependence between all water uses. It is thus a cross-sector policy approach designed to replace the traditional fragmented sector-based approach to water resources and management that has led to poor services and unsustainable resource use.

This integrated water resources management-based strategic approach requires a paradigm shift. For years, sector development has focused on an infrastructure-based approach. This approach has led to:

- Sector monitoring that focuses on infrastructure rather than on users' access to services and service quality;
- Significant gaps between the infrastructure developed and actual and sustainable access to the service;

- No anticipation of the facilities' operating and maintenance costs in the design and construction phase;
- Little consideration being paid to the technical and financial capacities of the service operator when designing the facilities.

Planning sustainable access to integrated water resources management means that infrastructure must be re-positioned as part of a more comprehensive system and not as an objective in itself. This requires taking the three links that make up the resource and service management chain into account:

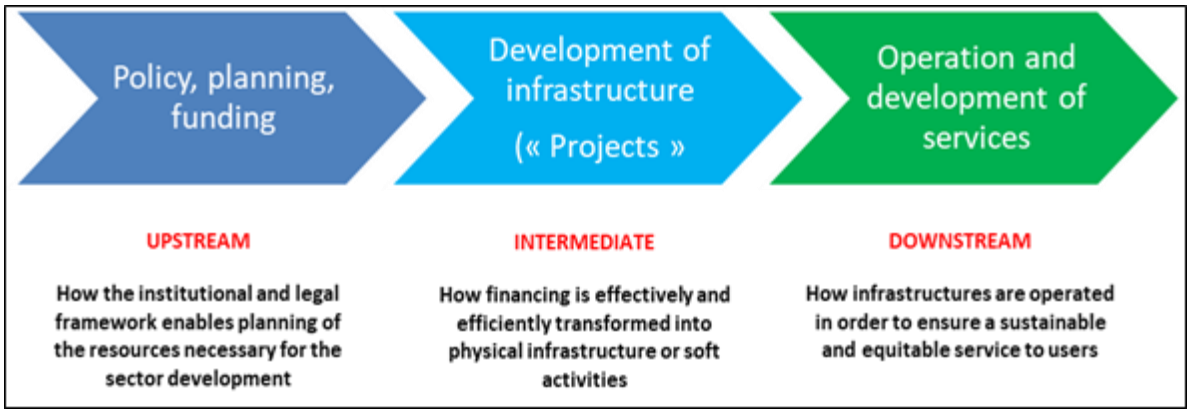

Figure I 1 Resource and service management chain

I 1.2 OBJECTIVES

The general objective of this strategy, which plans the next 15 years of the water sector up to 2035, is to structure and develop sustainable water services in order to improve people's living conditions.

The achievement of the strategy's overall objective is based on the following specific objectives:

- Build an operational and sustainable legal and institutional framework to ensure a proper management of the water sector allowing the development of sustainable and efficient services.
- Develop financing tools for the sector to set-up financial mechanisms allowing the sustainability and the financial balance of the services.
- Involve all actors in the service chain and establish sustainable mechanisms for collaboration and coordination to improve the sector monitoring and transparency.

I 1.3 PILLARS OF THE UPDATED NWSS

I 1.3.1 Integrated Water Resources Management

Integrated Water Resources Management (IWRM) is the main background framework of the strategy. IWRM has several implementation principles that are included as core principles of the Water Code (law 77/2018) and its anticipated revision. These principles are:

- The principle of equity

  Equitable treatment of all categories of the population, including the right of access to water and sanitation for all;

- The principle of subsidiarity

  Which aims to encourage resource mobilisation and user participation at the lowest possible level, to develop skills to enable greater decentralisation of decision-making, to discourage centralised structures or monopolies from retaining full responsibility for the management of the country's water resources;

- The principle of information

  According to which everyone has the right to be informed of the state of water resources and to participate in consultations and procedures prior to decisions being taken that are likely to have adverse effects on these resources;

- The principle of planning and participation

  Which aims to increase the involvement of users and partners in all water resources planning and management processes, while at the same time achieving transparency in decision-making and better implementation of joint decisions;

- The principle of sustainable development

  According to which water resources management must meet the environmental needs of the present without compromising the ability of future generations to meet their own needs;

- The principle of water management at river basin level

  Which is being used in some countries instead of administrative units as the framework for planning and management/protection of water resources, coherently integrating all components of the natural water cycle and all its uses, including upstream/downstream relationships. In Lebanon's case, water management at river basin level will be applied at a technical level, but shall not replace the current administrative and institutional framework within which the Lebanese water sector is functioning.

- The principle of cooperation

  According to which public authorities, international institutions, development partners, civil society and users contribute in an organised way to the management and protection of water resources;

- The precautionary principle

  Which refers to preventive measures taken to avoid or reduce any risk of water resources pollution or any threat to water resources when planning or carrying out activities that may have an impact on this natural environment and the communities that depend on it;

- The polluter-pays principle

  According to which the polluter should be charged for expenses relating not only to action taken to combat water pollution but also to preventive measures taken by the public authorities;

- The user-pays principle

  Which includes a set of defined rules that allow water consumption to be priced according to qualitative and quantitative uses;

- The principle of responsibility

  Which determines how society, individuals, and operators/WE's must assume their rights and duties with regard to water resources. This responsibility must be exercised by ensuring that current and future uses do not cause damage to the resource.

I 1.3.2 Users as key actors for implementing sustainable services

IWRM overlaps with the human rights-based approach to development and the combination of the two approaches, linked to the SDGs, tends to place the user at the heart of the strategy. Furthermore, the Water Code recognises "the principles of water law", namely sustainable water management and the right to water and sanitation. It is therefore necessary to ensure water conservation and water distribution to the entire population and all production sectors.

This implies defining a strategy that is not based on objectives expressed in terms of the number of facilities to be built, but on objectives related to sustainable access to the water services for users. On the one hand, this starts with user consumption and, on the other, it involves making these users responsible and identifying them as key actors in the functioning of the service.

The implementation of the strategy will therefore be based on a consumption-based approach in order to:

- Ensure access to the water service across socio-economic groups and different types of user throughout the country without geographical imbalance;
- Ensure equity in the distribution of water services;
- Send price signals to users about the relationship between water use and water scarcity.

And, as a knock-on effect:

- Improve facilities maintenance;
- Ensure transparency of the utilities' operations;
- Ensure better monitoring and management of service quality and the regulation of these services.

The incentive nature of the system seeks to make as much of the population as possible aware that the service provided by WE's is more appropriate to their needs. To implement such system, effective

communication mechanisms will need to be set up to provide information to the population concerned. Thus, IEC (Information, Education, Communication) will be an essential component for implementing this strategy. IEC actions are not only necessary for applying the principle of beneficiary empowerment, but also for building ownership of the strategy principles by each of the actors and for improving the distribution of roles.

In particular, each actor will:

- Need to be properly informed of their position in the sector's organisation;
- Need to be aware of the positioning of the other actors, in particular the users and the local contracting authority;
- Contribute to providing information and training to other actors in order to help them to fully play their role, and to acquire the necessary capacities.

The information related to the strategy will thus target all communities in order to raise their awareness of the essential role the strategy allocates to users. It will also target other sector actors (NGOs, for example) in order to clarify the new positions to be adopted as a result of the sector reform.

Such a positioning implies also a reorganisation of the pricing system which requires compliance with several principles. On the consumer side, it requires that the polluter-pays, user-pays and beneficiary responsibility principles be respected. On the provider side, this system requires compliance with the principles of transparency and accountability.

Ultimately, the implementation of this system will establish a better balance between water supply and water consumption within a regulated and monitored framework. Through developing the social equity principle, it will be possible to implement the two other core principles of IWRM, which are economic efficiency and environmental sustainability. Developing consumption power will help re-establish a virtuous circle for water services: first, the access to, quality and efficiency of the service will be improved; and second, profitability for both users and providers will ensure the service's sustainability. In other words, this system seeks to reconcile efficiency and equity.

The principles of user pays, polluter pays, and the role of the WE's are all identified in the Water Code.

Six (6) strategic components have been identified to achieve a sustainable and integrated management of the water sector. They constitute the strategic components that structure the Updated Water Sector Strategy as summarized in the figure below. Details are given in the table that follows.

Figure I 2The six strategic components

Table I 1 Summary of the Strategic Components

Strategic Component	Specific Objectives
Sector Governance	A.1 Implement the legal and regulatory framework reform (Water Code)
	A.2 Rationalize the tutelage framework with a view for clear dispatching between operational and regulatory activities
	A.3 Develop proper mechanisms for performance monitoring
Financial and Commercial	B.1 Conduct a customer and user census
	B.2 Implement consumption-based tariffs for the water service
	B.3 Revise the tariff structure for sanitation services
	B.4 Revise the tariff structure for irrigation
Reporting and Monitoring	C.1 Enhance sector monitoring
	C.2 Enhance sector transparency
	C.3 Enhance sector coordination
	C.4 Enhance communication with users
Capacity-Building	D.1 Strengthen the MoEW monitoring capacities
	D.2 Streamline and structure WE internal organization and management
O&M of Facilities and Services	E.1 Improve operating cost control
	E.2 Enhance private sector involvement
	E.3 Adopt a shared wastewater management framework
Service Coverage	F.1 Enhance water service coverage
	F.2 Enhance wastewater service coverage
	F.3 Structure the irrigation service

I 2 WATER GOVERNANCE: LEGAL, INSTITUTIONAL & FINANCIAL ANALYSIS

In Lebanon, water supply falls under the jurisdiction of 4 public Water Establishments (WE's) (North Lebanon, Beqaa, Beirut mount Lebanon, South Lebanon) each enjoying a certain degree of autonomy under the tutelage of the Ministry of Energy and Water (MoEW).

Water sector governance is faced with a very challenging situation that affects the various areas of the sector management. In general, the performance of the four WE's does not match the admitted standards for public utilities, with water shortages facing customers in several areas including the modern downtown Beirut. The financial situation is also difficult and alarming in some cases where MoEW is requested to provide an equilibrium subsidy.

This is accompanied with a lack of transparency, unreliable accounting books, and poor management of financial and technical data. Such instability in reporting varies from one WE to the other.

To address the sector's challenging situation, it is crucial (i) to build an operational and sustainable institutional framework to ensure a proper management of the water sector allowing the development of sustainable and efficient services, (ii) to develop financing tools for the sector to set-up financial mechanisms allowing the sustainability and the financial balance of the services and (iii) to involve all actors in the service chain and establish sustainable mechanisms for collaboration and coordination to improve the sector monitoring and transparency.

Challenges of the water sector and recommended actions are summarized here below.

Challenge 1: Status of Human Resources at WE's and MoEW

a. MoEW is understaffed and lacks qualified management and technical staff able to supervise properly the activity of WE's and to ensure the overall sector management.

b. Understaffing is also a recurrent issue at all WE's that is often highlighted as the key factor behind the WE's lack of operational capacity and their low levels of service.

c. There are large gaps between the number of staff specified in the WE's and MoEW's organizational decrees and the number of positions occupied.

d. An average of 26% of the positions defined in the decrees are filled by permanent staff within the four WE's (20% for NLWE, 37% for BMLWE, 23% for BWE, and 12% for SLWE). By adding the temporary staff that are recruited to fill some critical positions, the sum of permanent and temporary staff combined covers only 50% of the planned positions (49% in NLWE, 51% in SLWE, and 52% in BWE).

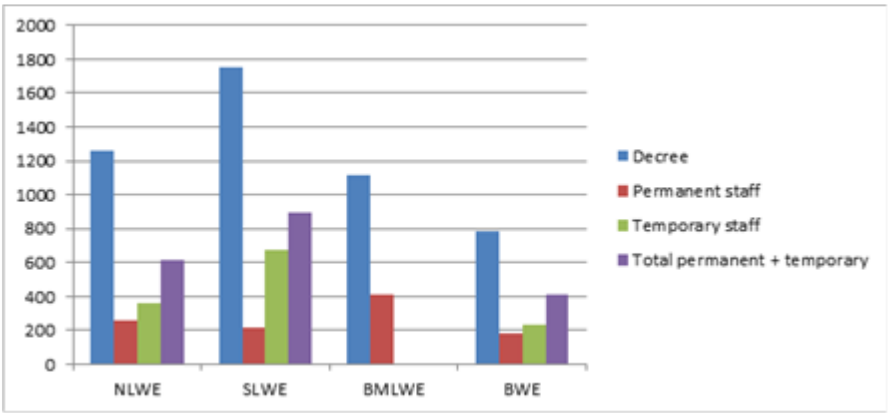

Figure I 3 Staffing status of the 4 WE's

e. The above numbers do not include the number of staff working for the WE's' subcontractors (under Ghob Talab projects); including them could narrow the staffing gap and reduce the apparent need for mass recruitment within the WE's.

f. The number of staff does not reflect the performance of WE: it is important to analyze the qualification of existing staff to better understand possibilities of improving performance of existing staff or the necessity to recruit more qualified personal.

g. Employees are assigned several tasks that do not correspond to their initial training or specialization, including management functions to employees that do not have the required profiles, thus creating a poor working environment that directly affects efficiency and performance.

h. The current recruitment of temporary staff poses challenges around the sustainability of their position and highlights the difference in financial status as compared to permanent staff.

i. According to law 221/2000, WE's have the mandate of managing the wastewater and irrigation systems, but their current organizational charts do not include these services which means that, not only are they already understaffed for delivering water supply services but they also have to provide two other challenging services.

j. They need to outsource some of their tasks to private operators, but lack an efficient and effective contracting framework and internal technical skills to properly supervise private operators.

k. Funding agencies (donors and NGO's) provide temporary technical assistance to build MoEW's and the WE's capacities on specific tasks, but these agencies do not implicate themselves in financing permanent staff or any type of employment at the level of MoEW and the WE's.

Actions to overcome Challenge 1:

The capacity-building of the water institutions is fundamental to the future of the sector. There is no point in planning activities or investments if the sector does not have the human and technical resources required to implement them. It is a cross-cutting challenge that should be addressed by several priority initiatives:

a. To fill the staffing gaps within the different WE's departments and within MoEW, an authorization to recruit permanent staff is required. The no-recruitment policy means that the initial thinking behind the water institutions' organizational decrees needs to be reviewed.

b. If MoEW and the WE's are given the opportunity to recruit permanent staff in the short term, they will conduct an in-depth analysis of the skills of their permanent staff and prioritize recruitment according to the identified crucial and essential gaps and needs. It will also inform the work required to structure technical assistance and capacity-building actions, and identify legal or regulatory measures to enable the WE's to improve service operation.

c. Analysis of indicators such as i) staff categories (knowing that categories 1 to 3 have management responsibilities, and categories 4 and 5 are task execution teams), ii) the main profiles, positions and tasks of permanent and temporary staff, and iii) qualifications and position of engineers, will enable a general analysis of MoEW and the WE's' situation and help define strategic orientations for their development and for service management improvements.

d. The objective is not to achieve the staff volumes set out in the organizational decrees but to review these decrees, which are outdated and no longer aligned to the water institutions' mission or to the opportunities for developing service management in the coming years.

e. Currently, the WE's are delegating the management of specific services to the private sector (through Ghob Talab projects) and redirecting their focus on contract management, but this also requires staff that specialize in managing performance-based contracts and that have the technical skills to supervise and monitor private operators.

f. The recruitment of engineers and staff with business management degrees is crucial in order to develop a customer service oriented strategy and to improve service management.

g. It would be more efficient to include less detail in the organizational decrees brought forward for adoption by the Council of Ministers, but instead set out the main orientations to give the water establishments the ability to develop their organization charts in line with their evolving needs.

h. The Litani River Authority's organization chart has never been formalized by a Council of Ministers decree. However, this allows the LRA to adapt its structure to new projects or new tasks without causing any major obstacles. This approach provides greater flexibility and should be used to inform the review of the WE organizational decrees.

i. A cell within the Ministry of Energy and Water and more particularly within the Minister's Office should be created to follow up on the implementation of all the strategy recommendations and action plans in the field of water governance, water and wastewater tarrification, and the administrative reforms. This cell would be composed of one legal and institutional expert, one water and wastewater expert, a dams' expert, an irrigation expert, one financial analyst, and one public administration expert.

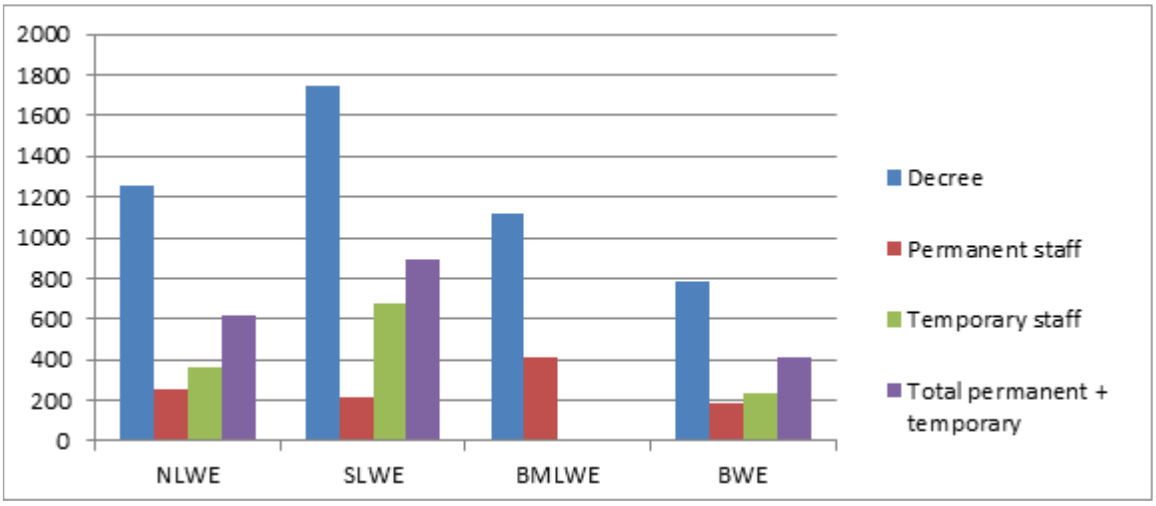

Figure I 4 General overview of WE's staff

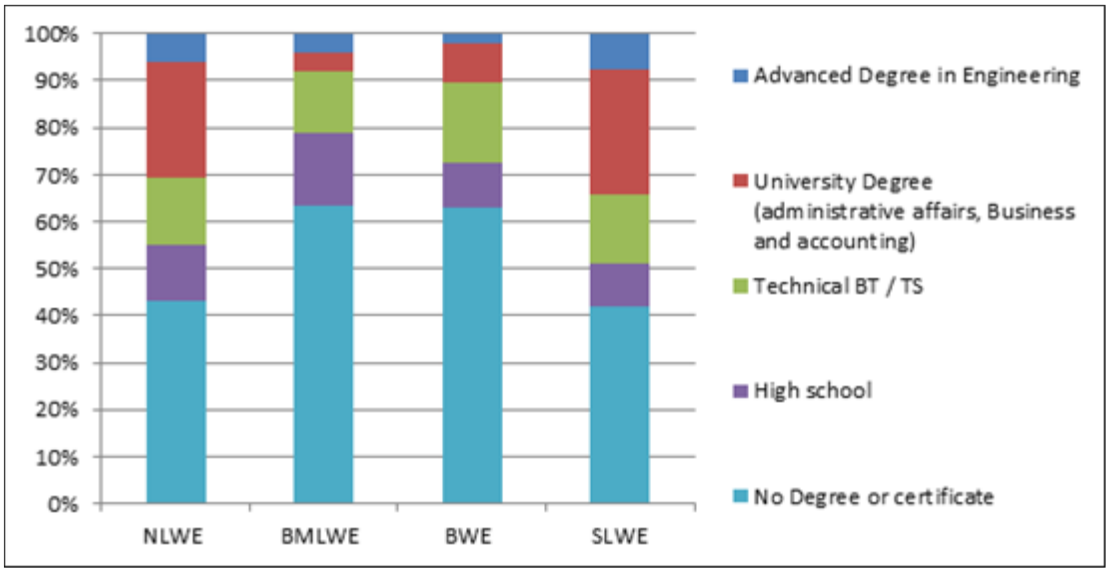

Figure I 5 Overview of WE staff qualifications

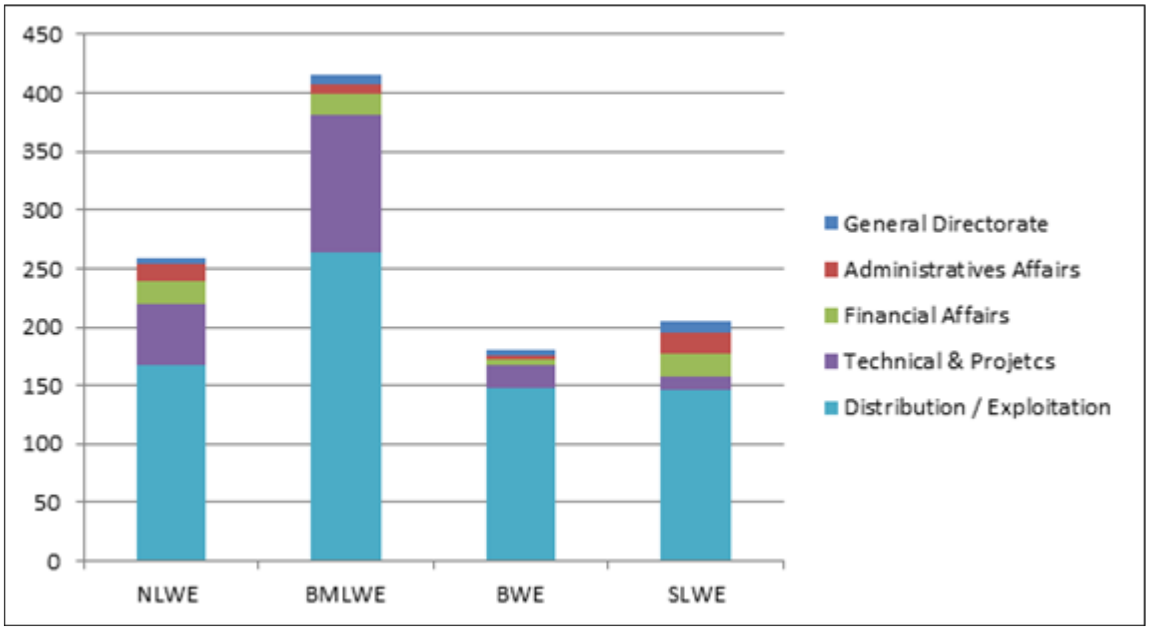

Figure I 6 Staff allocation per main Department

Table I 2 Percentage of WEs permanent staff by categories

	Percentage of permanent staff			
Category	**NLWE**	**BMLWE**	**BWE**	**SLWE**
1 and 2	11 %	5 %	2 %	4 %
3 and 4	84 %	94 %	96 %	85 %

Challenge 2: The legal framework

The current legal framework is composed of 4 main legal documents: i) the Ottoman decision number 320/1920, ii) decision number 144/S/1920, iii) the sector's organizing law 221/2000 and its amendments, and iv) the Water Code law 77/2018 and its amendment currently being under revision.

The main features of these decisions and laws are as follows:

1. On the institutional level, law 221 of 29 May 2000 and its amendments had identified and specified the prerogatives of the MoEW and the WEs.
2. On the legal level, the legal provisions of the Arrêtés laws 144/1925 and 320/1926 and of the Water Code promulgated by law 77 dated 13 April 2018 target the harmonization of the management of the water sector and take into account the international principles in this field.

The Water Code of 2018 was ratified without taking into account the revisions made by the sub-parliamentary committee. The revised version was completed in May 2020; it is therefore crucial to have the revised Code ratified soon to allow for its executive decrees to be drafted.

Actions to overcome Challenge 2:

- Law 77/2018 is currently on the agenda of the parliamentary commission of Public Works, Energy and Water, and is expected to be ratified by the Parliament in summer 2020.
- It is a top priority to implement the reforms identified in the Water Code by preparing and adopting the decrees stated in it. Specific studies will need to be conducted for some decrees (such as the tariffs and fees regime), while others may be developed immediately after the Parliament's adoption of the latest version of the Water Code.
- It is of high importance to draft the executive decrees to make the law implementable and clear.
- The implementation of the Water Code requires several decrees to be adopted or reviewed, such as:
  - Decree on vested rights over water;
  - Composition and organisation of the National Water Council;
  - Preparation of planning in the water sector;
  - Operations subject to authorisations;
  - Tariffs and fees regime;
  - Public water service delegation types and arrangements;
  - Public utility services in flood-risk areas;
  - Prevention of water deficits;
  - Reuse of treated wastewater.

Challenge 3: Tutelage, Administrative Supervision, Monitoring & Reporting in the Water Sector

- The current tutelage framework is highly administrative, involves close supervision by the Ministry of Energy and Water over the water establishments and does not focus on monitoring their performance, leading the tutelage to suffer from a loss of purpose and effectiveness. On the one hand, the MoEW spends lot of time validating procedures that are almost part of the WE day-to-day management, and on the other, WE's are constrained and restricted in their ability to develop their water establishment or manage their day-to-day affairs.
- MoEW and the WE's have very limited capacities for producing technical reviews of projects or for monitoring actions across the entire sector and across the country, as there is no specific body dedicated to conduct this activity. As a consequence, the current sector data is incomplete and full of discrepancies and does not enable systematic monitoring.
- The sector transparency is hampered by the lack reliable data communicated to users; this results in lack of trust from users in the water institutions (especially the WE's that are the service providers), and partly explains the low recovery rate of water bills.
- The sector also suffers from lack of communication and coordination between its institutions leading to a dilution of responsibilities in the different segments of the services management.
- For instance, large infrastructure projects are financed by donors through the Council for the Development and the Reconstruction, which contracts the private sector to carry out the work.

WE's, who are the ultimate service providers, have little involvement in the project preparations and management. As a consequence, there is little consideration paid to the technical and financial capacities of the service operator (WE) when designing the facilities.

In reality, the infrastructure project implementation framework is more as set out in the diagram below:

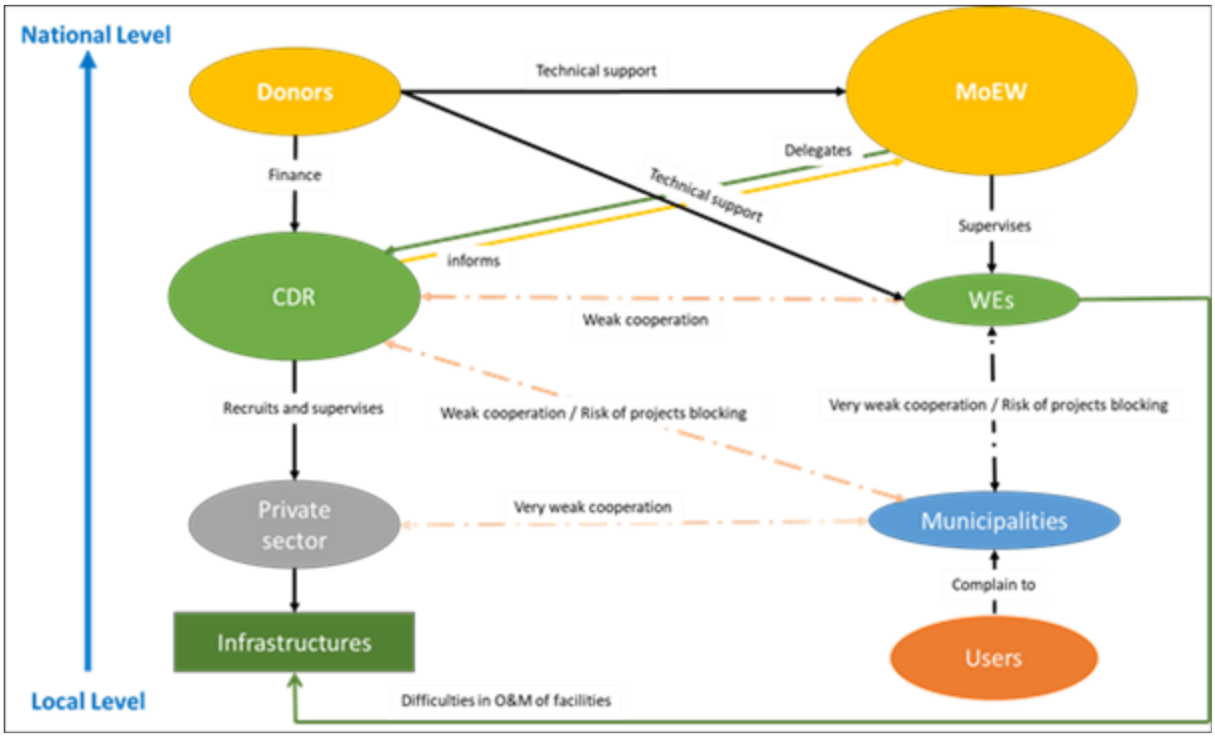

Figure I 7 WE involvement according to current practice

The donors provide technical assistance to the WE's and the Ministry of Energy and Water, who delegates the monitoring of works to the CDR that has a very large sphere of influence. WE's have very little influence and there is poor cooperation between the WE's and the CDR.

Municipalities also appear to have an influence over project implementation, mostly because they are the main point of contact for users and are able to block projects should they wish. There is poor cooperation between the WE's and municipalities, and between the municipalities and the CDR. There is also poor communication between the WE's and the users (as described in previous chapters).

Actions to overcome Challenge 3:

- The creation of a monitoring department within the MoEW is a top priority. It is strategic to enhance the administrative supervision framework of MoEW by restructuring the Ministry's supervisory functions, focusing them on the WE's' performance monitoring. This framework development has to be carried out progressively through specific support provided to the MoEW and the WE. A specific legal assessment has to be carried out to specify the appropriate procedure to creating such a department. This would greatly improve transparency and coordination within the sector's institutions and enhance communication with users.

- The WE's organisational and operating decrees should be reviewed and directed towards defining guidelines for their internal organisation, restructuring specific procedures and progressively developing a framework for the WE's performance monitoring.
- To reach these objectives, several actions should be undertaken as follows:

  a. Set up a unit to coordinate and supervise the implementation of the updated NWSS

  b. Set up a unit in charge of performance monitoring within the MoEW administrative supervision department, composed of internal administrative supervision department staff and trained on performance monitoring through a specific long-term technical assistance (TA) that will support the ministry and the WE with developing a shared WE performance monitoring framework.

  c. Standardize the structure of reports and audits.

     The TA will support the Ministry and the WE in structuring three types of reports:

     - Annual activity reports: Including the financial and business reports already prepared by the WE but which need to be standardised to enable the Ministry to cross-reference data and results.
     - Monthly activity reports: These are new and will be introduced with the aim of developing a culture of reporting and transparency on key activity and performance indicators.
     - Annual external audit and evaluation of WE: WE's should appoint an auditor at the end of the first year of the strategy, and that the monitoring and supervision TA will review the first reports and ToRs and will work to improve and standardize the initial framework. The annual WE external evaluation is a new provision that will be added to the administrative supervision decrees. The aim of this evaluation will be to review the activities implemented, identify bottlenecks and blockages, and produce recommendations for improving services and internal operating methods.

  d. Progressively develop a framework for performance monitoring within each WE.
     With the support of the dedicated technical assistance, MoEW and WE will progressively develop a shared framework for WE performance monitoring.
     The first step will involve assessing the monitoring capacities of each WE in order to define basic key performance indicators to be monitored, and to set targets for developing improved indicators within an achievable timeframe. Indicators will be reviewed and progressively developed after four years, in order to be able to set contractual KPI and establish performance-based contracts between the MoEW and the WE's.

- To enhance transparency and proper communication, it is important to establish a unified database to include all sector monitoring data and ensure it is regularly updated (including the WE KPI): This database shall include all specific sector data on water resources, water quality, water uses, management of water, wastewater and irrigation services (as part of the WE KPI to collect and harmonize within this unified database managed by the Ministry), status of infrastructure projects and on financing tools of the sector.
- Setting up an annual sector review involving the main local and international stakeholders and partners is a key element of transparency.

- Regular reporting (annual report, financial report, commercial report) will ensure a transparent flow of information between WE and MoEW through
- Communication with users is a key element for service sustainability through assessing existing tools and communication strategies at MoEW and WE, while coordinating with other programs aiming to support the WE and MoEW in their communication with users.
- A strong and clear coordination platform will be developed to improve the coordination between the CDR, MoEW and the WE's for all projects related to the water sector involving any of these institutions. This would avoid duplication of works and reduce the cost of investments and of O&M of the projects at hand.
- The structuring and enhancement of the private sector involvement is a priority of this strategy and will start by reviewing existing contracts with private operators and developing a new contracting framework and performance-based contracts.

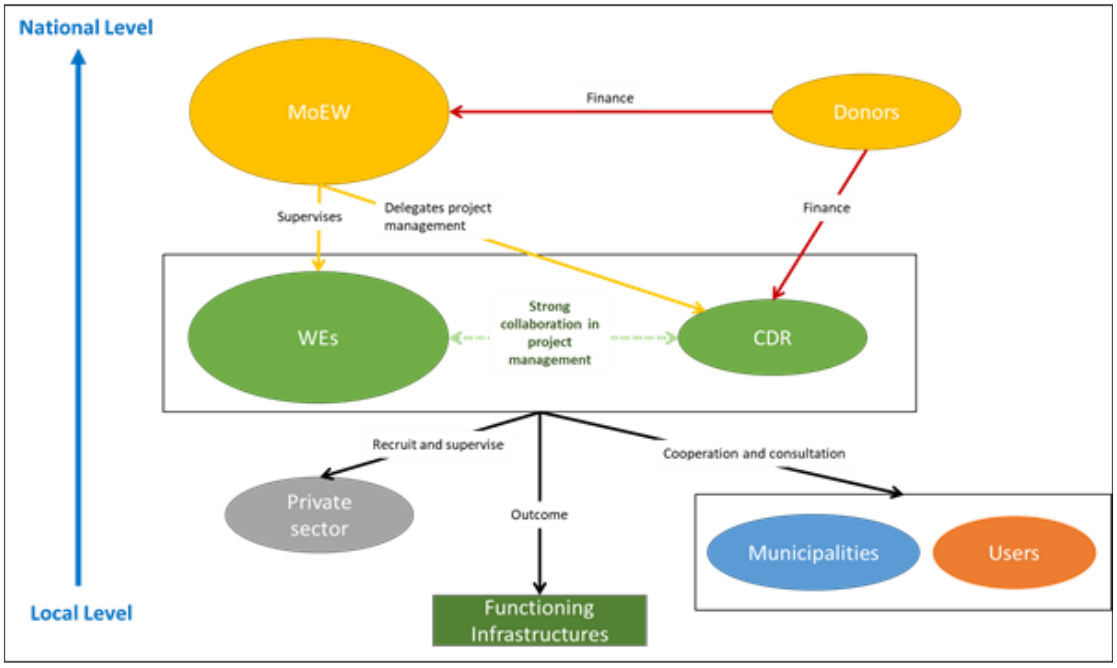

Figure I 8 WE involvement according to Law 221 and the NWSS

According to Law 221 and the National Water Sector Strategy, WE's should play a central role in project planning and management, alongside MoEW & CDR.

Under this arrangement, the donors finance the CDR and the Ministry, with the Ministry then providing guidance to both the WE's and the CDR.

The WE's and CDR should be responsible for ensuring the infrastructure functions correctly by monitoring the private sector and by working with municipalities and communicating with users.

The below graph shows the relationship that should be developed between stakeholders in order to achieve the reforms proposed in this strategy and in the Water Code.

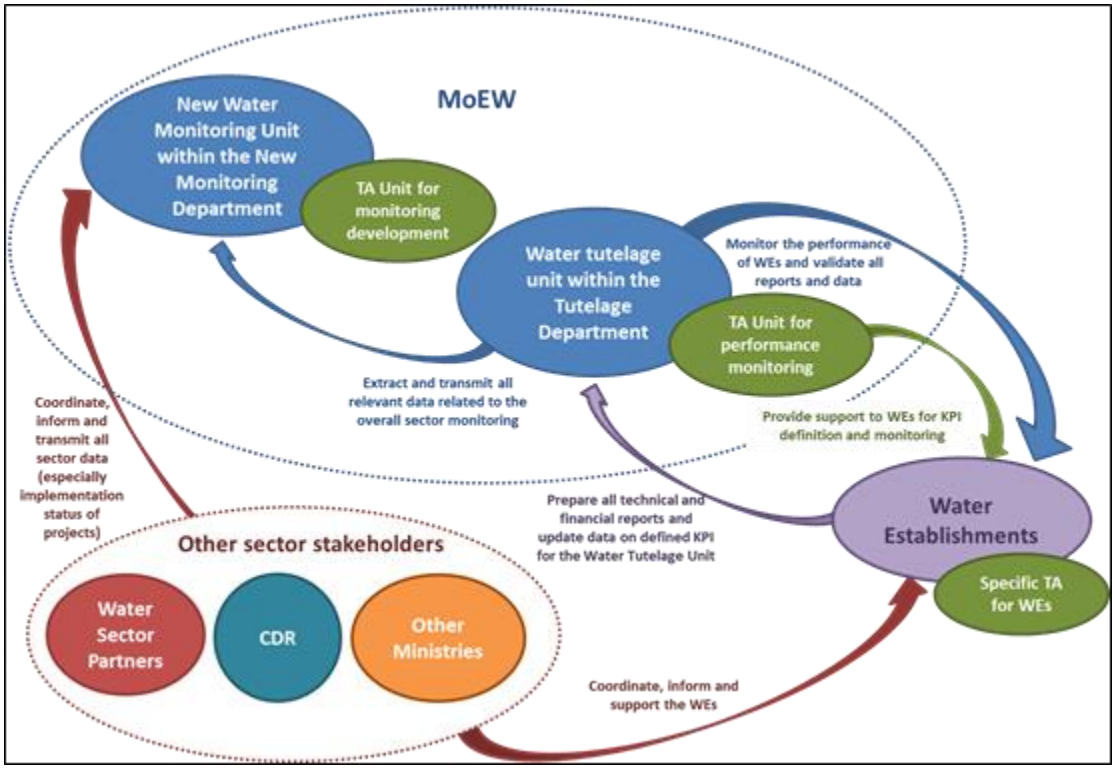

Figure I 9 Proposed overall structure of the sector-monitoring framework

Challenge 4: The sector's financial and commercial framework

- In the Financial field, the key issues refer to the absence of International Financial Reporting Standards for all WE's together with an annual audit of the financial statements and ledgers by an international independent audit firm. Such a gap obstructs the transparency of financial statements and the ability of MoEW to properly monitor the utilities and fairly compare the WE's performances.
- The current service pricing system is not adapted to the needs of the water establishments to ensure a financial balance and achieve basic performance in the service delivery across all sectors mandated by WE's (water, wastewater and irrigation).
- The gauge system is inaccurate and produces side effects both on the technical side (no measurement of Non-Revenue Water and over consumption) and on the financial side (efforts made for keeping control of NRW is not financially rewarded). The gauge system and the associated flat rate billing system do not allow to spot the over consumption of water. Such systems lead to wasting of water and draining of the financial resources of the WE's.

Table I 3 Overview of the WE's

	NLWE	BWE	BMLWE	SLWE
Est. population of the service area	1 716 000	750 000	2 907 000	1 200 000
Nbr of villages	457	250	533	385
Nbr of subscribers/subscribed households (2018)	124 793	86 761	592 835	176000
Est. population supplied (est. 4.5 persons per HH)	561 569	390 425	2 667 758	792 000
Est. population tapping the water from unknown origin	1 154 432 (67 %)	359 576 (48 %)	239 243 (8 %)	408 000 (34 %)
Nbr of actual employees	637	403	782	236
Nbr of autonomous sub-systems	8	11	6	7
Est. length of the networks (km)	1 839	4 384	9 000	5 000
Est. Unaccounted for water (%) (1)	46 %	48 %	30 - 40 %	55 %
Nbr of water meters	56 266	38 400	185 960	N/A
Volume produced (Million m³/Y)	106	68	171	113
Est. collection rate	63 %	32 %	79 %	51 %
Nbr of WWTP under the WE's jurisdiction(2)	29	13	20	27

Note : (1) Unaccounted for water % as per verbal communication from the WE's.
(2) This is the total nbr of WWTP in service or currently under construction, that are located under the jurisdiction of the WE, and operated either directly by the WE, or by CDR, or other.

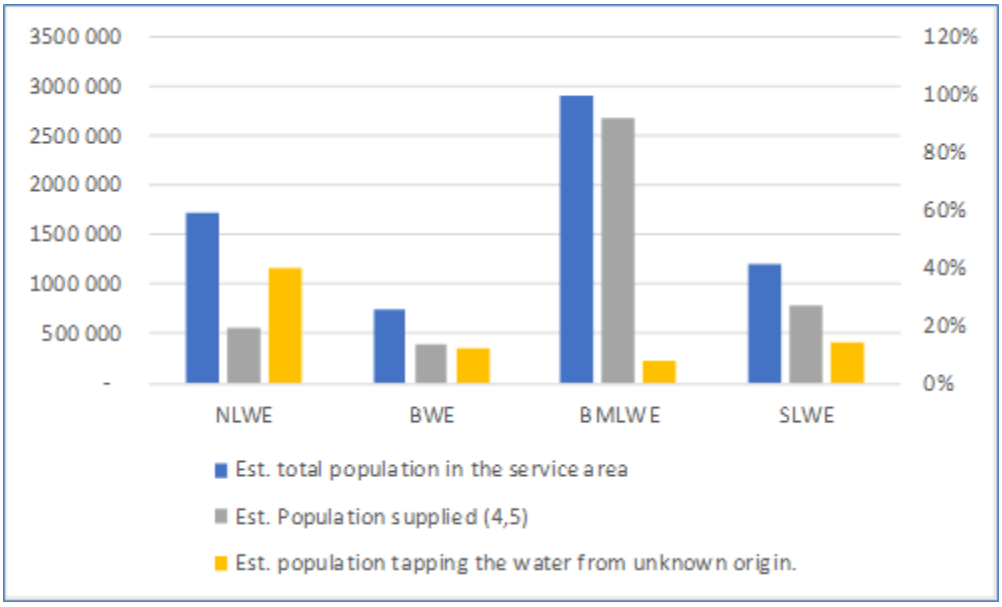

Figure I 10 Population supplied v/s overall population

- WE's have installed water meters in order to start implementing consumption-based tariffs but many are not read and the staff need training and support for the water meters' management.
- Tariff level and tariff settings are set differently by each WE with high discrepancies among the 4 WE's. Such differences should be justified based on the operating models of the WE's (gravity supply v.s water pumping, treatment v.s. spring water), but they are not. In addition, the billing computation corresponding to water meters differs from one WE to the other.

Table I 4 Annual water tariff for a 1 m³/day subscription

	NLWE		BWE		BMLWE		SLWE	
In LBP	Gauge	Meter	Gauge	Meter	Gauge	Meter	Gauge	Meter
Tariff for 1 m³/D	228 000	228 000	180 000	NA	230 000	275 940	216 000	216 000
Maintenance fee	12 000	24 000	20 000	NA	40 000	120 000	25 000	35 000
TOTAL	**240 000**	**252 000**	**200 000**		**270 000**	**395 940**	**241 000**	**251 000**

Table I 5 Status of Water meters in WE'

	Number of water meters	% of the subscribers	Comments
NLWE	56 266	45%	Individual meters are not read and billed on a flat basis. Seems that only big consumers water meters are actually read.
BWE	38 400	44%	Approximately 38 000 meters have been installed, but billing is made on a flat rate. Only 3000 meters are read for monitoring purpose.
BMLWE	185 960	31%	Metering is a success and even smart meters have been installed. Management is willing to increase the number of meters.
SLWE	NA	NA	Seems that metering is not comonly encontered.

- On the Commercial side, customers' databases (for the drinking water services) are not comprehensive and WE's deal with a large gap between the number of official customers (listed in the databases) and the actual population tapping from the network. The current situation demonstrates that lot of households/dwellings are supplied from unknown origins and this refers to private wells or multiple connections, or even wrong allocation within the database down to illegal connections.

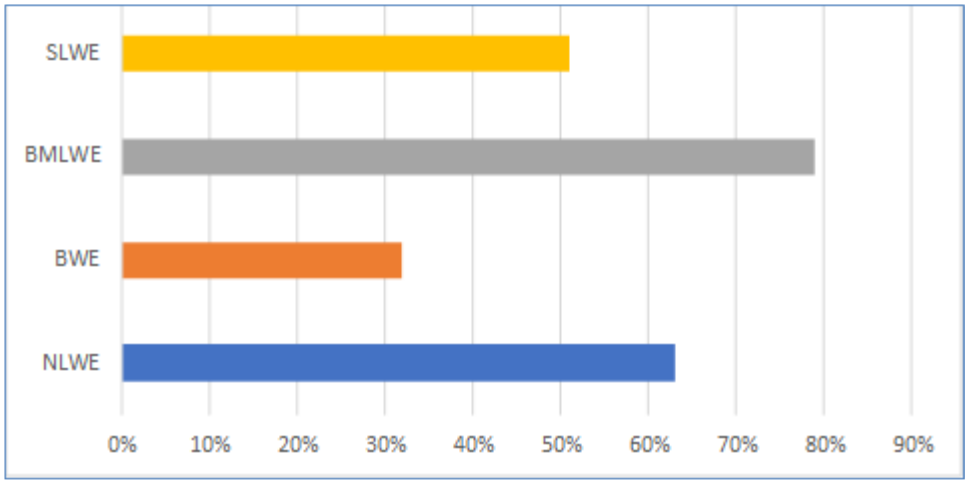

Figure I 11 Estimated collection rate (2018)

- Users' databases for the wastewater management services have not been developed yet. Users of the services need to be identified and registered in specific databases as in some regions not all users of wastewater services (households connected to sewage networks and ultimately to treatment plants) are subscribers to the water service of water establishments.

Table I 6 Yearly sewage fee (LBP)

	Connected to the Waste Water system	
	Yes	No
NLWE	20 000	10 000
BWE	60 000	15 000
BMLWE	40 000	25 000
SLWE	30 000	15 000

According to the Water Code, a wastewater fee must be paid by non-connected houses to the sewage network as a sort of “pollution tax” for damaging the environment. Today the WE’s are charging the fees shown in the above table but this fee is not sufficient to cover the O&M of wastewater systems.

Such fee has to be elaborated soon to become proportional to the water actual consumption. The pollution tax for non-subscribers would be a low tax when a properly designed septic tank exists and high when such a system does not exist.

Actions to overcome Challenge 4:

Improving collection rates and financial performances of the WE's, restructuring the general billing system and the water-meter readings are crucial and require the following specific actions:

1. The top priority is to bridge the gap between the number of official customers as existing in the various customer databases and the actual population tapping from the network. The main recommendation is to conduct a customer census campaign (each WE in its jurisdiction) to detect and attract potential new customers and include them in the customer database and

billing system. Expected output is to increase revenues of the WE's with no real additional operating cost and to reduce the commercial losses. A comparison with EDL's customer database could be a starting point for such a clean-up.

2. Working on increasing the number of subscriptions and the collection rates through an intensive communication plan at national level. Financial reforms and changes in the water tariff, in addition to increasing the collection rates, should be accompanied with a communication campaign, reaching out to local citizens, informing them about the importance of paying their dues for the sustainability of the WE's services, encouraging those who are not subscribed to legalize their status, motivating them to save on water and to installing water meters.

3. To complement the second step, and to encourage citizens further, a financial plan needs to be set by the WE's to have arrears, subscriptions and fees settled in periodic instalments.

4. Introducing wastewater fee proportionally to the water consumed and defining a specific wastewater fee for households that are not subscribing to the WE's are very important steps required today especially that WE's will take over all operational WWTP's in 2020 or 2021.

5. Eventually, a new category of customers targeting big consumers (Industrials, Hotels, others to be identified) should be gradually introduced with specific tariff level. Possibly introduce blocks of tariffs with specific rate; the rationale being that first block of tariff is low and increasing gradually with increased consumption.

6. Not only should revenues increase, but also expenses should decrease as well as the cost of water production and wastewater treatment.
   - To decrease the cost of water supply, removal of illegal connections, reduction of technical losses and optimization of the cost of production are required. For this reason, work should be done with involved ministries and institutions and the Government's approval on this action plan is crucial in order to effectively enforce the law; in parallel implementation of district meters and eventually household water meters to reduce technical losses and minimize costs should start immediately.
   - To decrease the cost of wastewater treatment, the minimum requirements for that purpose were estimated. At the same time, the types of contracts with private operators should be upgraded to PBC to optimize performance and cost of service. Note that an assessment of all existing WWTP's is being conducted to identify the gaps obstructing their full performance, the actions required and the estimated cost of their rehabilitation/upgrading.

If these reforms can be achieved, the immediate increase of tariff might be avoided for the time being especially that Lebanon is passing through a dire economic and financial situation. Taking BMLWE as an example, it shows that their collection rate reaches 70%, allowing them to invest in Dam construction and other big water supply projects, which implies that the real problem at the WE's is more a rate of collection and high UFW than an inadequate tariff.

The above action points are priority and major elements towards a sustainable management and to achieving financial stability.

Sustainability of service delivery and proper management of the water sector is a medium term process expected not to take less than 3 years. The adoption of the updated NWSS, the ratification of the revised Water Code (law number 192/2020), the technical assistance programs financed and supervised by different Donors, the most imminent of which being the AFD/EU program and USAID's WSC program (starting in 2021/2022), and with the willingness and involvement of the WE's, progress towards a sustainable management of services will surely happen.

For the wastewater management, users of the services need to be identified and registered in specific databases. It is essential to be able to cross-reference the database of subscribers to the WE's with the database of users of wastewater services. A specific system of pricing and collection of the sanitation fee will have to be applied to those who are not yet WE's subscribers.

In parallel, a nationwide awareness raising communication campaign should be conducted and Key Performance Indicators set for proper monitoring of progress. At that point, it will be possible to have a solid water metering system across the country, a socially fair and financially adequate tariff to include water and wastewater services, and an optimized volume of non-revenue water adequate. Then, the objective will be to introduce water meters on a large scale targeting 100% of households by the end of 2035.

Any increase in the Water tariff, the application of a Wastewater tariff, or a change in the tariff structure should be economically justified and would require the enforcement of the International Financial Reporting Standards (IFRS) concept and the introduction of an annual audit carried out by an independent firm of international reputation.

Table I 7 Typical baseline scenario for financial recovery of WE's

Scenarios	2019	2020	2021	2022	2023	2024	2025	2026
Subscribers increase rate	1%	30%	20%	10%	5%	4%	3%	3%
Volume billed increase rate	1%	20%	20%	10%	10%	5%	4%	4%
Average tariff increase rate	0%	30%	20%	10%	5%	5%	5%	5%
Collection rate increase rate	1%	5%	15%	10%	10%			
Operating cost increase rate	1%	2%	2%	1%	1%			

The above table is a theoretical but possible scenario of the targets that should be set by the WE's to reach a positive balance. This scenario tackles the increase in subscriptions, reduce non- revenue water (through the customer census and district metering) and the increase of the tariff accordingly.

Table I 8 Results of the typical scenario if applied to WE's over 8 years period

WE	Est. Additional customers in % over 8 years	Increase of the tariff in % over 8 years	Collection rate In % From - To
SLWE	99%	109%	52% - 77%
NLWE	111%	76%	58% - 85%
BWE	171%	117%	39% - 67%
BMLWE	125%	93%	61% - 90%

All these targets are illustrative only and the final packaging might be different, including keeping moderate tariff level but increasing the number of metered connections and collection rate.

Challenge 5: Operation and maintenance of facilities and services

The operation and maintenance of facilities and services are key factors for developing the sector and strengthening the sustainability of services. Three main axes form the basis for the proper and sustainable management of facilities and provision of services:

- The high operating cost control:
  The high energy bill is the main burden on the operating cost of facilities
- The private sector involvement
  WE already have contracts with private operators for facilities operation but they lack an efficient and effective contracting framework and internal technical skills to supervise properly private operators.
- The fragmented wastewater management framework
  This is a challenge on its own and a high priority for the sector sustainability. All main stakeholders agree on the institutional framework that is based on the responsibility of WE for managing wastewater system. However, the effective framework for wastewater management is not clear and needs to be refined. Several actors may be involved in wastewater management (WE's, municipalities, and private operators) but the process of identifying modalities of involvement and the financing method still needs to be defined.

Actions to overcome Challenge 5:

- Developing a specific strategy to control the energy costs of the facilities
- Defining guidelines to ensure that design of facilities is adapted to the capacity to cover operating costs and provide proper maintenance.
- Structuring and enhancement of the private sector involvement by reviewing existing contracts with private operators and developing a new contracting framework and performance-based contracts
- Identifying the activities to be outsourced and the outsourcing arrangements to be adopted
- Expanding the use of performance-based contracts when recruiting private operators

- Adopting a shared wastewater management framework: A specific study should be carried out to:
  - Analyse the current wastewater facilities management arrangements and wastewater financing tools (fee added to the water bill, municipal tax, etc.),
  - Conduct a full cycle analysis for each wastewater system currently operational,
  - Set benchmarks from successful frameworks used in Lebanon and abroad,
  - Coordinate with WE, MoEW, CDR, donors and partners to conduct joint discussions,
  - Propose scenarios and an overall framework for wastewater facilities management and propose financial arrangements for O&M (in coordination with the tariff study that will be carried out in the framework of the water metering development).

It shall be noted that the financial stability of WE's is strongly impacted by the current crisis:

- The collection rate of the water bill has drastically dropped since November 2019;
- The WE's have to deal with serious financial and administrative obstacles to the purchase of consumables that are necessary for operating facilities (fuel oil, chlorine, etc.);
- If the crisis persists throughout the year 2020, WE's will no longer be able to cover the wages of permanent staff.

Table I 9 below represents the detailed Priority and Short Term Action Plan, the associated activities for the reform of the Water Sector and the timeline for implementation. This Action Plan extends over a period of 5 years, and will be implemented with the help of technical assistance programs financed by Donors of the Water Sector, starting with AFD's (Agence Française de Développement) Long Term Technical Assistance programme over a period of 4 years as of September 2020.

Table I 10 identifies the list of required priority and complementary actions for financial sustainability to cover all the aspects of the water sector's reform activities.

The budgets estimates of these complementary studies together with other studies, and other plans such as the surface and groundwater management that should be conducted simultaneously with the priority and short term Action Plan in order to implement reforms and abide by the requirements of the legal, institutional and infrastructures frameworks of this updated NWSS 2020 are listed in Sub-Section I 10.1.

Table I 9 Priority and short term Action Plan

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
RS-B.1. Sector Governance							
RS-B.1.1 Implement the legal and regulatory framework reform (Water Code)							
RS-B.1.1.1 Prepare, adopt and implement the Water Code bylaws as already listed	High	MoEW	WE, LRA, MoE, MoA	Recruitment of legal consultant	Phase 1 : Q1 2021 Revision : end 2025	Adopted Decrees	INT
RS-B.1.1.2 Draft revised WE organisation bylaws, support the approval process and follow up on their enactment	High	MoEW	WE	Recruitment of legal consultant	Phase 1 : end 2020 Revision : end 2025	Adopted Decrees	INT
RS-B.1.2 Rationalise the tutelage framework with a view for clear dispatching between operational and regulatory activities							
RS-B.1.2.1 Restructure the Ministry's supervisory functions and introduce a substitute function in the event of WE failure (incl. direct procurement of external audit if not conducted by WEs and cost deduction from their budget)		MoEW		Recruitment of legal consultant	End of 2020	Revised Decree	INT
RS-B.1.2.2 Review the organisational decrees by focusing them on defining guidelines for WEs organisation and streamline specific procedures	High	MoEW		Recruitment of legal consultant	Phase 1 : end 2020 Revision : end 2025	Adopted Decrees	INT
a. Define guidelines for the WEs' HR recruitment and organisation structures / simplify the organisation chart validation procedure			WE				
b. Streamline the HR recruitment process and make it possible to enhance recruitment outside the public service procedures			WE				
c. Raise the expenditure and procurement validation thresholds			WE, MoF				
d. Define guidelines for WE performance monitoring			WE				
e. Define guidelines for pricing services and simplify the validation procedure			WE				
f. Define guidelines for procurement management and the management of performance-based contracts			WE				
RS-B.1.2.3 Conduct an assessment of the administrative supervision department roles and capacities and develop a specific staff capacity-building plan	High	MoEW		Recruitment of consultants / experts (water services management, HR, capacity-building)	Assessment : End of 2020 Implementing the capacity-building plan : End 2025	Assessment and CB plan validated by MoEW and activity reports of the supporting activities	INT
RS-B.1.3 Develop proper mechanisms for performance monitoring							
RS-B.1.3.1 Set up a unit in charge of performance monitoring within the MoEW administrative supervision department	Short Term	MoEW		Recruitment of technical assitants (to 2 Experts in water services management and performance monitoring)	Recruitment : End 2020 TA until end 2025	*Standardized reports prepared by WEs *Conduction of external annual audits starting in 2021 *Production of KPI *Performance contracts between MoEW and WEs	INT
RS-B.1.3.2 Standardise the structure of annual reports incl. financial and business reports	Mid Term	MoEW	WE				
RS-B.1.3.3 Define the monthly activity report submission and validation structure and procedure	High	MoEW	WE				
RS-B.1.3.4 Develop the framework for the annual external audit and evaluation of WE	High	MoEW	WE				
RS-B.1.3.5 Define key performance indicators to be monitored in the short, medium and long term (in alignment with the WE monitoring capacities)	High	MoEW	WE				
RS-B.1.3.6 Establish performance contracts between the MoEW and WE	High	MoEW	WE				
RS-B.1.3.7 Set up the performance monitoring committee as required by law 221	High	MoEW	WE, MoF				

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
RS-B.2. Financial and commercial							
RS-B.2.1 Conduct a customer and user census							
RS-B.2.1.1 Identify customers connected to piped water and convert unknown customers tapping into the network into legal users	High	WE	MoEW	Recruitment of consultants (technical experts and census experts) - Census to be conducted for all customers / estimated to 1 500 000 of households (price: $3 for 1 household)	Phase 1 : End 2020 Complete census : Beginning 2021	Census reports and updated WEs' consumers database	INT
RS-B.2.1.2 Identify users of collective wastewater services (network or network+WWTP) / identify those who are / are not WE customers (cross-reference with the water supply customer census) in order to define specific approaches for tariff-setting	High	WE	MoEW	Recruitment of consultants (technical experts and census experts)	Complete census for zone 1 by mid 2021	Census reports and updated WEs' wastewater services users database	INT
RS-B.2.1.3 Ensure the take over of new customers/users by WEs and their inclusion in the customer/users database for the billing/collection cycle		WE	MoEW	if needed support from specific TA	Beginning 2022	Increasing subscribers base	INT
RS-B.2.2 Implement consumption-based tariffs for water service							
RS-B.2.2.1 Streamline the water meter billing procedure		MoEW		Recruitment of financial and water tariff expert(s)	Mid 2022	Harmonized guidelines and procedures for water meter billing	INT
RS-B.2.3 Revise the tariff structure for sanitation services							
RS-B.2.3.1 Conduct a proper cost analysis of facilities O&M		MoEW		Recruitment of technical and financial experts on wastewater	End 2020	Adoption and implementation of new tariff policy for wastewater	INT
RS-B.2.3.2 Base the tariff on the cost analysis and, as a minimum, cover O&M costs		WEs			Mid 2021		

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
RS-B.3. Reporting and monitoring							
RS-B.3.1 Enhance sector monitoring							
RS-B.3.1.1 Create a Monitoring Department within the Ministry		MoEW		Recruitment of legal consultant	End of 2020	Revised Decree or Amendment to the Law 247	INT
RS-B.3.1.2 Establish a unified database to include all sector monitoring data and ensure it is regularly updated (incl. the WE KPI)		MoEW		Recruitment of water sector monitoring (part-time assistance) and 1 IT expert (full-time assistance)	Mid 2021 Mid 2022	*TA recruitment *TA activity reports *Establishment and regular update of the sector database Database	INT
RS-B.3.1.3 Set up an annual sector review involving the main stakeholders and partners		MoEW		Organisation of annual sector workshop	Mid 2020	Workshop / annual review and annual sector review report	National
RS-B.3.1.4 Set up the process for monitoring the Strategy implementation status		MoEW		Analysis of sector data	Mid 2025	Strategy implementation status report	National
RS-B.3.2 Enhance sector transparency							
RS-B.3.2.1 Ensure a transparent flow of information between WEs and MoEW through regular reporting (annual report, financial report, business report)		MoEW		Reports production and publication / TA support	Continuious activity	Meeting minutes, reports	National
RS-B.3.2.2 Publish annual WE reports (incl. results of audits performed by independent auditors)		WEs		Recruitment of external auditors	starting from mid 2021	Annual WEs' reports publication	National
RS-B.3.2.3 Prepare financial reports based on IFRS book-keeping standards		WEs		Reports preparation with TA support if needed	starting from mid 2021	Financial report	National and INT TA
RS-B.3.2.4 Publish the main sector indicators, ensuring these are updated on a regular basis		MoEW		Update of sector indicators (with TA - see C.1.1)	starting from mid 2021	Publication of main sector indicators	National and INT
RS-B.3.2.5 Publish the breakdown of the water bill		WEs		Publication and communication support	starting from mid 2021	Publication by each WE of the water bill breakdown	National
RS-B.3.3 Enhance sector coordination							
RS-B.3.3.1 Improve coordination between CDR and WEs on infrastructure project planning and management		MoEW		Regular meetings, MoEW follow-up on coordination, support from donors and sector partners	Continuious activity	Participation of WEs in the projects design and implementation	National
RS-B.3.3.2 Organise an annual sector review involving all stakeholders and partners		MoEW		Organisation of annual sector workshop	Mid 2020	Workshop / annual review and annual sector review report	National
RS-B.3.4 Enhance communication with user							
RS-B.3.4.1 Develop a communication strategy for MoEW and WE		MoEW		Recruitment of communication experts	End 2020	Communication strategy, tools and supports	Internatio nal
RS-B.3.4.2 Design and launch a national communication campaign on the water sector		MoEW			Beginning 2021		

Activity	Priority	Stakeholder		Means to mobilize	Deadline	Indicators	Funding
		Lead	Involved				
RS-B.4. Capacity-building							
RS-B.4.1 Strengthen the MoEW monitoring capacities							
RS-B.4.1.1 Appoint specific technical assistance to the MoEW to help develop monitoring		MoEW		***Covered under item C.1.1***			
RS-B.4.1.2 Support the MoEW in defining sector key performance indicators		MoEW					
RS-B.4.1.3 Support the MoEW and the WEs in developing a performance monitoring		MoEW		***Covered under item A3***			
RS-B.4.1.4 Identify the MoEW staff to be trained and supported in monitoring activities		MoEW					
RS-B.4.2 Streamline and structure WE internal organisation and management							
RS-B.4.2.1 Conduct an overall internal audit in each WE (organisational, HR management, financial - assets, commercial, technical), propose measures and guidelines for streamlining internal WE organisation		WEs		Recruitment of the following experts: institutional, O&M of water utilities, capacity-building and HR management, water and wastewater	Beginning 2021	Audit report validated by MoEW and the four WEs	INT
RS-B.4.2.2 Prepare a handbook of jobs in the WEs with minimum skills required per position and standard training / capacity-building plan to be implemented		WEs			*Beginning of 2022 for the hanbook validation *End of 2025 for implementing the capacity-building plan and TA support	*Handbook *Capacity-building plan *TA activity reports and specific studies	INT
RS-B.5. O&M of facilities and services							
RS-B.5.1 Improve operating cost control							
RS-B.5.1.1 Develop a specific strategy to control the energy costs of the facilities (based on ongoing studies)		MoEW		Recruitment of technical and financial experts	End of 2021	Validated reports and strategic guidelines	INT
RS-B.5.1.2 Define guidelines to ensure that facilities design is adapted to the capacity to cover their operating costs		MoEW		Recriutment of technical and financial experts (coordinate with other financial and technical studies)	End of 2021	Publication of guidelines	INT
RS-B.5.2 Enhance private sector involvement							
RS-B.5.2.1 Review existing contracts with private operators and develop a new contracting framework and performance-based contracts		WEs		Recruitment of institutional, legal and technical experts in overseeing water facilities O&M contracts	Mid 2021 for pilot contract for wastewater facilities management End of 2025 to assess the contracts and revise the framework (if needed)	Implementation of performance-based contracts Assessment report of the efficiency and ownership by WEs of this framework and propose improvements	INT
RS-B.5.2.2 Identify the tasks or activities to be outsourced and the outsourcing arrangements to be adopted		WEs		Recruitment of the following experts: institutional, O&M of water utilities, capacity-building and HR management, water and wastewater	Mid 2021	Reports and validation of the proposed framework by WEs and MoEW	INT
RS-B.5.3 Adopt a shared wastewater management framework							
RS-B.5.3.1 Address the issue of the organization(s) responsible for managing the WW network and treatment plants (WEs, municipalities, private operators.) and determine the financing method		MoEW		Recruitment of institutional, financial and technical experts in wastewater facilities operation and management	Mid 2021	Publication of the wastewater management framework	INT

Table I 10- Priority Action Plan for Financial Sustainability

	Priority	Estimated duration	Rationale, objectives & comments
Customer Database Management			
Conduct an experimental Customer census in 2 test areas in parallel, one rural and one urban	High	3 months (depending on the size of the zone to be explored)	There is a gap to bridge between the estimated population and the number of connections officially recorded in the customer data base. Such gap is also obvious when making a comparison between the water sector (WE's) and the energy sector (EDL), the latest being well above the first one. As a conclusion, there is a great deal of chance that many customers are tapping the water from the network for free. The objective is to establish and test a methodology for systematic customer census, including i) comparison with EDL customer database, ii) liaising with WE's for transforming illegal / unknown customers into legal ones immediately and iii) set the billing cycle for the areas and facilitate the settlement of arrears of the account receivables. Such exercise will give valuable indications for a national systematic customer census.
Conduct a National customer census in the 4 WE's	High	2 years	Based on the results of the customer census in test areas, carry out a systematic national customer census. The phasing of this survey should be thoroughly defined. Such counting is to be accompanied with a refurbishment of the connection works. This requires appointing contractors to fix connections according to standards on the spot and install individual water meters for all new customers.
Streamline the water-meter readings and billing procedures	Medium	4 months	In Lebanon, a lot of meters are not read and the billing system of water meters is different from one WE to the other. Therefore, the idea is to appoint a consultant to streamline the tariffication system for water and wastewater and conduct training on this particular issue. The objective is to produce a standard tariff grid for the 4 WE's but not a standard unique tariff level.
Financial and Accounting Systems			
Appoint a chartered accountant firm to introduce IFRS accounting standards common to the 4 WE's.	High	3 years	Such technical assistance will help introduce the IFRS and possibly to select a unique accounting software package compatible with the customer management software of each WE.
Appoint an Auditing firm to certify the WE's annual financial statements	Medium	To be appointed on an annual basis	Once financial statements become in line with IFRS, auditors should be appointed to conduct the annual auditing of the financial books.
Water Metering Systems			
Enhancing the Water Metering System across the country	High	6 years	The objective is to build a system able to measure the water flow at the various stages (production, transport and distribution) with a view for targeting 100% of the connections metered by year 2026.

	Priority	Estimated duration	Rationale, objectives & comments
Metering at Production level	High	1 year	Establish a plan for installing production water meters in all the catchments and water sources (springs, wells, boreholes, water treatments plants). Introduce a close monitoring system of the water abstracted from the various sources.
District metering		2 Years	Establish a plan for installing district meters in the water networks of the 4 WE's and monitor the situation as well as the functioning of the system. Introduce leak detection campaigns.
Metering at the Customer level		6 years	In parallel with the customer census, generalize the water meters and progressively drop the gauge system which is technically obsolete and financially counterproductive.
Reporting Mechanisms			
Produce a standard annual report covering the technical, financial, commercial, personnel and organizational aspects	High	6 months	Appoint a consultant to design the standard annual report of the WE's. Disseminate and socialize the report among the management of the WE's. Such exercise is a buildup process which should be progressively introduced while taking into consideration progress made by the WE's in the various field (Customer management, finance, accounting, technical etc.) Such standard document is to be produced upon request of the Minister and shall be revised by the WE's board.
Key performance Indicators (KPI)	High	1 year	Introduce progressively the key performance indicators as a must for proper management of the utility and a formal requirement of the line minister.
The Information Technology System			
Address the IT problems of the various WE's and	High	3 months	Appoint a consultant for the provision of: • Analyzing the current situation of the 4 WE's • Assess the possibility / feasibility of a unique centralized system. • Define the main specifications and functionalities • Prepare a cost estimate.
Install a common central integrated data center at the level of the MoEW with free access for the WE's and the ministry	High	1 year	A central database system should be installed at MoEW to form the hub of all the data and an area for information sharing. This database should be updated on a daily basis in strong coordination with the WE's (data such as implemented projects, water quality monitoring and analysis, wastewater analysis, existing projects, proposed projects and master plans…)

I 3 WATER DEMAND CRITERIA AND ASSUMPTIONS FOR WATER SUPPLY AND IRRIGATION

I 3.1 GENERAL

Updating the NWSS aims at identifying the projects that should be implemented to fill the gap between what has been implemented and what remains to be executed to cover the needs of the population in terms of drinking water, wastewater, and water for irrigation. The strategy is targets the projected needs in year 2035. Therefore, it is necessary to assess the future number of populations and needs per capita at an acceptable level of accuracy in order to identify relevant solutions and propose cost effective projects.

As reliable statistics on the population count and projection are not available in Lebanon to date, the criteria given in this section are based on the previous experience of all the Consultants who contributed to this strategy. Those figures may not be the exact values of water demand, but they can be considered close enough to form a solid basis for the purpose of this strategy.

I 3.2 POPULATION AND GROWTH FACTOR

The current figures number for year 2020 are given in the water balance tables of APPENDIX IV.3, under Section IV C of the volume IV, and they are extracted from recent studies collected from various sources. As the population varies from winter to summer (mainly in rural areas), the figures given are for summer season where available.

It is not possible to establish a population growth factor based on reliable data about population count because this data is not available. Therefore, the growth factor has to be estimated based on past experience, common practice and scattered field surveys.

The NWSS 2012 has estimated the growth factor at 1.75 %, which is a relatively high figure.

Recent field surveys[1] covering a number of municipalities have shown that the demographic growth factor is much lower than that estimated in the NWSS 2012. Moreover, in a number of rural municipalities, the growth factor appeared to be negative. This may be due to the fact that those surveyed areas are getting close to saturation or affected by emigration or some kind of "rural exodus".

It is therefore realistic to consider a slightly lower factor for urban and rural areas.

For the period 2020-2035, we shall consider the following Growth Factors for all of Lebanon except SLWE as follows:

- In rural areas: 1.5% (slightly lower than what was considered in 2012)
- In urban areas: 0.75% (one-point difference between 2020 and 2012 assumptions)
- For the districts under the jurisdiction of SLWE, ongoing studies, supported by field investigations and surveys, have shown a tendency for the population to "return to their lands", probably due to

[1] Bcharreh district; ELARD 2016 – Baadda Aley district; BTD 2018 – Kesrwan district; BTD 2019

the stable socio-political conjecture. Therefore, a flat growth factor of 2% is used so that needs and gaps are coherent and consistent between the studies conducted by SLWE and the updated NWSS.

I 3.3 POTABLE WATER DEMAND PER CAPITA

WE's are installing more and more household water meters, but the areas covered are not large enough to be representative and the meters are not read on a regular basis. Therefore, there is a lack of large scale data on measured water consumption. Therefore, as long as water consumption is not metered and billed correctly, the strategy cannot be designed to meet the "water demand", but rather the realistic "water need".

Ultimately, WE's aim to generalize water metering, to abolish illegal connections, and to reduce all types of Non-Revenue Water. Therefore, the water consumption in 2035 will certainly decrease. The water consumption figures adopted in the NWSS of 2012 having values of 180 l/c/d in urban and 160 l/c/d in rural zones are revised in this update. Therefore, we set the strategic target for 2035 as follows:

Drinking water demand per capita in 2035 shall be:

• Domestic consumption:	125 l/cap/day
• Non-Domestic = 20 % of the domestic	25 l/cap/day
	150 l/cap/day
• Physical losses = 20 % of the total needs	50 l/cap/day
Total needs	**200 l/cap/day**

Wastewater flow per capita is calculated based on the following assumptions:

- Produced wastewater flow = 80 % of the needs (excluding physical losses) = 120 l/cap/day
- Infiltration = 10 %

Assumptions governing the value of Domestic water consumption

It is important to note that several important factors affect water consumption:

1. Quality of water: good quality water encourages water use.
2. Cost of water: high water cost will limit water consumption.
3. Water pressure: high water pressure will raise water consumption.
4. Weather conditions: hot and dry conditions favour water consumption.
5. Living standard: people with high living standards will consume at least two times more than those living in poor areas.
6. Size of town or city: theoretically, the daily per capita water consumption in a small village is less than that in a larger village or town, due to the higher incidence of gathering centres and other facilities with high water requirements.

7. Type of water connections: the average consumption per capita per day in households supplied through water gauges is 15% higher than that in households supplied through water meters (Nassar, 1993). This shows that water consumption is flexible and that pricing can be used as a very important factor to control water consumption (Frayha, 1992).

The of water demand per household and per capita used in this strategy was reached according to the below criteria obtained from field surveys.

BTD conducted a household survey on a number of housing units in an attempt to determine households' unit consumption by evaluating water quantities used during activities like showers, washing, flushing systems, laundry, dishwashing, cooking and drinking, house cleaning, plants watering, etc.. The average weekly water consumption per household was as follows:

- Showers 1305 liters
- Washing 609 liters
- Flushing systems 1586.4 liters
- Laundry 360 liters
- Dishwashing 420 liters
- Cooking and drinking 162.4 liters
- House cleaning 240 liters.
- Plants watering 300 liters

TOTAL **4983 liters/week/household**

That is equivalent to 123 liters/day/capita, rounded to 125 liters/day/capita as was used for the purpose of this update.

By a similar exercise, non-domestic water was evaluated in different types of buildings, and a value of 20% was considered sufficient to account for additional types of water consumption.

I 3.4 METHODOLOGY AND CRITERIA USED FOR IRRIGATION WATER NEEDS ASSESSMENT

The aim of this section is to give a clear picture of the water balance and irrigation infrastructure of each irrigation scheme. This results in setting prioritized projects and the corresponding investment plan until year 2035.

Estimated Water Supply

To calculate water balances, an estimation of water availability is crucial. The assessment of the irrigation water supply for each scheme entails the following activities:

- Assessment of conventional water resources: rivers, minor springs exploited at one or few plots level, major springs captured and utilized by the Water Establishments and usually conveyed by public network, private and public wells used for irrigation or drilled in agricultural lands;

- Assessment of unconventional water availability: from wastewater treated effluents (existing and planned WWTPs);
- Assessment of rain water harvesting in Hill Lake Systems;
- Assessment of existing water network used for irrigation purposes; and
- Assessment of the storage volumes in the existing and planned dams.

This activity faces several limiting factors:

- The majority of the springs are neither gauged nor measured;
- Lots of private wells are unlicensed and the data about them and water exploited from them are absent and could not be estimated;
- The same goes for rivers that are mostly ungauged within or near some schemes, or their measurement records are either old or unreliable;
- Data on well discharges are also very scarce because all private wells and most public wells are not monitored: The discharge data are seldom found and when available they include only few readings.

In order to mitigate these limitations, some practices were used such as:

- The discharges of some of the springs would be estimated based on previous studies available for the area;
- The yield of the wells could be estimated based on the tapped formation and their discharges from pumps and fittings data when available.

Estimated Irrigation Requirements

The general overview of the country existing irrigation schemes (Figure I 12 below) leads to the following observations:

- Most of the observed traditional irrigation schemes suffer from a water shortage as proven or explained by the following:
  - Ancestral conflicts among farmers on water use and rights has often been reported.
  - Competition between domestic use and irrigation use is a common trend in many villages and locations.
  - Permanently irrigated areas are often less than arable areas within the same scheme; dry farming does not seem to be deliberately adopted.
  - Intensive drilling of water wells within many schemes is a common practice to mitigate water deficit whenever geological and economic situation allow.
  - Cropping pattern intensification is not always possible and therefore not practiced in many schemes.
  - Reported lower crops yields than standards in some cases is due to water shortage and drought.
- Aged and partly damaged irrigation infrastructure is a common observation among most traditional irrigation schemes. The existing irrigation infrastructure conditions is responsible of

important water losses and reduce drastically water efficiency. Construction and/or rehabilitation works is required at many levels.

- At the level of water intake structures (catchment works at spring levels and/or diversion dams or hydraulic structures at rivers or water courses level).
- At the level of main conveying structures such as primary channels or conveyors and distribution control devices (slide gates, valves…).
- At the level of secondary network.
- At farm level and tertiary distribution network.

- Irrigation water is mostly contaminated with raw sewage water in most irrigation schemes located downstream urban agglomerations. Some areas are solely dependent on raw sewage water, especially during dry season.
- Development of modern irrigations schemes is observed in many newly reclaimed areas and often compensates irrigated area shrinkage within traditional schemes due to uncontrolled urban development over agricultural and fertile areas.
  These new developed areas are mainly dependent either on pumped water from existing close irrigation schemes or from newly developed water resource such as:
  - Rain and snow melting harvesting by constructing storage Hill lakes and ponds.
  - Underground water exploitation by drilling (deep) wells.

  In most of these newly developed areas modern irrigation equipment and practices are adopted optimizing water use and crop production. These modern schemes represent relatively success story examples and concretize promising prospects for the entire irrigation sector in Lebanon.

Figure I 12 Existing irrigation schemes in Lebanon

The following methodology was adopted to estimate the water demand for each irrigated scheme:

1. Estimation of the total agricultural area for each scheme and the main agricultural types;
2. Estimation of the irrigated areas per scheme using the intensification index of the agricultural land calculated from the MoA Agricultural Census of 2010 as the ratio between the irrigated area and the cultivated land by type (seasonal and permanent);
3. Characterization of seasonal and permanent crops obtained from the MoA Agricultural Census of 2010 based on the FAO classifications;
4. Definition of a cropping pattern for each Mouhafaza based on the data such as:
   - Crop Coefficient: The crop coefficient was calculated and entered according to the growth stage of the crop. This intimal crop coefficient was adopted from the FAO 56 Irrigation and Drainage paper (Allen et al., 1998);
   - Effective Rainfall: The precipitation data were obtained from ClimWat software for the available weather stations all over Lebanon. These data were used to calculate the effective rainfall for each weather station;
   - Reference Evapotranspiration (ETo): The Nimah, 2007 ETo tables were adopted for the crop water needs calculations. ETo data were calculated using the Penman-Monteith equation;
   - Crop Development Stage: The crop development stages (number of days) for each crop were obtained and used from the FAO studies;
   - Crop Plantation Date: The plantation date for each type of crop in each Mouhafaza was expected based on previous surveys done by the Consultant.
5. Estimation of the water need for each type of crop in all Mouhafazas by elevation ranges;
6. Application of the water needs for latest agricultural areas of the existing schemes using the data of the Remote Sensing Center of the CNRS in 2017.
7. Re-categorization of the seasonal and permanent crops, based on crop types;
8. Delineation of the perimeters of the irrigated areas by irrigation type (gravity, sprinkler or drip).

Irrigation Water Balance

The water balance is thus the difference between supply and demand.

It should be noted that:

- A severe water deficit indicates the need for providing new water resources;
- A limited water deficit could be mitigated by network upgrade;
- A remarkable surplus due to a positive water balance indicates the need for water storage.

Negative values that appear in the water balance for the schemes indicate that either there are no sufficient data about public resources or that irrigation is assured through wells, private in general and illegal in many cases. Although this practice is compulsory to feed the need, it puts lot of stress on the

Groundwater aquifers and cause depletions and salt-water intrusion for costal ones in the absence of good water management and sufficient storage of surface water.

Recommendations

Consequently, the target of this strategy is to address the following (the proposed projects - see Volume V - are selected accordingly):

- Develop water resources by increasing water harvesting through promoting hill lakes and dams
- Rehabilitate and modernize existing irrigation infrastructure to reduce water losses and improve water efficiency by upgrading water catchment and deviation structures, and by repairing concrete broken structures and converting earthen channels into concrete one.
- Open channel systems to be eventually converted into pressurized piped system. This conversion will enhance modernization of on-farm irrigation systems.
- Accelerate wastewater treatment strategies up to Irrigation acceptable standards and in conjunction with crops selection criteria.
- Perform detailed study for each existing irrigation scheme in order to assess the existing condition, and identify all necessary actions needed to upgrade and modernize the selected scheme.

I 4 PROPOSED PROJECTS

I 4.1 GENERAL

The strategy reviewed all the water, wastewater and irrigation needs across Lebanon; it reviewed existing operational systems and identified gaps that should be filled to cover the needs of all the citizens across the territory.

These gaps were then translated into projects in all three sectors, and these projects prioritized by order of urgency and impact. Three levels of priority were used over the period of the strategy extending between 2020 and 2035; priority 1 being from 2020 to 2025; priority 2 from 2026 to 2030; and priority 3 from 2031 to 2035.

This strategy provides an update on the status of the Dams identified in the Lebanon's Surface Water Storage Strategy of 2011.

It should be noted that due to the fine-tuning of the daily per capita demand in the updated strategy of 2020, and because the water balance was calculated at the level of every water source or village or group of localities, many of the water balances resulted in positive figures when projected till the year 2035.

I 4.2 DAMS

Some of the dams identified in the 2011 strategy were scheduled beyond 2035. However, following feasibility or design studies, some of these were found geotechnically not feasible. In other cases, the selected sites for dam's construction are not available any more due to the expansion of private construction.

Therefore, some of the dams foreseen in the 2011 strategy are now dismissed. Table I 11shows the list on dams currently considered and their status.

Table I 11 Status of currently considered dams.

	Caza	Project status in 2020
BMLWE DAMS		
Janneh Dam	Jbeil	Under Construction
Chabrouh Dam	Kesserwan	In Use
Ballout lake	Metn	In Use
Bisri Dam	Jezzine	Under Construction
Boqaata Dam	Kesserwan	Under Construction
Qaysamani Dam	Baabda	In Use
Aazounieh Dam	Aley	Tendered & budget secured since 2013; Expropriation should be completed.
Damour Dam	Chouf	Priority 2; after year 2026
Maaser El Chouf Dam	Chouf	Financially not feasible ($/m3> 26)

Table I 11 Status of currently considered dams.

	Caza	Project status in 2020
Laklouk Lake	Jbeil	Priority 1; design and funds should be secured soon because the lake will be used for Irrigation
El Manzoul Dam	Metn	Financially not feasible because of high expropriation cost
Ratiba Lake	Jbeil	Priority 1; design and funds should be secured soon because the lake is used for Irrigation
NLWE DAMS		
Kouachra Lake	Akkar	Constructed (downstream irrigation system needs completion)
Bared Dam	Akkar	Priority 1; design and funds should be secured soon so that the dam is ready when the supply is needed in 2030
Adline Noura Tahta	Akkar	Priority 3; Tender Documents have to be reviewed in view of the water master plan of Akkar
Mseilha Dam	Batroun	Constructed but not yet in use
Balaa Dam	Batroun	Under Construction
Rahwe Dam	Batroun	Priority 2; after year 2026
Qarkaf Dam	Akkar	Technically not feasible
Dar Boochtar Dam	Koura	Priority 2; after year 2026
Iaal Dam	Zgharta	Technically not feasible; the site has been constructed by locals
Brissa Dam	Danniyeh	Constructed; needs concrete lining for which the funds are secured and works should start soon
Ouadi Chich - El Arz	Bcharreh	Financially not feasible ($/m3> 26)
Atolbe Lake	Akkar	Technically not feasible; the optimal site of the dam has been constructed by locals
Hadath el Jebbeh	Bcharreh	Priority 3; after year 2030
Kammoua Lake	Akkar	Priority 2; after year 2026 and/or when land ownership problems are resolved
BWE DAMS		
Aassi Dam (Phase 1)	Hermel	Priority 1; design and funds should be secured soon because the dam is used for Irrigation
Aassi Dam (Phase 2)	Hermel	Priority 2; after year 2026
Ouadi Sbat Dam	Hermel	Site for potential surface storage facility if the need arises but has not been seriously considered so far.
Barhacha Lake	Zahle	Technically not feasible
Yammouneh Lake	Baalbeck	In Use
Younine Dam	Baalbeck	Priority 3; after year 2030 for irrigation purposes
Massa Dam	Zahle	Priority 3; after year 2030 for irrigation purposes

Table I 11 Status of currently considered dams.

	Caza	Project status in 2020
Rachaya - Ain Arab Lake	Rachaya	Site for potential surface storage facility if the need arises but has not been seriously considered so far.
Qaraoun Dam	WE'st Bekaa	In Use
SLWE DAMS		
Ibl es Saqi Dam	Marjayoun	Priority 2; after year 2026 for irrigation purposes
Kfarsir or Choumariyeh Dam	Nabatiyeh	Priority 2; after year 2026 for irrigation purposes
Khardaly Dam	Nabatiyeh	Priority 3; after year 2030 for irrigation purposes
Ansar Dam	Saida	These are sites for potential surface storage facilities if the need arises, but none has been seriously considered so far
Ain Baal Dam	Sour	
Khiam Dam	Marjayoun	
Chohour Dam	Sour	
Barich Dam	Sour	
Nabaa el Tasse - Jarjou	Nabatiyeh	
Lebaa Lake	Jezzine	
Kounine Dam	Bint Jbeil	
Jinsnaya Dam	Jezzine	
Aita el Chaab Dam	Bint Jbeil	
Balatet el Jamejem Dam	Saida	
Kfarwa Lake	Nabatiyeh	
Aazbieh Lake	Jezzine	
Jbaa Lake	Nabatiyeh	
Salaa Lake	Hasbaya	
Kfarhouna Lake	Jezzine	

Surface storage is still a strategic priority for resource exploitation within the updated National Water Sector Strategy of 2020. Construction of storage facilities are encouraged to be the first resort to compensate for water supply needs, as long as they are financially, technically and environmentally feasible.

Exploiting groundwater resources is kept for areas where surface storage is not possible or insufficient to cover the growing needs; but most importantly, groundwater resources should be regarded as strategic reserve to the next generations that will witness harsher effects of climate change and reduced surface runoffs.

Yet, it shall be noted that the development of any type of resources shall be accompanied or better, preceded, by an effective reduction in Non-Revenue Water, resulting from technical losses in the

transmission and distribution networks, or from illicit connections to those networks or any other cause.

The installation of District Meters allows tracking of defaults along the water systems, implies immediate action where these are detected, optimizes the cost of production, increases the volumes and the hours of water supply to the customers. It is at this stage that installation of water meters at household level becomes realistic and efficient.

The final list of dams that have been selected is the following:

Table I 12 List of selected dams in the NWSS 2020

Governorate	Dam Name	Capacity	Purpose	Nature of Works	Cost (M USD)
Priority 1					
Akkar	Bared Dam	37 Mcm	Water Supply	Dam, WTP, Transmission Lines and Reservoirs	196
Beqaa	Assi 1 – Derivation Dam	-	Irrigation	-	52
Mount Lebanon	Azzounieh Dam	4 Mcm	Water Supply	Dam, WTP and Transmission Lines	65
Priority 2					
North Lebanon	Dar Baachtar Dam	7 Mcm	Water Supply + Irrigation	Dam and Major Transmission Lines	50
South Lebanon	Ibl El Saki Dam	50 Mcm	Water Supply + Irrigation	Dam, Transmission Lines and Reservoirs	145
South Lebanon	Choumariye Dam	28 Mcm	Water Supply + Irrigation	Dam, Reservoirs, WTP and Transmission Lines	128
Mount Lebanon	Damour Dam	42 Mcm	Water Supply + Irrigation	Dam, WTP, Transmission Lines and Reservoirs	200
Beqaa	Assi 2 Dam	37 Mcm	Irrigation	Dam, Power Generation and Lift Lines	150

Table I 12 List of selected dams in the NWSS 2020

Governorate	Dam Name	Capacity	Purpose	Nature of Works	Cost (M USD)
Priority 3					
Akkar	Noura El Tahta Dam	35 Mcm	Water Supply + Irrigation	Dam and WTP	150
Beqaa	Younine Dam	5.8 Mcm	Irrigation	Dam and Major Irrigation Lines	70
Beqaa	Massa Dam	8 Mcm	Irrigation	Dam and Major Irrigation Lines	37
South Lebanon	Khardale Dam	128 Mcm	Water Supply + Irrigation	Dam, Reservoirs, WTP and Transmission Lines	180
Mount Lebanon	Maasser El Chouf	2.2 Mcm	Water Supply	Dam + WTP	53

I 4.3 WATER SUPPLY PROJECTS

The main objective of the proposed projects is to secure the required water resources to cover the needs, with priority to regions with the most severe water scarcity; and to ensure adequate transmission, storage and distribution.

Projects are selected and prioritized according to the following criteria:

- Priority 1

  Development and expansion of water resources to cover potable water needs, i.e. in water systems having a negative water balance in 2020

  Provide adequate water storage capacities, i.e. in villages that currently have very small reservoirs compared to the required storage or in those that have very old reservoirs

  Provide adequate main transmission lines by increasing the capacity of existing ones or replacing very old ones

  Construction of distribution networks, mainly in villages that currently don't have a distribution network or in those that have very old one (i.e. > 30 years old)

  Monitoring main transmission and distribution lines through the installation of water meters, in order to better control and isolate leakages.

- Priorities 2 and 3:

  Extension of existing distribution networks

  Expansion of existing water storage capacities

  Development and expansion of water resources to address future negative water balances, along with the construction of any related works (i.e. transmission lines, pumping stations and reservoirs).

The cost of proposed projects is given in Sub-Section I 10.3

I 4.4 WASTEWATER PROJECTS

The main objective of the proposed wastewater projects is to protect the environment and the health of the citizens by eradicating or at last minimizing the discharge of untreated wastewater into the environment or in waterbodies. The projects were selected and prioritized according to the following:

- Priority 1

  Implementation of new WWTPs and sewer networks in densely populated areas

  Expansion and upgrade of major existing WWTPs if their treatment capacity isn't enough to treat the influent wastewater (in 2020).

- Priority 2:

  Implementation of new WWTPs and sewer networks in less densely populated areas

  Expansion and upgrade of existing WWTPs if their treatment capacity isn't enough to treat the influent wastewater flows in the near future.

- Priority 3:

  Implementation of small wastewater treatment units in isolated villages/areas

The total cost of the wastewater projects by priority is given in Sub-Section I 10.3

I 4.5 IRRIGATION PROJECTS

I 4.5.1 Irrigation projects under SLWE jurisdiction

Prioritization of the projects was elaborated as follows:

- Priority 1

  For projects that are included in the Litani River Authority strategy plan. These are:

  - 1st phase of conveyor 800 Irrigation Distribution Networks Project (465 km). The first phase of this project is composed of the transmission system and Related reservoirs is presently under construction.
  - Saida-Jezzine Project - Replacement of 45 km of irrigation networks in the existing project.

- Priority 2

  Priority 2 projects include:

  - Second phase of Conveyor 800 - Irrigation Distribution networks (1335 km).
  - Rehabilitation of existing local irrigation schemes in Bint Jbeil, Rashaya, Jezzine, Nabatiyeh, Saida, Sour districts.
  - Construction of 9 hill lakes.
    The projects are located outside the areas served by the main irrigation projects in order to provide additional water quantities. The locations of the hill lakes were determined in a conceptual manner. A feasibility study should be conducted for the final definition of these projects.

- Priority 3

  Priority 3 projects include:

  - Phase II of Khardaleh Dam consisting of the construction of related irrigation distribution networks (1300 km).
  - Construction of Phase II of Ibl es Saqi dam scheme consisting of the construction of related distribution networks (380 km).
  - Rehabilitation and modernization of existing small-scale projects in 39 localities. The projects are located outside the areas served by the main irrigation projects (141 km).

The total proposed area to be irrigated based on the three priorities of projects is around 41,500 ha without taking into consideration the local schemes which constitutes around 80% of the agricultural lands.

The cost estimate of the different projects was conducted based on the level of details of each of the projects' studies. The total cost of the implementation of the irrigation projects in South Lebanon is as follows (excluding dams):

- Priority 1 86,550,000 USD (irrigation networks)
- Priority 2 416,380,000 USD (Hill lakes and irrigation networks).
- Priority 3 299,700,000 USD (irrigation networks).

  802,630,000 USD

The total cost of projects is given in Table I 15 below.

I 4.5.2 Irrigation projects under NLWE jurisdiction

The results of the water balance estimation for Aakkar and North Lebanon schemes show that the estimated water supply from rivers, springs and few identified wells is 328 Mm^3 ; the total crop demand is around 216 Mm3. The resulting water balance is a surplus of 128 Mm3.

Although the analysis concluded that the water balance is positive, this area is characterized by an overexploitation of groundwater, which caused a drop in its groundwater table. This implies that the water management practices are poor with the uncontrolled pumping.

Moreover, the surplus should be stored in the dams mainly recommended by the NWSS 2012, for water supply during peak demand periods and to cut-off the illegal supply from wells.

- Priority 1

Rehabilitation of existing irrigation networks in Akkar	19,970,000 USD
Rehabilitation of existing irrigation networks in remaining areas	9,150,000 USD
Construction of 4 hill lakes with their associated irrigation networks	33,370,000 USD
	62,340,000 USD

- Priority 2

Construction of 11 hill lakes with their associated irrigation networks	110,720,000 USD
Irrigation networks related to Dar Baachtar dam	11,200,000 USD
	121,920,000 USD

- Priority 3

Rehabilitation of existing irrigation networks in 5 schemes	47,265,000 USD
Construction of irrigation networks associated to Noura Tahta dam	56,000,000 USD
Hill lakes and related irrigation networks	22,900,000 USD
	125,765,000 USD

The cost of projects is given in Table I 15 below.

I 4.5.3 Irrigation projects under BMLWE jurisdiction

The results of the water balance estimation for Mount Lebanon schemes show that the estimated water supply from rivers, springs and several wells is 241 Mm3; the total crop demand is around 58 Mm3. The resulting water balance is a surplus of 172 Mm3.

This water surplus is an indication of the importance of storing water in the dams mainly recommended by the NWSS 2012, for water supply during dry season.

The total cost of the projects in the jurisdiction of BMLWE is (see Table I 15 below):

- Priority 1

For irrigation networks in 2 schemes	1,020,000 USD

- Priority 2

For irrigation networks in 1 scheme	1,150,000 USD
For 8 hill lakes with their associated irrigation networks.	33,500,000 USD
	34,650,000 USD

- Priority 3

For 10 irrigation networks schemes	5,220,000 USD

I 4.5.4 Irrigation projects under BWE jurisdiction

The results of the water balance estimation for Beqaa and Baalbek-Hermel schemes show that the estimated water supply springs and several wells is 187 Mm3; the total crop demand is around 521 Mm3. The resulting water balance is a deficit of 345 Mm³.

This water deficit could be attributed to the fact that this area relies heavily on well extraction. Unfortunately, most of these wells are unlicensed and non-monitored with flow meters. To add on it, the agricultural area is remarkable compared to the other mandates (BWE: 70,911 ha, NLWE: 33,555 ha and BMLWE: 7,251 ha).

The total cost of the projects in the jurisdiction of BWE is:

- Priority 1

For improvement of existing irrigation networks in 22 schemes	25,437,000 USD
For new irrigation networks in Qaa and Hermel - Aassi dam 1 (phase 1)	84,272,000 USD
	109,709,000 USD

- Priority 2

For 7 hill lakes with their associated irrigation networks	55,200,000 USD
For construction of new irrigation networks - Aassi dam 1 (phase 2)	83,000,000 USD
	138,200,000 USD

- Priority 3

For irrigation networks in 4 schemes	4,524,000 USD

I 4.5.5 Rationale for Project Selection

After estimating the water budgets of all schemes, several technical interventions could be concluded:

- Increasing canal conveyance efficiency by the rehabilitation of poorly maintained concrete canals and converting earthen canals into concrete;
- Optimizing the existing resources through water quality and quantity monitoring;
- Promoting the reuse of TSE for irrigation;
- Construction of Hill Lakes for rainwater harvesting;
- Construction of dams previously recommended by the NWSS of 2012;
- Promoting the use of drip irrigation and changing cropping patterns towards less water demanding crops.

These projects should be implemented hand in hand with strategic environmental assessment (SEA) and environmental impact assessment (EIA) studies to mitigate any environmental hazard.

I 4.5.6 Irrigable land

Based on the inventory of the irrigation schemes across the country, presently irrigated land area is around 105,000 ha.

Irrigation development in the future is conditioned by:

- Implementing new projects
- Securing new water resources (storage structures & water wells).

The construction of the proposed projects would allow for the irrigation of an additional 38,000 ha at the country level.

Details are given in Table I 13 below

Table I 13 Irrigated areas in Lebanon

	Presently irrigated area (ha)		Proposed irrigation projects	(ha)	Total (ha)
NLWE (18 schemes)			Noura el Tahta & Dar Baachtar dam	4 200	
			Hill lakes	730	
		28 600		**4 930**	**33 530**
BMLWE (15 schemes)		**5 835**	Hill lakes	**540**	**6 375**
BWE (36 schemes)			Aassi dams	6 000	
			Massa dam	1 600	
			Younine dam	1 200	
		66 115		**8 800**	**74 915**
SLWE	Qasmieh Ras El Ain	3 200	Conveyor 800	13 250	
	Saida Jezzine	430	Khardale dam	1 300	
	Small local projects	580	Choumaryeh dam	4 000	
		4 210	Ibl es Saki dam	3 800	
			Hill lakes	1 235	
				23 585	**27 795**
Total		**104 760**		**37 855**	**142 615**

I 4.5.7 Water requirements for irrigation

Under the presently prevailing irrigation conditions, considering network losses and the irrigation practices, the irrigation efficiency is around 50 to 60%. The average irrigation water requirement for a representative ha at the country level is around 8,400 m³/ha /year as shown in Table I 14

Table I 14 Irrigation water needs

	Presently irrigated area (ha)	**Adopted requirements** (m^3/ha/year)	**Mm^3/year**
NLWE	28,600	7,500 (Most of the area is coastal)	214.5
BMLWE	5,835	6,500 (Most of the irrigated area is at high altitude)	37.9
BWE	66,115	9,000 (Most of the irrigated area is inland /dry weather)	595.0
SLWE	4,210	7,500 (Most of the irrigated area is coastal)	30.9
Total	**104,760**	**≈ 8,400** Average irrigation water requirement for one representative ha at country level	**878.3**

Future irrigation water requirements

Assessment of future irrigation water requirements is based on the following assumption:

- Irrigated areas would reach in 2035 around 138,000 ha.
- Irrigation efficiency will be improved and will be upgraded from 60% to 75% by rehabilitating or constructing concrete or piped & conveyance structures and catchment structures and by modernizing on-farm irrigation practices (micro-irrigation). Consequently, irrigation water requirement for 1 representative ha will drop from 8,400 m3/ha/year to 6,720 m3/ha/year (based on 5040m3/ha/year as a net water requirement, i.e. without water losses, then 5040/0.75=6720m3/ha/year would be the gross water demand per ha per year when overall system efficiency will reach 75%).

Based on the above, the present irrigation water requirement at the country level is 878.3 Mm^3 and would reach 930 Mm^3 in 2035, should the proposed project be implemented.

On the other hand, Agricultural National Census (MoA) 2010 reveals that only 65% of the irrigated areas are permanently irrigated whereas 35% of the remaining are partially irrigated. Moreover, only 50% of the irrigated area are covered by natural surface water whereas the rest is covered by "expensive" underground water and/or hill lakes stored water.

The above observations lead us to conclude the existence of a serious gap between irrigation water demand and the irrigation water "real" use.

Therefore, it is estimated that only some 75% of the present Irrigation water requirement (660 Mm3) are presently sustained by available water for irrigation and reflect the Irrigation water consumption figure across the country.

Out of these 660 Mm3 it is estimated that some 330 Mm3 are covered by surface water.

I 4.5.8 Prioritized Projects and Cost Estimate

The recommended projects per scheme were organized over four levels of priority throughout the implementation timeframe of this strategy:

- Priority 1 Network upgrade (rehabilitation and/or improvement) for schemes with a negative water balance,
- Priority 2 Hill Lake system construction for schemes with a negative balance, in addition to other projects with a direct impact on the schemes.
- Priority 3 Upgrade and /or expansion of the network for schemes with a positive water balance. Construction of dams to serve adjoined schemes.

Table I 15 below summarizes the needed investment plan by priority for each WE

Table I 15 Irrigation projects Cost Estimates

	Estimated Capital Investment Including Design and Supervision (M USD)		
	Netwoks	Hill lakes	Total
Priority 1			
NLWE	29 120	33 370	62 490
BMLWE	1 020	-	1 020
BWE	109 709	-	109 709
SLWE	86 550	-	86 550
	226 399	**33 370**	**259 769**
Priority 2			
NLWE	11 200	110 720	121 920
BMLWE	1 150	33 500	34 650
BWE	83 000	55 200	138 200
SLWE	296 680	119 700	416 380
	392 030	**319 120**	**711 150**
Priority 3			
NLWE	103 265	22 900	126 165
BMLWE	5 220	-	5 220
BWE	4 524	-	4 524
SLWE	299 700	-	299 700
	412 709	**22 900**	**435 609**
Grand Total	**1 031 138**	**375 390**	**1 406 528**

I 5 ENVIRONMENTAL RECOMMENDATIONS

I 5.1 GENERAL

A Strategic Environmental Assessment (SEA) shall be developed for the draft Updated National Water Sector Strategy (NWSS) and submitted to the Ministry of Environment (MoE) for approval. The SEA report shall comply with the Decree 8213/2012 requirements and its Annex 3 regarding the information to be included in the SEA report.

The SEA shall be used as a decision-making tool for issuing the final version of the updated NWSS and shall facilitate the preparation of the Environmental Impact Assessments (EIAs) for specific components by providing an important amount of information to the EIA preparer, especially with respect to baseline conditions, environmental impacts, possible mitigation and monitoring measures.

The SEA report of NWSS 2012 was issued in 2015, and it was a comprehensive study financed back then by the World Bank. Today, the World Bank is ready to finance the update of that SEA and adapt it to the context of MoEW's updated NWSS, while aiming at issuing it within the shortest delays. Following the completion of this updated SEA, it will be possible for the Council of Ministers to approve and issue the updated NWSS officially through a decision.

I 5.2 SEA METHODOLOGY & LEGAL STEPS

The legal text defines the scope of the SEA, the different phases, review procedures, screening methodology, validity of the PPP (Policy, Plan, Program), and the content of the scoping and final reports. Table I 16 shows the various stages of a SEA along with the requirements of each stage.

Table I 16 SEA Process Components

SEA Stage	Description
Screening	• To determine whether the proposed strategic action (plan or program) requires SEA
Scoping	• To delineate the zone of influence of the proposed plan or program (geographical coverage, time span, sector of activity and social groups) • To establish the range of issues and level of detail to be included in the assessment • To decide on the significant impacts to be considered • To determine data collection requirements
Stakeholder involvement	• To inform and ascertain the opinion of all those who are likely to be affected by the proposed plan or program • To determine what tradeoffs are acceptable • To identify implementation needs and mechanisms

Table I 16 SEA Process Components

SEA Stage	Description
Analysis of Alternatives	• To identify, analyze, and compare the impacts of the different shortlisted alternative options • To evaluate the technical and financial feasibility of alternative options • To determine the consistency of the components with pre-set objectives and priorities • To evaluate the compatibility with current legal, institutional, and planning frameworks. • To determine the "most suitable strategic option" and means of implementation
Performing the assessment	• To identify, analyze, and compare the impacts of the most suitable strategic option selected • To propose a relevant Environmental Management Plan (EMP) for reducing or eliminating negative impacts and enhancing environmental opportunities
Submission of SEA report	• To document the methodology and findings of the SEA
Peer review and integration of SEA findings	• To ensure that the assessment has proceeded in a scientific and objective manner • To verify that all significant impacts have been considered • To determine whether the "most suitable strategic option" has been proposed • To determine the feasibility and suitability of the EMP • To review, amend or reformulate the proposed plan or program
Decision making	• To decide whether to adopt, amend or reject the proposed plan or program
Monitoring and quality assurance	• To evaluate performance with respect to set objectives • To monitor implementation and assess the continued suitability of the EMP • To assess the efficiency of the SEA process in "greening" public decisions

I 5.3 SEA SCOPE

In summary, the updated SEA report shall include the following:

- Assessment of baseline data on the physical, hydrogeological, environmental, and socio-economic conditions of the project area,
- Identification of environmentally significant areas in the project sites,
- Assessment of the best alternative(s) or option(s) for the project in terms of socio-economic, health, financial, and environmental aspects,
- Identification of potential impacts of the project and assessment of their significance,
- Description of mitigation measures to minimize impacts, and
- Elaboration of an environmental management plan including a monitoring program for the whole project.

I 6 WASTEWATER EFFLUENT AND SLUDGE MANAGEMENT AND REUSE

I 6.1 GENERAL

Huge quantities of treated wastewater and biosolids (sludge) are produced every day all over the world, which exert a strong pressure on the environment. An important question that is raised is "what to do with them?". An effort is put by the scientific community to eliminate the concept of "waste" and to replace it with the concept of "recycling of resources", by means of effective management.

In many countries, quality standards have been developed governing the discharge and/or reuse of wastewater and sludge. To date, Lebanon lacks legislation and/or standards related to:

- Soils and sediments standards;
- Guidelines for the disposal and reuse of sewage sludge; and
- Guidelines for effluent/wastewater reuse.

I 6.2 WASTEWATER REUSE

I 6.2.1 Relevant National standards and guidelines

Wastewater Discharge: The standards for discharge into receiving water bodies are presented in MoE Decision no. 8/1, which updates similar standards set by Decision 52/1.

Wastewater Reuse: In Lebanon, there is no legal basis for reuse of wastewater. There are no regulations, guidelines and standards for the reuse of treated wastewater for different purposes. Two propositions for Lebanese Guidelines on Sewage Sludge Use in Agriculture and for Lebanese Wastewater Reuse Guidelines have been prepared by FAO in 2010. However, these have not been officially enforced yet.

I 6.2.2 Relevant International guidelines and standards

Wastewater Treatment and Reuse for Irrigation

The EU Council Directive 91/271/EEC (Directive on Urban Wastewater Treatment) was adopted on 21 May 1991. Its objective is to protect the environment from the adverse effects of urban waste water discharges and discharges from certain industrial sectors. The Directive provides no specifications for treated effluents reuse. Nevertheless, many European countries have adopted respective criteria for the reuse of the treated wastewater. The criteria for Greece and for the neighbouring Cyprus are presented in the document.

A careful consideration is needed whenever the effluent is reused in agriculture. The treatment requirements must address the local agricultural practices, potential public exposure, and environmental impact. US EPA guidelines for water reuse make this distinction and the corresponding specifications are described in the document. However, the US EPA standards do not include the

required limits for the disease-causing nematode eggs, which are persistent. The WHO standards address these requirements as presented in the document.

Wastewater Treatment and Reuse for Groundwater Recharge

Various sources of water are available for groundwater recharge but, in recent years, the use of nonconventional water resources such as recycled municipal wastewater, has received increasing attention.

Water Framework Directive 2000/60/EC (WFD) objectives for groundwater relate to chemical status and quantitative status, which are required to meet good status and avoid deterioration in status. The reuse of treated wastewater for recharge of aquifers can contribute to WFD objectives, as long as the water is of sufficient quality.

Groundwater Directive 2006/118/EC (GWD) establishes further provisions for the protection of groundwater against pollution, including more detailed criteria to assess the chemical status of groundwater bodies and identification of significant and sustained upward trends, along with specific measures to prevent or limit inputs of pollutants to groundwater.

Industrial Reuse

Based on EPA - Guidelines for Water Reuse (2012), pulp and paper facilities, textile facilities, and other facilities using reclaimed water for cooling tower purposes, have been the primary industrial users of reclaimed water. Standards, presented further in the document, are for cooling towers and boiler water makeup.

I 6.3 SLUDGE REUSE

I 6.3.1 Relevant national standards and guidelines

In Lebanon, there are no regulations, guidelines and standards for the reuse of sludge for different purposes. Two propositions for Lebanese Guidelines on Sewage Sludge Use in Agriculture and for Lebanese Wastewater Reuse Guidelines have been prepared by FAO in 2010. However, these have not been officially enforced yet.

The Master Plan for sludge recovery or disposal - CDR 2003 states that among the various sludge disposal and treatment options studied for different stations, the reuse of sludge in the agricultural areas is the preferred alternative. The analyzed reuse and disposal alternatives are as follows:

- Sludge Reuse Alternative
  - Stabilization and reuse by spreading in agricultural areas (stabilized sludge);
  - Composting and reuse;
  - Co-composting with domestic solid waste and reuse;
  - Drying, granulation and reuse

- Sludge Non-Reuse Alternative
  - Incineration, and
  - Controlled disposal in domestic landfills.

In addition, the 2003 CDR study proposed an action plan for the study disposal as presented later in the document.

I 6.3.2 Relevant international standards and guidelines

Across EU, guidelines and requirements for the management and reuse or disposal of sewage sludge are related directly or indirectly with a set of legislation, mainly including the following Directives:

- Directive 2008/98/EC, Waste Framework Directive;
- Directive 1999/31/EC on the Landfill of Waste;
- Directive 86/278/EEC on Sewage Sludge application on land;
- Directive 2009/28/EC on the promotion of the use of energy from Renewable Sources.

I 6.4 RECOMMENDATIONS

The proposed recommendations take the following into consideration:

- Quality and quantity of fresh water sources need to be managed sustainably. In this perspective domestic water sources (aquifers, springs, wells, or surface-water) will be protected against contamination by wastewater, and conditions for water-based recreation (swimming, boating, and fishing) will be enhanced by improvements in water quality and control of marine disposal.
- Mitigation of health and environmental risks, requires that common norms and standards for the reuse of treated wastewater and sludge in Lebanon be elaborated.
- Water conservation by reuse, aquifer recharge, or industrial reuse of treated effluent should be practiced where it is cost-effective and water resources are otherwise inadequate. Irrigation of agricultural lands by wastewater should be promoted provided water quality is monitored and health standards are maintained.
- Water and sludge demand management: Wastewater and sludge reuse should be oriented to demand driven planning by focusing on projects that are committed to reuse.
- Lebanon should develop a platform for disseminating knowledge gained from existing wastewater treatment facilities in the region. Knowledge sharing would lead to improved availability of information on the economic and financial benefits, the volumes of treated and reused wastewater, benefits to the water economy, and cost recovery of water reuse systems.
- A clear-cut sludge treatment technology and thereupon based disposal/reuse strategy should be considered an indispensable, integral part of any WWTP project.
- Investigate and analyze the existing potential for sludge reuse.
- Promote:
  - Measures to minimize sludge volume, such as anaerobic sludge digesters, and solar sludge drying.

- Measures to generate and utilize biogas for power generation.
- Regional co-operation in sludge management should be assisted, since economy of scale can help in bringing down sludge disposal/reuse cost.

I 6.5 MONITORING SYSTEM

The proper implementation of a comprehensive environmental management and monitoring plan will ensure that the proposed wastewater treatment plants meet regulatory and operational performance (technical) criteria.

I 6.5.1 Performance Monitoring for Treated Wastewater Discharged into Surface Waters

The recommended process performance parameters suggested in a draft law by the Lebanese Ministry of Environment (MoE) were presented in the document.

I 6.5.2 Performance Monitoring for Treated Wastewater Reuse

Based on the proposition for Lebanese wastewater reuse guidelines (FAO 2010), the frequency of sampling at the wastewater treatment units is set, taking into consideration the following issues:

- The requirements of the European legislation (e.g. Directive 91/271/EEC)
- The necessity of achieving treated effluent with such a quality that ensures its safe reuse for irrigation purposes.

I 6.5.3 Monitoring Characteristics of Processed Sludge

Based on the proposition for Lebanese guidelines on sewage sludge use in agriculture (FAO 2010), the analyses of the sludge must be done regularly, to the minimum frequencies shown in the document.

I 7 SURFACE WATER MONITORING AND MANAGEMENT

The monitoring and the Management of the surface waters consists of:

- Carrying out a data collection and an assessment of the Lebanese meteorological information networks.
- Suggesting guidelines for the implementation of an Integrated Hydrological Information System (IHIS) within the Ministry of Energy and Water.

The first task details the findings of the revision and assessment of the existing meteorological and hydrological information networks; it includes a detailed list of all public 136 meteorological stations and 138 hydrometric stations, located on all catchments, rivers, springs and channels across Lebanon showing their locations and eventually their specifications and operational situation. The assessment identifies the actual gaps of the existing networks, mainly the proper coverage of hydrogeological aquifers and mountainous areas and suggests a methodology for the installation of new stations based on WMO recommendations and Lebanese climatic and landform characteristics.

The second task suggests, based on the findings of the first, a set of studies and action plans to carry out the meteorological and hydrological networks expansions and the design and implementation of the IHIS. Lebanon has not yet established an IHIS which shall provide public and private stakeholders an access to reliable information and management services to build this management approach. An IHIS shall allow all information providers to manage, publish, and share their data, products and services, and allow all users to develop value-added services and new products.

An IHIS design for Lebanon is suggested based on the combination between LMS's climatic zoning approach, LRA's catchment scale distribution approach and completed by LARI's agrometeorological network for agricultural areas. This ensures that each catchment microclimates are well covered (coastal areas, plains, lowlands and mountains), rivers specific hydrological regimes are taken into consideration (snow influence, spring contribution, etc.) and land-cover characteristics are covered by LARI's network for evapotranspiration estimation. This integrated network could be achieved without any institutional merge or tasks overlap but requires an elaborate inter-institutional coordination within a central IHIS unit located at MoEW.

The strategy for the implementation of this IHIS focuses on supporting Lebanon's decision regarding global agendas, such as the United Nations SDGs, the United Nations Framework Convention on Climate Change (UNFCCC), the Global Framework for Climate Services (GFCS), etc. An Implementation Coordination Team of the IHIS shall be formed to elaborate and maintain a strategic plan for developing the IHIS over the next period.

The proposed studies for IHIS implementation are:

1. Assessment studies for the meteorological and hydrometric networks including an assessment of the Institutional framework and working teams (skills, knowledge, expertise, trainings, etc…), an assessment of the data management centre and quality of measurements, etc…
2. Update and analysis of the National Land Use Master Plan and Geodatabase (NLUMP) in order to include the latest and most precise maps describing the Lebanese landscape, geology,

hydrogeology, land use, morphology, water and land resources with the contribution of both public and private sectors especially academic and research institutions.

3. Lebanese data rescue project to preserve all data at risk of being lost duet to deterioration of the medium and digitizing current and past data into computer compatible form for easy access as most of climatic data are still on paper.

4. Design studies of the IHIS implementation upon the achievement of all assessment studies of existing meteorological and hydrological networks and based on the resulting comprehensive analysis report of the NLUMP. The proposed studies are:
   - Institutional and capacity building of all administrations involved in the IHIS;
   - Design of the LMS, LRA, LARI and MoEW meteorological and LRA hydrometric networks;
   - Design of data management centre including server specifications, data collection, dissemination and archiving protocol,
   - Benefit - cost analysis of the implementation of the IHIS;
   - Preparations of terms of reference for IHIS implementation;
   - Integrated water resources management for 20 major Lebanese rivers using WEAP software;
   - Flood risk management plans for 20 major Lebanese rivers. This study includes the following:
     - Topographical and urban surveys of the river and its floodplain
     - Hydrological Study
     - Hydraulic Study and Flood Mapping
     - Risk Analysis
     - Social Environmental Assessment SEA / Habitat assessment
     - Flood Risk Management Plan including a conceptual and legal framework, a program of measures, early warning protocol, organizational framework.

The implementation timescale shall take into consideration the budgets and divide it into several phases either by gradually expanding the basic network to reach a complete network or by fully equipping one catchment at a time and then moving on to another catchment. We propose in the chart below the timescale of the four phases:

- Recommended studies
- Networks expansion
- IHIS implementation
- Integrated water resources management for 20 major Lebanese rivers.
- Flood Risk Management Plan

	Duration (months)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
A-Recommended studies for IHIS implementation	**100**									
Assessment studies	12									
Update and Analysis of the NLUMP	12									
Lebanese Data Rescue Project	24									
Design studies for IHIS implementation	16									
Integrated water resources managemetn studies	60									
Flood Risk Management Plan	84									
B- Networks Expansion	**64**									
LMS + LRA Meteorological Network	40									
LARI Meteorological Network	12									
MoE Meteorological Network	24									
LRA Hydrometric Network	64									
C- IHIS implementation	**16**									
IHIS Implementation	12									
IHIS Operation and Supervision	24									
WEAP Implementation	6									

Figure I 13 Recommended studies, networks expansion and IHIS implementation timescale

In addition, the implementation of two additional studies (the study related to the preparation of a drought mitigation plan and the study related to the rainwater harvesting program) would be implemented according to the below timescale.

The Drought Mitigation plan would be a national scale drought mitigation plan. It would include the following tasks:

- Define the conceptual and legal framework, methodology,
- Data collection including historical drought events
- Establish indicators and thresholds for drought classification
- Develop a program of measures, mitigations and recommendations for a nation scale strategy
- Establish drought early warning protocol
- Establish organizational framework for the production, implementation and update of the drought mitigation plan.

The rainwater harvesting program would be a national scale rainwater harvesting strategy and program. It would include the following tasks:

- Define the conceptual and legal framework, methodology
- Data collection
- Hydrological assessment of the rainwater harvesting potential
- Determination of the harvesting methods and potential implementation sites
- Development of an implementation strategy and program.

	Duration (months)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
Drought Mitigation (Nation scale drought mitigation plan	9									
Define the conceptual and legal framework, methodology,	2									
Data collection including historical drought events	1									
Establish indicators and thresholds for drought classification	3									
Develop a program of measures, mitigations and recommendations for a nation scale strategy	6									
Establish drought early warning protocol	2									
Establish organizational framework for the production, implementation and update of the drought mitigation plan	1									
Rainwater harvesting program (Nation scale rain water harvesting strategy and program	3									
Define the conceptual and legal framework, methodology	2									
Data collection	1									
Hydrological assessment of the rainwater harvesting potential	2									
Determination of the harvesting methods and potential implementation sites	3									
Development of an implementation strategy and program	6									

Figure I 14 Time Scale of the Recommended studies for the preparation of the drought mitigation plan and rainwater harvesting program

I 8 GROUNDWATER RESOURCES MONITORING MANAGEMENT AND DEVELOPMENT

I 8.1 GENERAL

Water scarcity has been a redundant problem in Lebanon for the past decades due to the mismanagement of water resources which has been causing the disparity between supply and demand. The difficulty of balancing between supply and demand requires the need for a sustainable Water Resources Management (WRM), especially with the growing population. The World Bank defines WRM as the "process of planning, developing, and managing water resources in terms of both water quantity and quality, across all water uses". It includes the institutions, infrastructure, incentives and information systems that support and guide water management.

Groundwater resources constitute 53.4% of all water resources in Lebanon (IFI, 2014). For a sustainable use of water resources, an improved and forward-thinking groundwater management is necessary. Therefore, valid and accurate information on groundwater quantity and quality, its renewability and the hydrogeological structure of the underground are necessary (BGR, n.d.).

The two most prominent factors affecting groundwater availability are population growth and climate change. A study done by the UNDP in 2014 confirmed the relationship between population size and groundwater availability. It showed that stressed aquifers are located in urban areas (such as Beirut, Tyre and Tripoli), and in areas where the demand for irrigation is high (such as in the Bekaa plain and Akkar plain).

Lebanon is currently going through a critical phase in managing its natural resources. Particularly in the water sector, the socio-economic evolution of the population from one side and the Syrian refugees' crisis on the other, greatly add to the stress on available resources and will exacerbate the expected 10-20% decrease in precipitation volumes by 2040, related to climate change (SNC - MoE 2011).

The resulting issues from the assessment of the present situation in groundwater management revealed the following:

- Mismanagement or decentralization of groundwater data due to the large number of participants resulting in data loss and data inconsistency between the different establishments and the MoEW.
- Reliability of the collected groundwater data is uncertain due to data redundancy and inaccuracy.
- Existing groundwater data exchange procedures are not based on a uniform format.
- Insufficient staff to cover all the duties of the geology and underground water service in the MoEW.
- Damaged or insufficient meteorological and hydrometric stations spread on the groundwater and river basins.
- Overexploitation of groundwater resulting in seawater intrusion in the coastal aquifers.
- Huge number of unlicensed private wells.
- Wastewater mismanagement leading to groundwater contamination.
- No studies of springs protection zones

- Absence of monitoring systems for groundwater quantity and quality.
- Absence of detailed wells and springs inventory.
- No control of groundwater extracted from wells for drinking and irrigation purposes.

If the above-mentioned constraints are not taken care of in the near future, the situation will get worse leading to a water crisis. Therefore, it is crucial to start adapting a sustainable groundwater resources management.

The current situation of groundwater extraction can be described as follows:

- In coastal and urban areas, the number of existing drilled water wells is extremely high putting the tapped aquifers under stress and consequently preventing a full material replenishment. This uncontrolled situation has led to the draining of the groundwater resources and to their contamination by seawater intrusion.
- In the remaining areas, most of the groundwater aquifers are being overexploited by private wells which are extracting large volumes of water without any restrictions nor monitoring made by the Ministry of Energy and Water.
- The uncontrolled number of private wells and the uncontrolled extraction of groundwater from these wells decreased dramatically the flows discharged by many springs, which water is primarily used for domestic supply and irrigation.
- No detailed groundwater balance studies have been made on the identified aquifers since 1970.
- No monitoring on the extracted water volumes from public and private wells is made.
- No monitoring of the fluctuations of the water levels in the wells is being made.
- No monitoring of the quality of the extracted water from the wells is being made.

There is therefore a big necessity to sustain a serious groundwater resources management.

I 8.2 STRATEGIC RECOMMENDATIONS FOR GROUNDWATER RESOURCES MANAGEMENT

The increased fluctuations in precipitation and extreme weather events will directly affect the availability of groundwater and our dependency on it. For example, during long periods of droughts, rivers and springs will become almost dry to the point where people will increasingly rely on wells to secure their water needs, resulting in a higher risk of aquifers depletion or contamination by seawater intrusion. In other cases, such as flooding events, the rate of surface run-off will be very high resulting in a lower infiltration rate which leads to a lower recharge rate and eventually a higher risk of aquifers depletion. There is therefore a necessity to build up a strategy which target is to enforce the management capacities of the MoEW by:

- Recruiting a specialized staff in the fields of geology, hydrogeology and water resources;
- Implementing simultaneously with the recruitment of staff a Project Management Unit (PMU) to assist the Ministry and the newly recruited staff;
- Refreshing and completing the detailed geologic mapping of Lebanon at scale of 1/20,000;

- Assess the sea-water intrusion in the major coastal aquifers. The study is on-going and will be completed in June 2021.
- Refreshing the 2014 UNDP water resources study by performing in stages hydrogeological studies and producing hydrogeological reports on the identified hydrogeological basins in the North, Central, South, North Bekaa valley, South Bekaa valley and Eastern Lebanon mountain chain area;
- Drilling deep reconnaissance water wells to detect the presence of new potential aquifers in some specific areas and proceed with their water testing;
- Proceeding with the second phase of the rehabilitation of the springs catchment structures;
- Enhancing the Artificial Recharge of some selected aquifers;
- The Ministry of Energy and Water performed a feasibility study of 22 selected sites in the 2014 UNDP study and selected out of them 4 sites (Berdawni, Damour, Abou Ali and Zahrani) to start their implementation with a preference to start with Berdawni project as a pilot project.
- Enhancing the vulnerability studies in relation with the springs and the definition of their protection perimeters;
- Refresh the water budgeting of all aquifers progressively;
- Perform progressively the modelling of the karstic, saline and porous aquifers.

The detailed activities (studies, investigations and works) to be performed, their sequence in time and their cost estimate are shown on Figure I 15 below.

No.	Activities and Projects	Time in years														
		1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	PMU implementation in the MoEW	*														
2	Review the licensing procedures of the MoEW for drilling and exploiting private water wells															
3	Staff recruitment in the MOEW															
4	Preparation of T.O.R for the purchase of vehicles, working tools, softwares, computers, etc... to the benefit of the MoEW.															
5	Equipment and vehicles procurement															
6	Review of all existing data in the data center in the MoEW and data collection of available and existing geological and hydrogeological studies															
7	Enter continuously all collected data in the database center in the Ministry of Energy and Water															
8	Monitor the flows of the majority of the public operating wells with the assistance of the Water Establishments knowing that all the public wells will be equipped with flow monitoring and water level monitoring devices															
9	Monitor continuously with the assistance of the Water Establishments the quality of the water extracted from the public wells															
10	Monitor continuously the flows and the water quality of springs which flows are higher than 80l/sec with the assistance of the Water Establishments															
11	Follow up with the Department of the river flows monitoring in the Ministry of Energy and Water the flows measurements of rivers															
12	Preparation of T.O.R for the preparation of a study to select the sites of the hydrometric stations along the major rivers in Lebanon taking into consideration the hydrologic, geologic and hydrogeologic prevailing conditions															
13	Detailed studies for implementing the hydrometric stations in rivers															
14	Construction of the hydrometric stations															
15	Geological Mapping															
15.1	Geological survey at 1/20,000 scale of Central area															
15.2	Geological survey at 1/20,000 scale of Bekaa and Eastern area															

Figure I 15 Detailed Activities to be performed

No.	Activities and Projects	Time in years													
		1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	**Hydrogeological Mapping**															
16.1	Production of hydrogeologic maps at a scale of 1/50,000 and hydrogeologic report on the identified hydrogeologic basins/aquifers of Beirut and Mount Lebanon area															
16.2	Production of hydrogeologic maps at a scale of 1/50,000 and hydrogeologic report on the identified hydrogeologic basins/aquifers of the North Lebanon															
16.3	Production of hydrogeologic maps at a scale of 1/50,000 and hydrogeologic report on the identified hydrogeologic basins/aquifers of the South Lebanon															
16.4	Production of hydrogeologic maps at a scale of 1/50,000 and hydrogeologic report on the identified hydrogeologic basins/aquifers of the Northern and Southern Beqaas areas															
16.5	Production of hydrogeologic maps at a scale of 1/50,000 and hydrogeologic report on the identified hydrogeologic basins/aquifers of the Eastern Lebanon															
17	**Aquifer Artificial Recharge**															
17.1	Proceed with the preparation of the detailed design of the AAR pilot project facilities in Berdaouni (A10 site)															
17.2	Implement the construction works of the Berdaouni AAR facilities															
17.3	Follow up the AAR of the Berdaouni aquifer															
17.4	Detailed design of the AAR facilities of Damour															
17.5	Construction of the AAR facilities of Damour															
17.6	Follow up of the AAR of Damour Aquifer															
17.7	Proceed with the detailed design of the AAR facilities of Mejdlaya - Abou Ali site															
17.8	Implement the construction works of Mejdlaya - Abou Ali AAR site															
17.9	Follow up the AAR of the Mejdlaya - Abou Ali site															
17.10	Proceed with the preparation of the feasibility study for the AAR of the Lower Cenomanian Limestones aquifer of Hadath-Hazmieh															
17.11	Detailed design of AAR facilities of the Hadath-Hazmieh Lower Cenomanian limestones aquifer															
17.12	Implement the construction works of the AAR of Hadath-Hazmieh															
17.13	Follow up of the AAR constructed site of Hadath-Hazmieh															
17.14	Proceed with the preparation of the feasibility study for the AAR of the Daichouniye Jurassic limestones (J4) aquifer															
17.15	Detailed design of the AAR facilities of the Jurassic (J4) limestones aquifer (Daichouniye)															
17.16	Construction of the AAR Daichouniye site facilities															
17.17	Follow up of the AAR constructed site of Daichouniye															
17.18	Feasibility study of the AAR of Akkar plain alluvial aquifer															
17.19	Detailed design study of the AAR of Akkar plain alluvial aquifer															
17.20	Construction of the AAR facilities of Akkar plain alluvial aquifer															
17.21	Follow up of the AAR constructed site of Akkar plain alluvial aquifer															
18	**Drilling testing reconnaissance and exploratory wells:**															
18.1	In Hadath-Hazmieh (3 wells)															
18.2	In Damour (3 wells)															
18.3	In Daichouniye (2 wells)															
18.4	In Akkar plain (5 wells															
18.5	In Brak (Zahrani) (1 well)															
19	**Refresh the water budget studies of the identified aquifers**															
20	**Perform groundwater vulnerability mapping and delineation of protection zones 1 and 2 for springs (Q > 100 l/sec)**															
21	**Perform groundwater vulnerability mapping and delineation of protection zones 1 and 2 for springs with 10 < Q < 100 l/sec**															
22	**Modeling of fractured and karst aquifer systems**															
23	**Modeling of aquifer systems: porous, permeable, saline water intrusion**															
	* 1 = year 2020															

Figure I 16 Detailed Activities to be performed (continued)

I 9 DECISIONS TO BE TAKEN BY THE COUNCIL OF MINISTERS

1. Approve that organizational charts/decrees of the Water Establishments be modified and made general to leave with some flexibility for filling their gaps in staffing the way they find appropriate
2. Emphasize on the importance of and Speed up the ratification of the updated version of the Water Code by the Parliament
3. Appeal for funding from the international community to the water sector, to complete ongoing projects, upgrade existing infrastructure to operate at their full capacity, and provide capacity building and technical assistance programs.
4. Approve some type of recruitment within the WE's. Ideally, recruitment through the Council of Civil Service for permanent employees, or else recruitment of temporary staff through Ghob Talab projects or through individual contracts financed by the WE, with the aim of making them permanent when the situation allows or the policy of no recruitment changes.
5. Nominate a committee composed of a Water Resources Expert, a Groundwater Resources Expert, Legal and Institutional Expert, Environmental Expert, Irrigation Expert and a Dam Expert, headed by the Minister of Energy and Water to follow up the implementation of the Strategy recommendations.
6. Encourage people who are illegally connected, or refuse to subscribe or to pay, to become legal and allow the WE's along with MoEW and MoIM and security forces to enforce the law as deemed appropriate.
7. Approve the addition of a flat Wastewater tariff of no less than 100,000 LBP to allow WE's to cover O&M of Wastewater systems at least partially, until the tariff restructuring study is done through the AFD Technical Assistance project.

I 10 SUMMARIES OF COST ESTIMATES

I 10.1 WATER GOVERNANCE

Table I 17 Summary of required Water Governance studies
Financial, Commercial, Reporting & Monitoring, Capacity Building, Operation and Maintenance Studies

Total Estimated Cost of the Action Plan = 12972 500 USD			
	Activity	Priority	Cost (USD)
RS-B.1. Sector Governance			
RS-B.1.1 Implement the legal and regulatory framework reform (Water Code)			
RS-B.1.1.1	Prepare, adopt and implement the Water Code bylaws as already listed	High	40,000
RS-B.1.1.2	Draft revised WE organisation bylaws, support the approval process and follow up on their enactment	High	35,000
			75,000
RS-B.1.2 Rationalise the tutelage framework with a view for clear dispatching between opera			
RS-B.1.2.1	Restructure the Ministry's supervisory functions and introduce a substitute function in the event of WE failure (incl. direct procurement of external audit if not conducted by WEs and cost deduction from their budget)		5,000
RS-B.1.2.2	Review the organisational decrees by focusing them on defining guidelines for WEs organisation and streamline specific procedures	High	
	a. Define guidelines for the WEs' HR recruitment and organisation structures / simplify the organisation chart validation procedure		
	b. Streamline the HR recruitment process and make it possible to enhance recruitment outside the public service procedures		*Covered under item A.1.2*
	c. Raise the expenditure and procurement validation thresholds		
	d. Define guidelines for WE performance monitoring		
	e. Define guidelines for pricing services and simplify the validation procedure		
	f. Define guidelines for procurement management and the management of performance-based contracts		
RS-B.1.2.3	Conduct an assessment of the administrative supervision department roles and capacities and develop a specific staff capacity-building plan	High	75,000
			300,000
			380,000
RS-B.1.3 Develop proper mechanisms for performance monitoring			
RS-B.1.3.1	Set up a unit in charge of performance monitoring within the MoEW administrative supervision department	Short Term	
RS-B.1.3.2	Standardise the structure of annual reports incl. financial and business reports	Mid Term	
RS-B.1.3.3	Define the monthly activity report submission and validation structure and procedure	High	
RS-B.1.3.4	Develop the framework for the annual external audit and evaluation of WE	High	900,000
RS-B.1.3.5	Define key performance indicators to be monitored in the short, medium and long term (in alignment with the WE monitoring capacities)	High	
RS-B.1.3.6	Establish performance contracts between the MoEW and WE	High	
RS-B.1.3.7	Set up the performance monitoring committee as required by law 221	High	
			900,000
		Total RS-B.1. Sector Governance : 1355 000 USD	

Total Estimated Cost of the Action Plan = 12972 500 USD			
	Activity	**Priority**	**Cost (USD)**
RS-B.2. Financial and commercial			
RS-B.2.1 Conduct a customer and user census			
RS-B.2.1.1	Identify customers connected to piped water and convert unknown customers tapping into the network into legal users	High	4,500,000
RS-B.2.1.2	Identify users of collective wastewater services (network or network+WWTP) / identify those who are / are not WE customers (cross-reference with the water supply customer census) in order to define specific approaches for tariff-setting	High	2,000,000
RS-B.2.1.3	Ensure the take over of new customers/users by WEs and their inclusion in the customer/users database for the billing/collection cycle		*No Cost*
			6,500,000
RS-B.2.2 Implement consumption-based tariffs for water service			
RS-B.2.2.1	Streamline the water meter billing procedure		50,000
			50,000
RS-B.2.3 Revise the tariff structure for sanitation services			
RS-B.2.3.1	Conduct a proper cost analysis of facilities O&M		200,000
RS-B.2.3.2	Base the tariff on the cost analysis and, as a minimum, cover O&M costs		
			200,000
		Total RS-B.2. Financial and commercial : 6750 000 USD	

Total Estimated Cost of the Action Plan = 12972 500 USD			
	Activity	Priority	Cost (USD)
RS-B.3. Reporting and monitoring			
RS-B.3.1 Enhance sector monitoring			
RS-B.3.1.1	Create a Monitoring Department within the Ministry		7,500
RS-B.3.1.2	Establish a unified database to include all sector monitoring data and ensure it is regularly updated (incl. the WE KPI)		750,000
RS-B.3.1.3	Set up an annual sector review involving the main stakeholders and partners		*No Cost*
RS-B.3.1.4	Set up the process for monitoring the Strategy implementation status		*No Cost*
			757,500
RS-B.3.2 Enhance sector transparency			
RS-B.3.2.1	Ensure a transparent flow of information between WEs and MoEW through regular reporting (annual report, financial report, business report)		*No Cost*
RS-B.3.2.2	Publish annual WE reports (incl. results of audits performed by independent auditors)		*No Cost*
RS-B.3.2.3	Prepare financial reports based on IFRS book-keeping standards		*No Cost*
RS-B.3.2.4	Publish the main sector indicators, ensuring these are updated on a regular basis		*No Cost*
RS-B.3.2.5	Publish the breakdown of the water bill		*No Cost*
			-
RS-B.3.3 Enhance sector coordination			
RS-B.3.3.1	Improve coordination between CDR and WEs on infrastructure project planning and management		*No Cost*
RS-B.3.3.2	Organise an annual sector review involving all stakeholders and partners		*No Cost*
			-
RS-B.3.4 Enhance communication with user			
RS-B.3.4.1	Develop a communication strategy for MoEW and WE		500,000
RS-B.3.4.2	Design and launch a national communication campaign on the water sector		
			500,000
			Total RS-B.3. Reporting and monitoring : 1257 500 USD

Total Estimated Cost of the Action Plan = 12972 500 USD			
	Activity	**Priority**	**Cost (USD)**
RS-B.4. Capacity-building			
	RS-B.4.1 Strengthen the MoEW monitoring capacities		
RS-B.4.1.1	Appoint specific technical assistance to the MoEW to help develop monitoring		
RS-B.4.1.2	Support the MoEW in defining sector key performance indicators		
RS-B.4.1.3	Support the MoEW and the WEs in developing a performance monitoring		
RS-B.4.1.4	Identify the MoEW staff to be trained and supported in monitoring activities		
			-
	RS-B.4.2 Streamline and structure WE internal organisation and management		
RS-B.4.2.1	Conduct an overall internal audit in each WE (organisational, HR management, financial - assets, commercial, technical), propose measures and guidelines for streamlining internal WE organisation		450,000
RS-B.4.2.2	Prepare a handbook of jobs in the WEs with minimum skills required per position and standard training / capacity-building plan to be implemented		2,500,000
			2,950,000
		Total RS-B.4. Capacity-building : 2950 000 USD	
RS-B.5. O&M of facilities and services			
	RS-B.5.1 Improve operating cost control		
RS-B.5.1.1	Develop a specific strategy to control the energy costs of the facilities (based on ongoing studies)		150,000
RS-B.5.1.2	Define guidelines to ensure that facilities design is adapted to the capacity to cover their operating costs		100,000
			250,000
	RS-B.5.2 Enhance private sector involvement		
RS-B.5.2.1	Review existing contracts with private operators and develop a new contracting framework and performance-based contracts		160,000
RS-B.5.2.2	Identify the tasks or activities to be outsourced and the outsourcing arrangements to be adopted		*No Cost*
			160,000
	RS-B.5.3 Adopt a shared wastewater management framework		
RS-B.5.3.1	Address the issue of the organization(s) responsible for managing the WW network and treatment plants (WEs, municipalities, private operators.) and determine the financing method		250,000
			250,000
		Total : 660 000 USD	

Table I 18 Cost Estimate of Legal and Regulatory Framework Reform Studies

Name of study	Duration (months)	Cost (USD)
Study to prepare, adopt and promulgate the implementation decrees as foreseen in law 77 dated 16 April 2018	8	50,000
Study to draft and revised water establishment organization bylaws, support approval process and follow up their enactment	4	45,000
Study to draft the new code of irrigation	6	50,000
Study to draft the decrees allowing the Ministry of Energy and Water to audit the efficiency of the Water Establishments on basis of their performances and define these performances	2	20,000
Study to draft a legal text related to the competence of the Tutelage	2	20,000
Total		**185,000**

Table I 19 Cost estimates for meteorological, hydrometric studies

Priority	Project code	Description		Estimated cost (USD)
MH A. Meteorological and Hydrometric network expansions and improvements				
1	MH-A.1	LMS + LRA Meteorological Network Expansion Coastal Catchments: 9 Uncovered Catchments (+5 stations) 6 Semi-covered Catchments (+3 stations) Snow monitoring stations (+1 station per catchment above 2000m)		790,000
1	MH-A.2	LMS + LRA Meteorological Network Expansion Interior Catchments: 1 Uncovered Catchments (+5 stations) 3 Semi-covered Catchments (+3 stations) Snow monitoring stations (+1 station per catchment above 2000m)		200,000
1	MH-A.3	LARI Meteorological Network Expansion Maintenance instruments for 10 stations		100,000
1	MH-A.4	MoEW Meteorological Network Expansion Natural reserves and Forests		250,000
1	MH-A.5	LRA Hydrometric Network Improvement: Improvement of hydrometric stations as per LWP assessment report		426,400
1	MH-A.6	LRA Hydrometric Network Expansion: Complementary hydrometric monitoring stations for stream connections coverage Complementary hydrometric monitoring stations for hydrogeology coverage Main springs ADCP Installation Groundwater well monitoring		4,300,000
			Total	**6,066,400**
			Out of which : Priority 1	6,066,400
			Priority 2	-
			Priority 3	-
MH-B. Integrated Hydrological Information System				
1	MH-B.1	**Required studies for IHIS implementation:**		
		* Assessment studies (1 x 250,000$)	250,000	
		* Update and Analysis of the NLUMP and annexed geodatabase (1 x 625,000$)	625,000	
		* Lebanese Data Rescue Project (1 x 675,000$)	675,000	
		* Design studies for the IHIS implementation (1 x 425,000)	425,000	
		* Integrated water resources management studies (Catchment scale study for 20 Lebanese major rivers that watersheds exceed 100 km2.		
		- Revision of existing studies (20 x 5,000$)	100,000	
		- Data collection (20 x 10,000$)	200,000	
		- Data analysis and compilation (20 x 25,000$)	500,000	
		- WEAP modeling (20 x 40,000$)	800,000	
1		- Report (20 x 25,000$)	500,000	4,075,000
1	MH-B.2	Flood Risk Management Plan		
		- Topographical and urban surveys of river and floodplains (12,000$ x 20)	240,000	
		- Hydrological Study (25,000$ x 20)	500,000	
		- Hydraulic Study and Flood Mapping (50,000$ x 20)	1,000,000	
		- Risk Analysis (15,000$ x 20)	300,000	
		- Social Environmental Assessment SEA/Habitat Assessment (15,000$ x 20)	300,000	
1		- Flood risk management plan including a conceptual and legal framework, a program of measures, early warning protocol, organizational framework… (25,000$ x 20)	500,000	2,840,000

Priority	Project code	Description	Estimated cost (USD)
		Drought Mitigation Plan	
		- Define the conceptual and legal framework, methodology (20,000$)	
		- Data collection including historical drought events (10,000$)	
		- Establish indicators and thresholds for drought classification (25,000$)	
		- Develop a program of measures, mitigations and recommendations for a nation scale strategy (50,000$)	
		- Establish drought early warning protocol (25,000$)	
1		- Establish organizational framework for the production, implementation and update of the drought mitigation plan (10,000$).	140,000
		Rainwater harvesting program	
		- Define the conceptual and legal framework, methodology (20,000$)	
		- Data collection (10,000$)	
		- Hydrological assessment of the rainwater harvesting potential (20,000$)	
		- Determination of the harvesting methods and potential implementation sites (25,000$)	
1		- Development of an implementation strategy and program (50,000$)	125,000
		Total	**7,180,000**
		Out of which : Priority 1	7,180,000
		Priority 2	-
		Priority 3	-
1	MH-C.1	IHIS implementation	2,000,000
1	III-C. A.3	IHIS Operation for 24 months	288,000
1	III-C. A.4	Establish a WEAP Unit within the Ministry of Energy and Water	
		- WEAP Entreprise license Purchase (2 years, multi projects) (10,000$)	
		- Hardware purchase (20,000$)	
1		- Establish a WEAP Unit including trainings and courses (50,000$)	80,000
		Total	**2,368,000**
		Out of which : Priority 1	2,368,000
		Priority 2	-
		Priority 3	-

I 10.2 GROUNDWATER STUDIES COST ESTIMATE

Table I 20 Groundwater Management Studies Cost Estimate

Priority	Project code	Description	Estimated cost (USD)
RS-A Implementation of a Project Management Unit for a 5 years period			
1	RS-A.1	Mobilisation of experts	6,700,000
1	RS-A.2	Purchase of cars, IT equipment, flow monitoring equipment, flow meters, manual dipmeters, misc working tools and required software	325,000
1	RS-A.3	Travel and transportation expenses	1,060,000
1	RS-A.4	Office expenses	420,000
		Total Implementation of PMU	**8,505,000**
		Out of which : Priority 1	8,505,000
		Priority 2	-
		Priority 3	-
RS-C General Geological and Hydrogeological Studies			
1	RS-C.1	Geology ang hydrogeology mapping and studies	9,500,000
3	RS-C.2	Refreshment of water budget studies of major hydrogeological basins	2,000,000
3	RS-C.3	Groundwater vulnerability mapping for springs Q > 10 l/s	1,600,000
3	RS-C.4	Modeling of major karst aquifers hydrogeological basins	3,000,000
3	RS-C.5	Modeling of major porous, saline aquifer systems	3,000,000
		Total Geology and hydrogeology mapping and studies	**19,100,000**
		Out of which : Priority 1	9,500,000
		Priority 2	-
		Priority 3	9,600,000
RS-D Drilling and testing exploratory wells			
1	RS-D.1	In Akkar plain - 5 wells	2,500,000
1	RS-D.2	In Brak (Zahrani) - 1 well	500,000
1	RS-D.3	In Damour - 3 wells	1,050,000
2	RS-D.4	In Hadath-Hazmieh - 3 wells	1,500,000
2	RS-D.5	In Daichouniye - 2 wells	600,000
		Total Drilling and testing exploratory wells	**6,150,000**
		Out of which : Priority 1	4,050,000
		Priority 2	2,100,000
		Priority 3	-

I 10.3 CONSTRUCTION PROJECTS COSTS ESTIMATES

Table I 21 Consolidated projects cost estimates, by WE
(in M USD, VAT and expropriation excluded)

	NLWE	BWE	SLWE	BMLWE	Total
Priority 1 projects					
Water	341.11	96.08	421.33	420.70	1 279.22
Wastewater	268.78	214.35	366.90	569.20	1 419.23
Irrigation	29.02	109.58	86.55	1.01	226.15
Dams	196.00	52.00	-	65.00	313.00
Hill Lakes	33.37	-	-	-	33.37
Aquifer Artificial Recharge **(*)**					3.65
Meteorological and Hydrometric networks **(*)**					15.61
General Studies and Investigations **(**)**					35.78
Total	868.28	472.01	874.78	1 055.91	**3 326.01**
Priority 2 projects					
Water	-	50.27	12.60	122.64	185.51
Wastewater	2.85	268.10	76.99	205.20	553.14
Irrigation	11.20	83.00	408.86	1.15	504.21
Dams	50.00	150.00	273.00	200.00	673.00
Hill Lakes	110.72	55.20	119.70	33.50	319.12
Aquifer Artificial Recharge **(*)**					11.60
Meteorological and Hydrometric networks **(*)**					-
General Studies and Investigations **(**)**					2.50
Total	174.77	606.57	891.15	562.49	**2 249.07**
Priority 3 projects					
Water	-	1.56	-	22.95	24.51
Wastewater	-	47.46	79.28	105.00	231.74
Irrigation	103.25	4.51	299.70	5.17	412.63
Dams	150.00	107.06	480.00	53.00	790.06
Hill Lakes	22.90	-	-	-	22.90
Aquifer Artificial Recharge **(*)**					16.50
Meteorological and Hydrometric networks **(*)**					-
General Studies and Investigations **(**)**					11.15
Total	276.15	160.59	858.98	186.12	**1 509.49**
Total Projects	**1 319.20**	**1 239.17**	**2 624.91**	**1 804.51**	**7 084.56**
15% Contingencies	**197.88**	**185.87**	**393.74**	**270.68**	**1 062.68**
Grang Total	**1 517.07**	**1 425.04**	**3 018.64**	**2 075.18**	**8 147.25**

*** Including studies and implementation**
**** Including General geological studies + PMU and Governance**

Table I 22 Consolidated projects cost estimates, by Sector
(in M USD, VAT and expropriation excluded)

	Water	Wastewater	irrigation	Dams	Hill lakes	Total
Priority 1 projects						
NLWE	341.11	268.78	29.02	196.00	33.37	868.28
BWE	96.08	214.35	109.58	52.00	-	472.01
SLWE	421.33	366.90	86.55	-	-	874.78
BMLWE	420.70	569.20	1.01	65.00	-	1 055.91
Aquifer Artificial Recharge **(*)**						3.65
Meteorological and Hydrometric networks **(*)**						15.61
General Studies and Investigations **(**)**						35.78
Total	1 279.22	1 419.23	226.15	313.00	33.37	**3 326.01**
Priority 2 projects						
NLWE	-	2.85	11.20	50.00	110.72	174.77
BWE	50.27	268.10	83.00	150.00	55.20	606.57
SLWE	12.60	76.99	408.86	273.00	119.70	891.15
BMLWE	122.64	205.20	1.15	200.00	33.50	562.49
Aquifer Artificial Recharge **(*)**						11.60
Meteorological and Hydrometric networks **(*)**						-
General Studies and Investigations **(**)**						2.50
Total	185.51	553.14	504.21	673.00	319.12	**2 249.07**
Priority 3 projects						
NLWE	-	-	103.25	150.00	22.90	276.15
BWE	1.56	47.46	4.51	107.06	-	160.59
SLWE	-	79.28	299.70	480.00	-	858.98
BMLWE	22.95	105.00	5.17	53.00	-	186.12
Aquifer Artificial Recharge **(*)**						16.50
Meteorological and Hydrometric networks **(*)**						-
General Studies and Investigations **(**)**						11.15
Total	24.51	231.74	412.63	790.06	22.90	**1 509.49**
Total Projects	1 489.24	2 204.11	1 142.98	1 776.06	375.39	7 084.56
15% Contingencies	223.39	330.62	171.45	266.41	56.31	1 062.68
Grang Total	**1 712.62**	**2 534.73**	**1 314.42**	**2 042.47**	**2 042.47**	**8 147.25**

*** Including studies and implementation**
**** Including General geological studies + PMU and Governance**

I 10.4 COST OF WATER AND WASTEWATER WORKS PER CAPITA

Table I 23 Ratio of projects cost per capita

Project	Cost M USD	Population capita	Ratio USD / cap
NORTH LEBANON WATER ESTABLISHMENT			
Drinking water projects			
NL-W A. District of Batroun	23.14	93 578	247
NL-W B. District of Halba	72.49	377 776	192
NL-W C. District of Koura	29.84	171 508	174
NL-W D. District of Minieh	32.17	167 742	192
NL-W E. District of Ed Danniyeh	31.93	121 074	264
NL-W F. District of Zgharta	47.39	139 251	340
NL-W G. District of Tripoli	30.80	483 451	64
NL-W H. District of Qobayate	73.36	179 838	408
		Average →	**197**
Wastewater projects			
NL-WW A. District of Akkar	111.70	635 838	176
NL-WW B. District of Koura	29.73	171 508	173
NL-WW C. District of Minieh	80.30	167 742	479
NL-WW D. District of Zgharta	41.50	139 251	298
NL-WW E. District of Batroun	8.40	93 578	90
		Average →	**225**
BEQAA WATER ESTABLISHMENT			
Drinking water projects			
BQ-W A. District of Baalbeck	60.19	588 872	102
BQ-W B. District of Hermel	38.52	107 820	357
BQ-W C. District of West Beqaa, Zahleh & Rachaiya	49.21	742 940	66
		Average →	**103**
Wastewater projects			
BQ-WW A. District of Baalbeck	295.28	588 872	501
BQ-WW B. District of Hermel	116.75	107 820	1 083
BQ-WW C. District of Zahleh - West Beqaa	44.00	665 560	66
BQ-WW D. District of Rachaya	73.88	77 380	955
		Average →	**368**

Project	Cost M USD	Population capita	Ratio USD / cap
BEIRUT & MOUNT LEBANON WATER EST.			
Drinking water projects			
BML-W A. District of Beirut	133.60	643 059	208
BML-W B. District of Jbeil	64.00	218 128	293
BML-W C. District of Baabda Aley	100.26	1 198 485	84
BML-W D. District of Keserwan	48.81	464 480	105
BML-W E. District of Chouf	127.42	409 006	312
BML-W F. District of Meten	92.20	1 064 429	87
		Average →	**142**
Wastewater projects			
BML-WW A. District of Beirut	50.00	643 059	78
BML-WW B. District of Jbeil	140.25	218 128	643
BML-WW C. District of Baabda Aley	289.25	1 198 485	241
BML-WW D. District of Keserwan	23.40	464 480	50
BML-WW E. District of Chouf	138.45	409 006	339
BML-WW F. District of Metn	238.05	1 064 429	224
		Average →	**220**
SOUTH LEBANON WATER ESTABLISHMENT			
Drinking water projects			
SL-W A. District of Nabatiye	94.80	353 107	268
SL-W B. District of Jezzine	31.55	46 964	672
SL-W C. District of Sour	76.87	639 726	120
SL-W D. District of Zahrani	70.50	210 183	335
SL-W E. District of Saida	43.90	317 202	138
SL-W F. District of Bint Jbeil	60.90	301 366	202
SL-W G. District of Marjaayoun & Hasbaya	55.41	136 057	407
		Average →	**216**
Wastewater projects			
SL-WW A. District of Nabatiye	78.70	353 107	223
SL-WW B. District of Sour	87.35	639 726	137
SL-WW C. District of Bint Jbeil	205.80	301 366	683
SL-WW D. District of Jezzine	15.62	46 964	333
SL-WW E. District of Saida	135.70	317 202	428
		Average →	**315**