COUNCIL FOR DEVELOPMENT
AND RECONSTRUCTION

BUSINESS PLAN FOR COMBATING POLLUTION OF THE LOWER LITANI RIVER BASIN

FINAL BUSINESS PLAN

July 15, 2020

ELARD LEBANON		
COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION	**Document Type:**	**Final Report**
	Contract Ref:	**20090**
BUSINESS PLAN FOR COMBATING POLLUTION OF THE LOWER LITANI RIVER BASIN	**No. of Pages:**	**624** **(incl. Appendices)**
Business Plan Report (Final Revised)	**Version no.:**	**B**

Document Control

Revision / Date	**Issued by:**	**Reviewed by:**	**Approved by:**
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ABQUAR	Alleviating Barriers for Quarries Rehabilitation in Lebanon
ALI	Association of Lebanese Industrialists
BML	Beirut and Mount Lebanon
BOD	Biological Oxygen Demand
BP	Business Plan
CCIAS	Chamber of Commerce, Industry, and Agriculture in Saida and South Lebanon
CCIAZ	Chamber of Commerce, Industry, and Agriculture in Zahle and Bekaa
CDR	Council for Development and Reconstruction
CDW	Construction and Demolition Waste
COD	Chemical Oxygen Demand
NCSR (CNRS)	National Center for Scientific Research
DEM	Digital Elevation Model
ELARD	Earth Link and Advanced Resources Development
GIR	Gestion Intégrée des Ravageurs
GoL	Government of Lebanon
GIS	Geographic Information System
ISWM	Integrated Solid Waste Management
LLB	Lower Litani Basin
LRA	Litani River Authority
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoI	Ministry of Industry
MSW	Municipal Solid Waste
OMWW	Olive Mill Wastewater
PD	Public Domain
SWMF	Solid Waste Management Facility
ULB	Upper Litani Basin

EXECUTIVE SUMMARY

INTRODUCTION

1. Earth Link and Advanced Resources Development s.a.l. (ELARD) was subcontracted by the Council for Development and Reconstruction (CDR), representing the Lebanese Government (particularly the Ministry of Environment), in order to provide consultancy services for the preparation of a Business Plan for Combating Pollution in the Lower Litani River Basin (LLB), Lebanon. This plan is based on Law No. 63 of 2016 that budgeted provisions for the execution of pollution-curbing projects and their associated expropriations in the Litani River basin from its source to mouth. The Law came as an implementation instrument for the Road Map for combatting sources of pollution of the Upper Litani River, which was based on the "Business Plan for Combatting Pollution of the Upper Litani" dating back to 2011. To complement this project, identification of the sources of pollution in the Lower Litani River basin and mitigation measures in the form of a business plan is provided in this report that involved desk and field data collection, analysis and assimilation, as well as stakeholder engagement. This Business Plan, like the Upper Litani plan, recommends well-fitted solutions that will serve as a tool for informed decision-making.
2. The overall aim of this Business Plan is to document and bring a holistic approach to remediate pollution sources of the Lower Litani River Basin in a sustainable way that ensures its long-term protection.

LOWER LITANI BASIN (LLB) STUDY AREA CHARACTERISTICS

3. The Lower Litani Basin (LLB) extends over an area of 637.20 km2, from the Qaraaoun Lake Dam wall to the River mouth, across the four Governorates of Mount Lebanon, Bekaa, Nabatiye and South Lebanon; and 10 Districts (cazas).
4. A total of 99 municipalities and 7 mokhtars (based in villages without municipalities) have jurisdiction over the 132 localities or villages within the Study Area. Most villages within the LLB have municipalities that are grouped into 11 Unions. The LLB Study Area has a surface area of 791.56 km2. It was extended beyond the borders of the watershed area to include the full cadastral extent of villages, in order to emphasize the role of municipalities in regulating the sources of pollution in their areas of jurisdiction. Figure 1 below shows the administrative coverage of the Study Area.

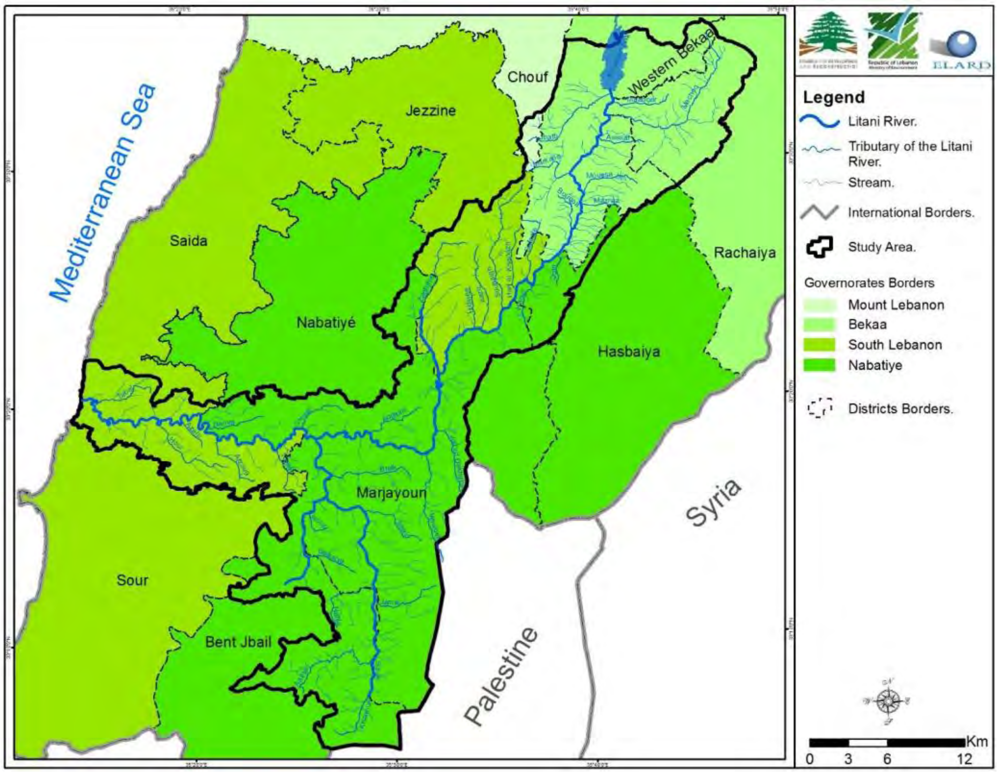


Figure 1 Administrative Map of the Lower Litani River Basin

5. For the purpose of this Business Plan, the Study Area is divided into 5 zones governed by sub-watershed areas drained by tributaries of the Litani River, and the cadastral extents of localities (Figure 2).

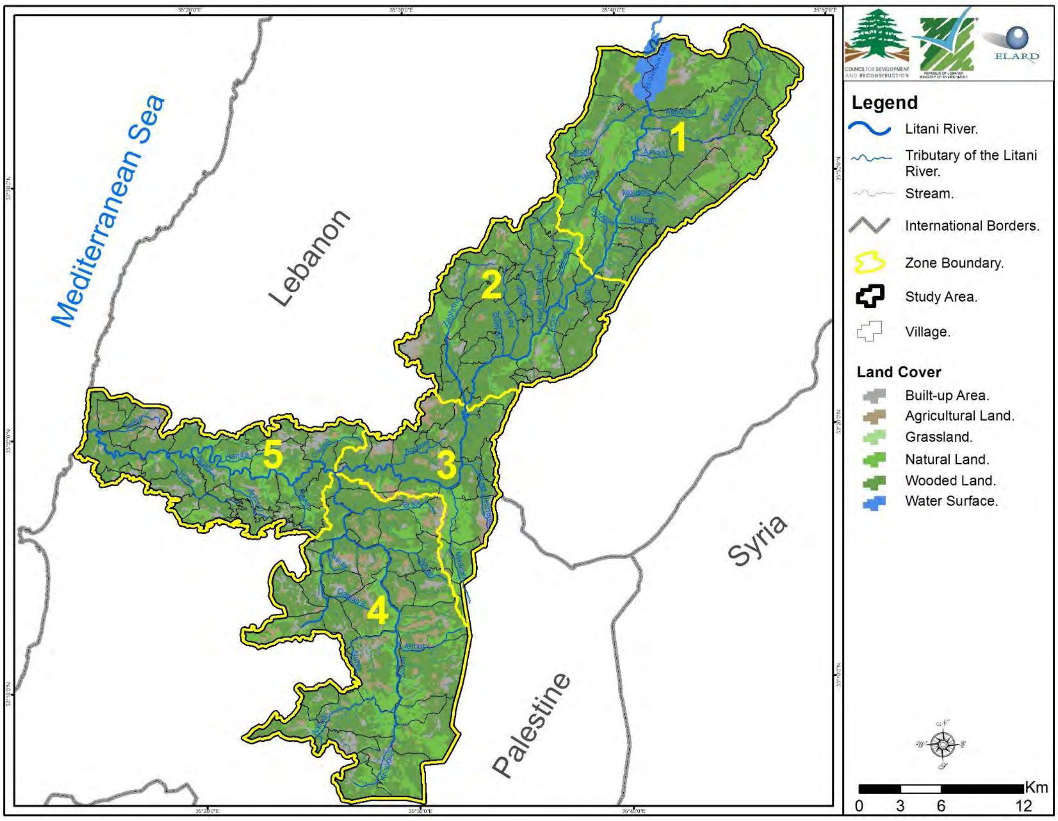


Figure 2 Study Zones of the LLB Study Area

POLLUTION PRESSURES, STATE OF RIVER WATER AND SEDIMENT QUALITY, AND SITUATION ANALYSIS

6. The scoped area was divided into multiple zones to assure a coherent examination and assessment of the existing pressures and the quality of water and sediment to ensure an effective responsive management scheme that considers the pre-existing cadastral and administrative characteristics of localities within the Lower Litani Basin.

7. Information on the pollution pressures within the LLB Study Area was collected through an extensive municipal survey and official data from public offices or officially commissioned studies. The state of river water and sediment quality was determined through a survey of the previous literature and study campaigns, as well as limited sampling of water and sediment samples. These revealed a poor biological state and physico-chemical quality of the river water quality, as well as heavy metals and organic compounds in river sediments often exceeding world averages.

8. The existing sources of pollution affecting the state of the river ranges from: solid and hazardous waste disposal, industrial and municipal wastewater discharge, agricultural and recreational activities. The July 2006 War was also a potential source of metals in soil and consequently in water as a result of the munitions used.

9. A graphical presentation of the pollution pressures is summarized in Figure 3.

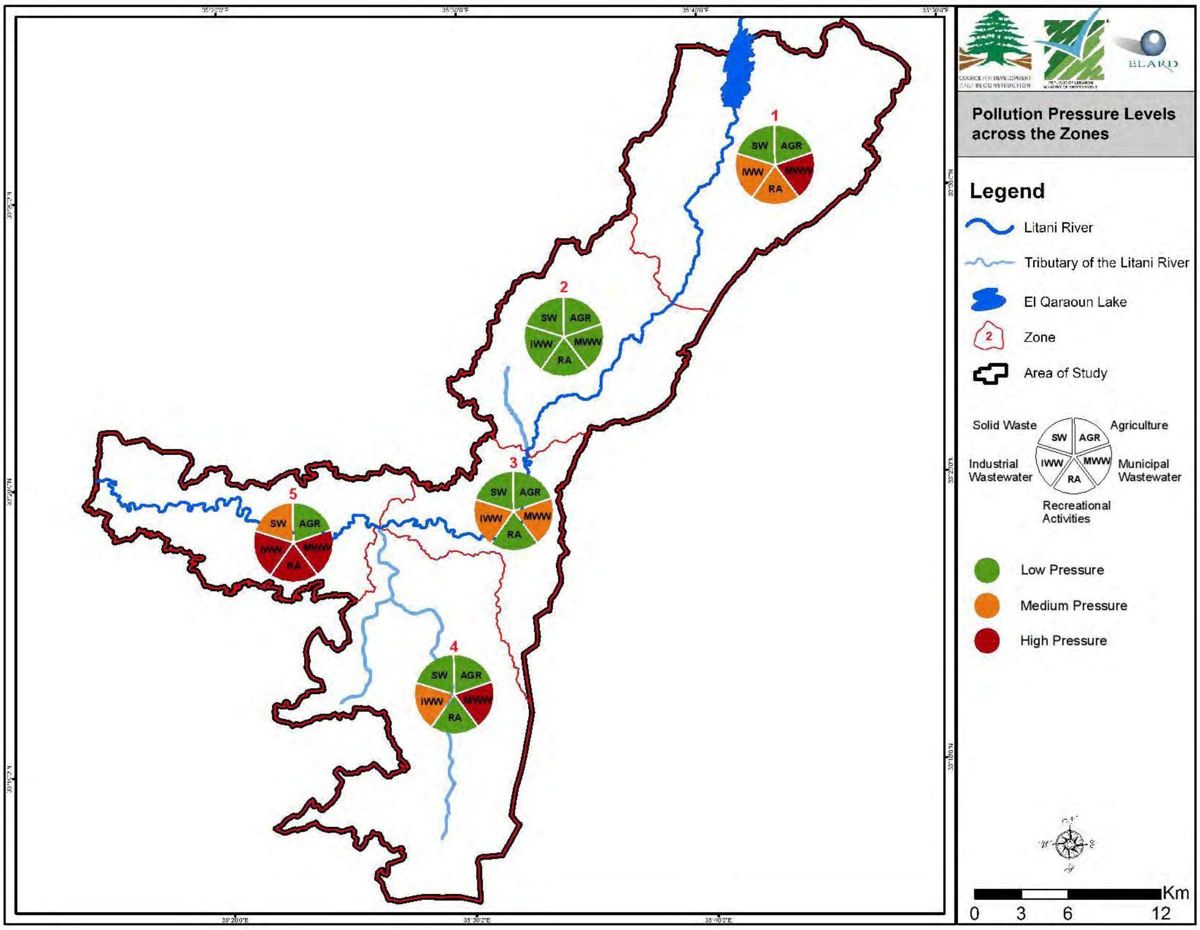


Figure 3 Pollution pressure levels across the zones of the Study Area

10. The pollution pressures discussed can all result in impacting the river's and waterhsed's health. This occurs when the pollution intensity and load over time exceed the capacity of the river to 'clean' itself. The data assessed consisted of 3,854 concentration entries of water quality parameters. These results were compared to various national and international water quality guidelines for the different parameters and for different water end uses. This includes maintaining aquatic life, bathing, drinking water and irrigation. River sediment results were also compared to the reference world averages and Dutch intervention values for soil and sediments.
11. Below is a summary on the existing pollution pressures located in the LLB:
    - Waste Management practices were assessed with municipal, industrial and healthcare waste disposal practices analyzed across the five zones to assess the threat posed by solid waste management to the Lower Litani River and its tributaries' surface waters. Poor management practices from open burning of hazardous (industrial, agricultural and healthcare waste as well as hazardous household items) and non-hazardous (domestic) wastes result in uncontrolled emissions to air, soil and water, posing a threat to river water quality and ecology from leaching effects.
    - Wastewater management practices are considered the most vital contributors to the water quality of the Lower Litani River. The inadequacy of the wastewater collection and treatment infrastructure in urban settlements is deemed to be the most important pollution threat to the quality of water in the Lower Litani River. Wastewater from healthcare establishments is of similar quality to urban wastewater but may also contain various potentially hazardous components. Within the study area, four hospitals (3 public, 1 private) should be surveyed/audited to ensure their waste and wastewater streams do not contain hazardous material. With regards to industrial wastewater, the study zone contains factories (mainly olive mills, rock cutting and shaping, and concrete blocks manufacturing) producing effluents loaded with organic pollutants that are conveyed to surface water without pre-treatment through either the nearby tributary or the existing sewer networks. Classified and non-classified non-industrial establishments discharging their waste and wastewater are mostly small businesses such as petrol stations, farms, vehicle repair shops, washing centers and butcheries that generate waste and wastewater; in addition to quarries (mostly sand quarries) located within close distances (< 500 m) from the Litani and tributaries' courses, especially in zone 2. In addition, recreational establishments, mainly consisting of restaurants, can be found along the river embankments stretching over a total of 5.7 km along the river, followed by farms. The main pollutant streams from recreational establishments are litter and wastewater discharges of municipal/domestic nature. A total of 145 infringements (encroachments within a 10-meter buffer zone of the Lower Litani river course) by various types of recreational establishments were recorded in 28 localities in seven districts, covering 11% of the river length or 9.5 km in total length.
    - The pollution pressure from the 384 ITS sheltering 2,005 refugees located within the LLB is considered low in all zones of the Study Area.
    - A main non-point pollution source in the region is due to agricultural activities that constitute one of the main economic activities in the Lower Litani Basin (LLB). The most important constituents of agricultural runoff and water seepage are agricultural chemicals (fertilizers) and non-degradable pesticides, which end up in waterways with

irrigation overflows or deep percolation. One of the main concerns is due to pesticide use where several pesticides are being applied in quantities that exceed recommended rates.

POSSIBLE RESPONSES AND MITIGATION MEASURES

12. A priority-based approach to address the pollution sources is recommended to be followed. The priority of the pollution pressure can be determined based on its impact as reflected in water and sediment quality. Based on the literature available as well as the studies assessed, solid waste and wastewater are the most pressing sources, followed by industrial (olive mills and rock cutting, sand washing) and irrigated agriculture. Therefore, mitigation measures taken into consideration should be thoroughly assessed by sector (solid waste, wastewater, informal settlements, etc.) and by zone.

13. Investments in infrastructure that are allocated in Law No. 63/2016 are expected to contribute directly (wastewater) and indirectly to the improvements in the environmental conditions of the Lower Litani River. The costs of the proposed measures are summarized in Table 1 below.

Table 1 Costs of Proposed Measures across all Zones

Sector	Total Cost (US$)
Municipal Solid Waste	24,204,250
Municipal Wastewater	34,341,000
Industrial Wastewater	2,622,000
Agricultural Improvement	2,570,000
Cross-sectoral and Governance	12,300,000
Total (US$)	**76,037,250**

SOLID WASTE

14. It is imperative to address the functionality of any dumping sites (zone 5 as a priority) that contributes to the alteration of the Litani River Banks. Hence, the encouragement of developing and implementing realistic and proper waste management initiatives and alternatives. Fortunately, initiatives for the management of solid wastes in Zones 1 to 5 are available and underway, yet more sanitary landfills are needed. As part of the EU-financed SWAM I scheme and the ongoing PROMARE scheme, projects are underway whereas some remain unfinanced after the cancellation of SWAM II projects (Table 2).

Table 2 Planned Projects for SWM in Zones 1 to 5

Zone	Project description	Funding Source	Estimated amount	Status
3&4	Construction of a sanitary landfill in Nabatiye	Not available	€ 2,177,000	Project on hold after cancellation of SWAM II
	Construction of a sorting and composting facility for Bent Jbayl and Marjaayoun	Not available	€ 2,135,000	Project on hold after cancellation of SWAM II

Zone	Project description	Funding Source	Estimated amount	Status
	Construction of a sanitary landfill for Bent Jbayl and Marjaayoun	Not available	€ 2,471,000	Project on hold after cancellation of SWAM II
5	Rehabilitation of Ras el Ain dump in Tyre	Not available	€ 4,424,000	Project on hold after cancellation of SWAM II
	Construction of a sorting and composting facility in Sahel El Zahrani	PROMARE (EU)	Unknown	Project still in the study and planning phase

15. Additional proposed responses to manage pollution pressures from solid waste in the future in each zone of the Lower Litani Basin are presented in Table 3. Nevertheless, direct dumping and disposal of waste in the river should be completely banned through law enforcement, and awareness activities at the local level.

Table 3 Proposed Responses to SWM in Zones 1 to 5

Zone	Proposed Response	Estimated amount
1&2	Operation and maintenance of the Joub Jannine SWM complex.	US$1.2 Million for annual O&M
	Stop waste dumping at Majdel Balhis, Sohmor, Ain Et Tineh and Rihane Jezzine dumps and transfer waste to the new Joub Jannine sanitary landfill	US$71,500
	Or close the above-mentioned dumps (excavate, line, cap and close)	US$34,000
3&4	Construction of a sanitary landfill for Nabatiye district (capacity 75 t/d) to complement the Kfour sorting and composting facility	€6.78 Million
	Construction of an integrated solid waste management complex for Bent Jbayl and Marjaayoun including a sorting and composting facility (capacity of 250 t/d) and a sanitary landfill of 100 t/d capacity.	
	Stop waste dumping at Yohmor (Nabatiye), Aadchit el Qoussair, Bani Haiyane, Kounine, Deir Siriane, Houla, and Rabb Et-Talatine dumps and transfer the waste to Nabatiye or Bent Jbayl/Marjaayoun sanitary landfills once implemented	US$133,500
	Or close the above-mentioned (excavate, line, cap and close)	US$76,500
5	Construction of a sanitary landfill in Tyre caza and construction of a new integrated solid waste management complex for Sahel El Zahrani including a sorting and composting facility (capacity of 150 t/d) and a sanitary landfill (capacity of 75 t/d)	US$ 14.6 Million
	Stop waste dumping at Borj Rahhal, Bedias, Deir Qanoun En-Nahr, Maaroub, Hmairi, Sir El Gharbiyeh and Srifa dumps and transfer the waste to Ras El Ain or Sahel el Zahrani sanitary landfills once implemented	US$139,000
	Or close the above mentioned (excavate, line, cap and close)	US$102,500
	Proper segregation of medical waste to reduce the volume of infectious waste; sending segregated infectious waste for disposal at the Aabbassiyeh sterilization centre	-

WASTEWATER

16. The largest wastewater pressures are identified by crossing the population pressure with the presence of water supply sources, whether for drinking, irrigation or recreational purposes. The top priority for response is indeed the municipal wastewater infrastructure investments (Table 4).

Table 4 Proposed Infrastructure Investments in Wastewater Systems

Zone	Project description	Capital Investment (USD)
1	Prepare the feasibility/design studies and construct/ operate the wastewater treatment system and collection networks for the Zilaya WWTP and Majdel Balhis service area	8,573,000
2	Assess the coverage, operational status and treatment effectiveness of the Rihane and Aaychiyeh wastewater treatment systems	16,013,000
	Establish networks in Sejoud and connect to the Rihane or Aaychiyeh plants	
	Assess the feasibility of wastewater collection and treatment systems for the localities of Chbail, Mazraat Daraya, and Qatrani	
	Establish networks in unserved areas of Jdaideh, Dibbine, Blat, Bouyada, Qlaiaa and Borj El Mlouk and connect to the Marjaayoun Plant	
	Assess the operational status and treatment effectiveness of the Kaoukaba Plant, and complete the network coverage in Kaoukaba	
	Prepare the feasibility/design studies and construct/operate the wastewater treatment system and collection networks for Aaramta and Kfar Houneh to be served by the Sarafand system. The locality of Zaoutar El Gharbiyeh in Zone 3 could be serviced by the Sarafand system.	
	Prepare the feasibility/design studies and construct/operate the wastewater treatment system and collection networks for Wadi El Jarmaq	
	Prepare the feasibility/design studies and construct/operate the wastewater treatment system and collection networks for Srayri to serve Srayri, Dellafi, Bourghos and Qelaya from Zone 1	
3	Prepare the feasibility/design studies and construct/operate the wastewater treatment system and collection networks for Kfar Roummane, Kfar Tibnit, and Arnoun as part of the Nabatiye wastewater treatment system	1,890,000
	Assess the coverage, operational status and treatment effectiveness of the Deir Mimas Plant, and assess the expansion of the network to Kfar Kila, Houra and Mazraat Doumiat	
	Assess the feasibility of collection networks in Zaoutar El Gharbiyeh and Mazraat El Hamra and connection with the existing treatment plant in Zaoutar Ech-Charqiyeh or with Sarafand Plant. Construct, operate and maintain operations of the wastewater treatment and collection system at Zaoutar.	
4	Discern the service areas of the Wadi Slouki and Braiqeaa wastewater systems	4,040,000
	Prepare the feasibility/design studies and construct/operate the wastewater treatment system and collection networks for Maroun Er Ras, Aaytaroun, Blida, Kounine, Beit Yahoun, Mhaibib, Chaqra, Meiss	

Zone	Project description	Capital Investment (USD)
	Ej Jabal, Houla, Souaneh, and Qalaouiyeh, with the connection of these villages to the planned Qaaqaaiyet Ej Jisr Plant	
	Establish wastewater collection networks in Tiri and Aaynata and connect them to the existing Bent Jbayl treatment plant	
	Complete wastewater collection networks in Soultaniyeh and Jmaijmeh and connect them to the existing Tibnine treatment plant	
5	Expand the network coverage of the Sour wastewater treatment system, by connecting it to the remaining areas of Maaroub, Borj Rahhal, Ain Abou Abdallah, Deir Qanoun En-Nahr, Jennata, Bedias, Arzoun, and the new localities of Bestiyat, Derdaghaiya, Chehour, Sir El Gharbiyeh, Kfar Dounine, Halloussiyeh, Tayr Falsay, Hmairi and Srifa	2,800,000
	Prepare the feasibility/design studies and construct/operate the wastewater treatment system and collection networks for wastewater treatment system in Sarafand	
	Complete the networks in the two localities of Zrariyeh and Kharayeb	
	Verify the network status in Kfar Sir and connect the network to the existing Kfar Sir treatment plant	

17. As for industrial wastewater, the pressures are seasonal, yet hold serious impacts on river water quality and consequently on aquatic life. The majority of the wastewater generating industries in the Lower Litani River catchment have small production scales and cannot afford to treat their wastewaters individually because of space constraints and financial limitations. MoE Decision No. 8/1/2001 sets wastewater discharge standards into the sewer system that industries are required to abide by. To achieve this, industries are required to (pre-)treat their industrial effluents to reduce the pollution load to an acceptable level so that the wastewater can be further treated in a biological treatment plant. Table 5 presents the cost estimates for the (pre-)treatment of effluents from priority 1 industries.

Table 5 Cost Estimate for the (Pre-)treatment of Effluents from Priority Industries

Zone	Priority 1 industries	Wet processes (discharging wastewater effluents)	(Pre-)treatment Cost (US$)	O&M cost (US$)	Studies' cost (US$)
Zone 1	11	Olive Mill (9), Stone Cutting (2)	600,000	90,000	57,000
Zone 2	1	Dairy industry (1)	60,000	9,000	5,000
Zone 3	11	Olive Mill (11)	520,000	78,000	42,000
Zone 4	9	Olive Mill (7) Stone cutting (1), Dairy industry (1)	515,000	77,250	41,000
Zone 5	14	Olive Mill (9), Stone cutting (4) Chocolate industry (1)	805,000	120,750	72,000
Total	**46**		**2,500,000**	**375,000**	**217,000**

18. The Ministry of Environment has set up the Lebanon Environmental Pollution Abatement Project (LEPAP) that aims to assist Lebanese industrial companies to reduce pollution and comply with the Lebanese Environment Protection Law No. 444/2002 through providing them with technical assistance and subsidized loans to invest in end-of-pipe treatment and pollution prevention.

19. LEPAP is a joint initiative between the MoE, the Ministry of Finance, Banque Du Liban (BDL), the World Bank and the Italian Cooperation to set up a mechanism for financing the abatement of industrial pollution in targeted industrial enterprises and to provide necessary technical assistance for ensuring the implementation and the sustainability of these interventions.

20. In addition to the above, other sectors existing in the LLB also act as pollution pressure sources on the Litani River. Table 6 presents a brief regarding these sectors along with the proposed measures to minimize or prevent their pollution impact.

Table 6 Proposed Responses for Different Sectors

Zone	Proposed Responses	Cost (USD)
Healthcare	• Support healthcare establishments in establishing separate waste and wastewater collection systems and strictly limit the discharge of hazardous liquids to sewers. • Advise healthcare establishments on pre-treatment systems (primary, secondary and tertiary treatment, disinfection, and anaerobic digestion of sludge)prior to discharge to the municipal wastewater network. • Healthcare establishments should ensure that their waste management effectively prevents the discharge of significant quantities of toxic chemicals, pharmaceuticals, radionuclides, cytotoxic drugs and antibiotics in the drains through carrying out the needed treatment • Establish routine effluent monitoring programs at healthcare establishments (temperature, pH, TSS, BOD5, COD, Nitrates, Total Phosphorous, E. Coli) to ensure compliance with applicable discharge standards.	100,000
Classified and Non-Classified Non-Industrial Establishments	• Local authorities to ensure environmental compliance and supervise establishments' operational activities • Capacity building training for local officials and police on environmental regulations. • Trade-focused media events and targeted technical assistance in order to raise awareness on simple public hygiene and resource conservation measures.	250,000
Quarries	• Enforcement of relevant legislation, to ensure quarrying activities do not cause undue harm to third parties, and to the river ecology.	--
Recreational Establishments	• Clarification of the river's public domain among the DGUP, MoEW and LRA and prevention of its infringement • Application of rules for setback distances where these apply by requesting and then enforcing demolition of built structures that are encroaching on the public domain and river/tributary courses, especially where these change the river flow regime. • Establish guidelines and operational parameters for recreational facilities of various sizes and activities to follow in the management of wastewater and solid waste • Observe implementation of these measures through a discharges custody process whereby facilities are required to contract waste and wastewater collection services to transport their waste and wastewater to the nearest processing facilities, with records maintained and compliance enforced by municipalities	530,000

Zone	Proposed Responses	Cost (USD)
	• Implement a strict no discharge policy of solid waste, anti-littering and wastewater into river water, and apply a penalty system	
Informal Tented Settlements (ITS)	• Ensure that waste and wastewater discharges are properly directed to the formal and existing collection and treatment systems. • Relief agencies shall ensure that ITS are abiding by the national and local legislation and coordinate the efforts with local authorities and governmental agencies to avoid creating a burden of waste clean-up and property rights infringements.	--

AGRICULTURAL SECTOR

21. The analysis has shown that agriculture does not constitute a major pressure on the River pollution in the LLB. However, overuse of pesticides and fertilizers was noted for all crops and eventually agricultural return flows will contribute to the river pollution as well as groundwater and soil pollution.

22. Addressing pollution from agriculture would serve to improve surface water quality over time, which would have positive implications on improving irrigation water quality. The proposed responses to tackle pollution from agricultural practices are general and apply to all zones. Several responses can be implemented to limit agricultural pollution pressures, these include but not limited to those shown in Table 7. Ecological and land rehabilitation (forests, rangeland, quarries, dumps, agricultural land) would also reduce soil erosion and surface runoff, which would indirectly reduce contamination of surface water with contaminated runoff.

Table 7 Selected Proposed Responses to Agricultural Pollution Pressures

Proposed Response	Cost (USD)
Development of integrated pest management (IPM) curricula of important crops in the region	201,500 (including relevant assessments: current practices, present pests and their natural enemies)
Introduction of new varieties/cultivars that are resistant to diseases and pathogens	
Familiarization of farmers with the different techniques and tools used in IPM	80,500
Setting up a collection and disposal system for empty containers and obsolete/unused pesticide stocks: training of farmers. Collection of used containers, and disposal through recycling	180,500
Setting up demonstration plots in several areas of the LLB and providing training on GAP including IPM	219,000
Promotion of produce cultivated using IPM techniques and Good Agricultural Practices (GAP)	-
Training on proper agrochemicals handling, application and storage	22,500
Performance of regular pesticide residue tests on certified IPM products throughout the production season	153,000

Proposed Response	Cost (USD)
Estimation of pollution loads by frequent soil and irrigation water sampling and analysis	84,500 + 99,500
Field training on water management, water budgeting and scheduling, and use of agro-meteorological data	22,500
Identification of potentially susceptible areas known as Nitrate Vulnerable Zones (NVZs) and restricting farms within NVZs with regard to how much nitrogen fertilizer can be applied to the land	108,000
Estimation of land use – land cover changes between two base maps or satellite images (e.g., 2005 and 2020); net primary productivity (NPP) and soil organic Carbon (SOC)	69,000
Multiseasonal ecological assessment based on tactical sampling (core and edge quadrates and transects) over up to 3 years	35,000
Land degradation assessment including establishment of a corridor	57,000
Topographic surveys of quarries and engineering studies to determine rehabilitation requirements of quarries using construction and demolition waste, and related Environmental Impact Assessments (EIAs)	575,000

23. In addition to the above-listed measures, the establishment of a well-functioning pesticide registration scheme by the MoA would help to control the distribution and use of pesticides.

CROSS-SECTORAL AND GOVERNANCE MEASURES

24. Table 8 presents the proposed cross-sectoral and governance measures for the LLB, responsible entities, estimated budget and current and relevant planned activities.

Table 8 Proposed Cross-Sectoral and Governance Measures

Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
Strengthening the governance and law enforcement procedures to ensure that technical measures are effectively carried out.	LRA & Courts (All Stakeholders)	$2,000,000	Implementing roadmap for Upper Litani Environmental Prosecutors Environmental Police Training of municipal police
Systemizing and standardizing data management to effectively measure, document and understand how and where mitigation actions are leading to improvements. Establishing a unified common data room/system on all pollution pressures in the basin	LRA (All stakeholders)	$2,000,000	None
Improvement of public administration management and inter-agency coordination to carry out the proposed measures, through capacity building.	Council of Ministers (All Stakeholders)	$2,000,000	None

Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
Physical and chemical monitoring systems for water quality, water balance, and river ecology baseline	LRA (MoEW & MoE)	$1,000,000	None
Masterplan for the LL Basin and creation/updating of land zoning that will determine river and tributary course boundaries, and permissible land uses (all economic activities) that can ensure river course integrity (setback distances) and protection from encroachments	DGUP (Local authorities, LRA and Line Ministries)	$5,000,000	Master plan for Upper Litani Basin

الملخص التنفيذي

المقدمة

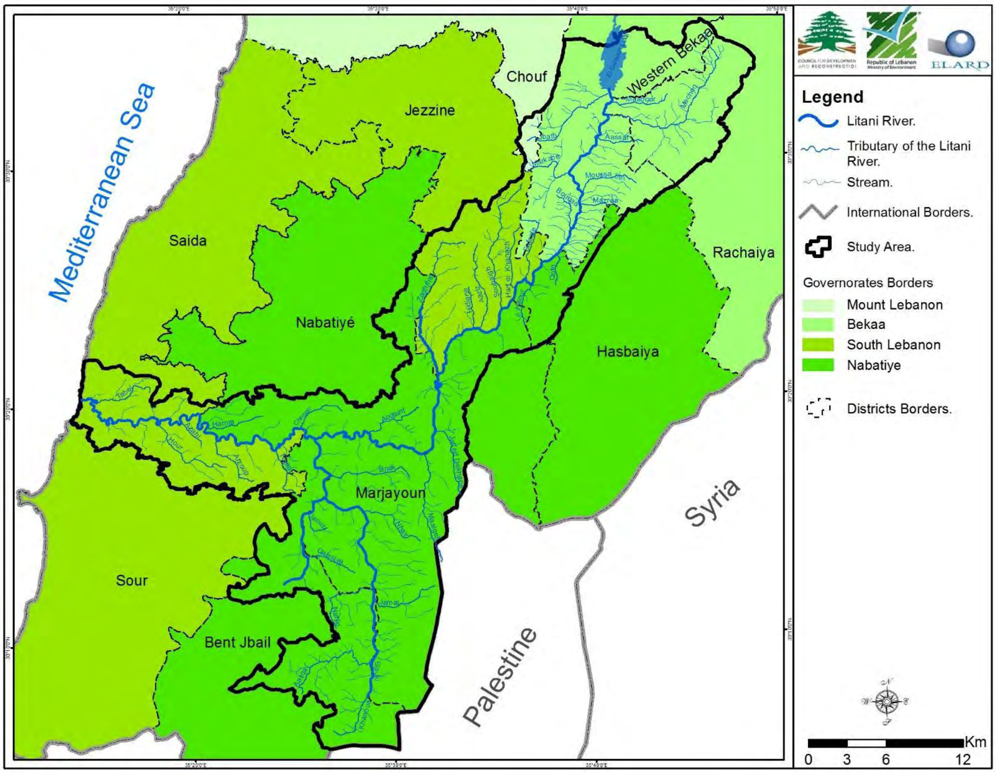
١. تعاقد مجلس الإنماء والإعمار الذي يمثل الحكومة اللبنانية (تحديداً وزارة البيئة اللبنانية) مع شركة الأرض للتنمية المتطورة للموارد ش.م.م. ELARD، وذلك من أجل تقديم الخدمات الاستشارية لإعداد خطة عمل لمكافحة تلوث الحوض الأدنى لنهر الليطاني في لبنان. تستند خطة العمل هذه إلى القانون رقم ٦٣ لعام ٢٠١٦ الذي خصص اعتمادات في الموازنة العامة لتنفيذ مشاريع للحد من التلوث وأعمال الاستملاك العائدة لها في حوض نهر الليطاني من المنبع إلى المصب. جاء هذا القانون كأداة تنفيذ لخارطة الطريق الهادفة إلى مكافحة مصادر التلوث في الحوض الأعلى لنهر الليطاني والتي استندت إلى "خطة عمل لمكافحة تلوث حوض نهر الليطاني الأعلى" التي يعود تاريخها إلى عام ٢٠١١. لتكملة هذا المشروع، يقدم هذا التقرير تحديداً لمصادر التلوث في الحوض الأدنى لنهر الليطاني وتدابير التخفيف منها، وذلك من خلال خطة عمل تم إعدادها بناءً على جمع البيانات المكتبية والميدانية وتحليلها، ومع مشاركة أصحاب المصلحة؛ وتوصي خطة العمل هذه، بشكل مماثل لخطة العمل لمكافحة تلوث حوض الليطاني الأعلى، بحلول معدة ومناسبة لمصادر التلوث ستكون بمثابة أداة لاتخاذ قرارات مستنيرة.

٢. الهدف العام لخطة العمل هذه هو توثيق وتقديم نهج شامل لمعالجة مصادر التلوث في الحوض الأدنى لنهر الليطاني معالجة مستدامة تضمن حماية الحوض على المدى الطويل.

خواص منطقة الدراسة: حوض الليطاني الأدنى

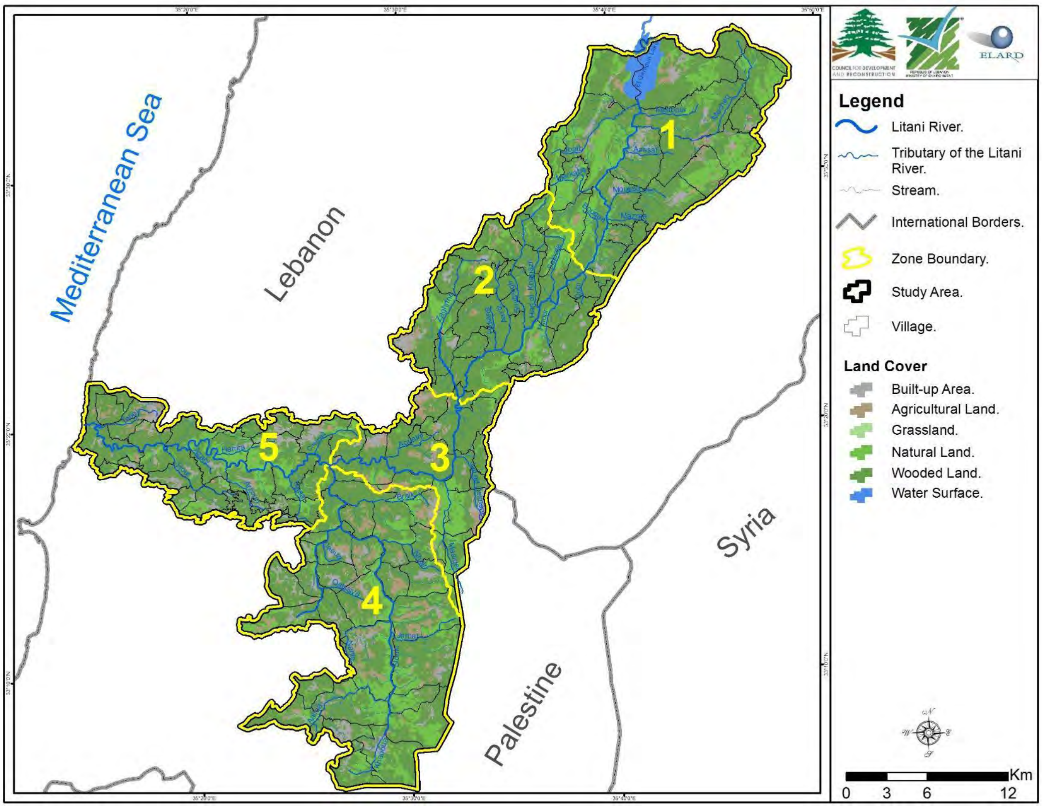
٣. يمتد حوض الليطاني الأدنى على مساحة ٦٣٧,٢٠ كيلومتر مربع، تبدأ من جدار سد بحيرة قرعون إلى مصب نهر الليطاني ويمر عبر أربع محافظات هي جبل لبنان والبقاع والنبطية وجنوب لبنان، التي تتألف من ١٠ أقضية.

٤. تمتد سلطة ٩٩ بلدية و٧ مخاتير (في القرى التي لا توجد فيها بلديات) على عدد ١٣٢ بلدة وقرية ضمن منطقة الدراسة. تمتلك معظم قرى حوض الليطاني الأدنى بلديات تشكل ١١ اتحاد بلديات. تبلغ مساحة منطقة دراسة حوض الليطاني الأدنى ٧٩١,٥٦ كيلومتر مربع، حيث تمتد منطقة الدراسة إلى ما بعد حدود منطقة مستجمعات المياه لتشمل النطاق المساحي الكلي للقرى، من أجل التأكيد على دور البلديات في ضبط مصادر التلوث ضمن نطاقها، ويوضح الشكل رقم ١ أدناه التغطية الإدارية لمنطقة الدراسة.



الشكل رقم ١: الخريطة الإدارية لحوض نهر الليطاني الأدنى

٥. لأغراض خطة العمل هذه قسمت منطقة الدراسة إلى ٥ مناطق حسب مناطق مستجمعات المياه الفرعية (sub-watersheds) التي تستقي مياهها من روافد نهر الليطاني والنطاقات المساحية للبلدات (الشكل رقم ٢).



الشكل رقم ٢: مناطق الدراسة في منطقة دراسة نهر الليطاني الأدنى

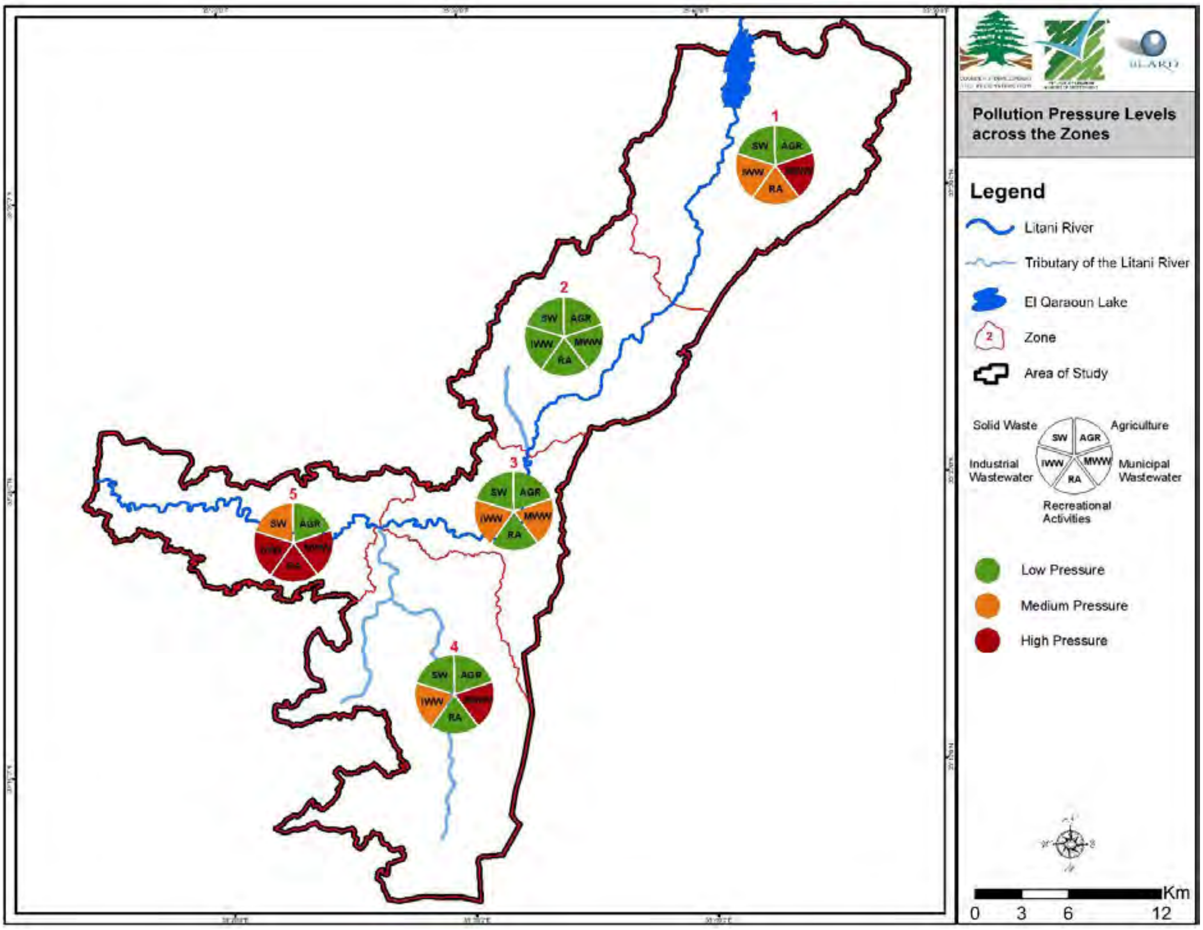
ضغوط التلوث وحالة مياه النهر وجودة الرواسب وتحليل الحالة الراهنة

٦. تم تقسيم المنطقة المحددة إلى مناطق متعددة لضمان فحص وتقييم متسقين لضغوط التلوث الحالية وحالة المياه وجودة الرواسب لضمان وجود خطة إدارة فعالة تستجيب للخصائص المساحية والإدارية المسبقة للبلدات ضمن حوض الليطاني الأدنى.

٧. تم جمع المعلومات حول ضغوط التلوث ضمن منطقة الدراسة لحوض الليطاني الأدنى من خلال مسح موسع شمل البلديات وبيانات رسمية من المكاتب الحكومية أو الدراسات التي تم التكليف بها رسمياً. تم تحديد حالة مياه النهر وجودة الرواسب من خلال مسح للتقارير والدراسات السابقة بالإضافة إلى أخذ عينات محدودة من المياه والرواسب، وكشف ما سبق الحالة البيولوجية والجودة الفيزيائية والكيميائية السيئة لمياه النهر، وكذلك المعادن الثقيلة والمركبات العضوية في رواسب النهر التي غالباً ما تتجاوز المعدلات العالمية.

٨. تتراوح مصادر التلوث الحالية التي تؤثر على حالة النهر بين كل من التالي: التخلص من النفايات الصلبة والخطرة وتصريف مياه الصرف الصناعية والبلدية والأنشطة الزراعية والترفيهية. وقد تكون حرب تموز ٢٠٠٦ مصدراً محتملاً للمعادن في التربة وبالتالي في المياه نتيجة الأسلحة المستخدمة,

٩. يلخص الشكل رقم ٣ عرضاً بيانياً لضغوط التلوث.



الشكل رقم ٣: مستويات ضغط التلوث عبر المناطق في منطقة الدراسة

١٠. يمكن أن تؤدي ضغوط التلوث المذكورة إلى التأثير السلبي على صحة النهر ومستجمعات المياه، فبمرور الوقت تتجاوز شدة التلوث وعبؤه قدرة النهر على "تنظيف" نفسه بنفسه. تضمنت البيانات التي تم تقييمها ٣,٨٥٤ مُدخل لتركيز العوامل المتعلقة بجودة المياه، وقورنت هذه النتائج بمختلف معايير جودة المياه الوطنية والدولية للعوامل المختلفة والاستخدامات النهائية المختلفة للمياه،

ويشمل ذلك الحفاظ على الحياة المائية والسباحة ومياه الشفة والري. كما تمت مقارنة النتائج المتعلقة برواسب الأنهار بالمتوسطات المرجعية العالمية وقيم التدخل الهولندية للتربة والرواسب.

١١. فيما يلي ملخص عن ضغوط التلوث الموجودة في الحوض الأدنى لنهر الليطاني:

- قُيمت ممارسات إدارة النفايات بتحليل ممارسات التخلص من النفايات البلدية والصناعية والنفايات الطبية عبر المناطق الخمس وذلك لتقييم التهديد الذي تشكله إدارة النفايات الصلبة على المياه السطحية لنهر الليطاني الأدنى وروافده. إن ممارسات الإدارة السيئة للنفايات الخطرة (الصناعية والزراعية والطبية وكذلك الأشياء المنزلية الخطرة) والنفايات غير الخطرة (المنزلية) من خلال الحرق في الهواء الطلق تؤدي إلى انبعاثات في الهواء والتربة والمياه مما يشكل تهديدًا لجودة مياه النهر والبيئة الحيوية نتيجة لآثار الرشح.
- تعتبر ممارسات إدارة مياه الصرف الصحي من أهم العوامل المساهمة في جودة مياه نهر الليطاني الأدنى. تعتبر عدم كفاية البنية التحتية لجمع مياه الصرف الصحي ومعالجتها في المستوطنات الحضرية أهم تهديد ملوث لجودة المياه في نهر الليطاني الأدنى. أما المياه المبتذلة من مؤسسات الرعاية الصحية، فهي ذات جودة مماثلة لمياه الصرف الصحي من المناطق الحضرية ولكنها قد تحتوي على العديد من المكونات الخطرة المحتملة أيضًا. ويجب ضمن منطقة الدراسة مسح / التدقيق في أربعة مستشفيات (٣ منها حكومية وواحدة خاصة) لضمان عدم احتواء نفاياتها ومياه الصرف الصحي الخاصة بها على مواد خطرة. أما فيما يتعلق بمياه الصرف الصناعي فتحتوي منطقة الدراسة على مصانع (خاصة معاصر الزيتون ومناشر الصخور وتصنيع الكتل الخرسانية) تنتج عنها نفايات سائلة محملة بالملوثات العضوية التي يتم التخلص منها إلى المياه السطحية دون أي معالجة مسبقة إما من خلال الروافد المجاورة أو شبكات الصرف الصحي الموجودة. المؤسسات غير الصناعية المصنفة وغير المصنفة التي تقوم بتصريف نفاياتها ومياهها المبتذلة هي في الغالب شركات صغيرة مثل محطات البنزين والمزارع ومحلات صيانة السيارات ومراكز الغسيل والملاحم التي تولد النفايات الصلبة والسائلة بالإضافة إلى المقالع والكسارات (معظمها مقالع رملية) التي تقع على مسافة قريبة (أقل من ٥٠٠ متر) من مسارات روافد نهر الليطاني خاصة في المنطقة رقم ٢. بالإضافة إلى ذلك نجد المؤسسات الترفيهية والتي تتضمن المطاعم بشكل أساسي على طول ضفاف النهر الممتدة على مدى ٥,٧ كيلومتر على طول النهر وتليها المزارع، وتتمثل الملوثات الرئيسية الناتجة عن المنشآت الترفيهية في رمي المخلفات وتصريف مياه الصرف الصحي البلدية أو المنزلية، حيث سجل ما مجموعه ١٤٥ مخالفة أو تعدي (التعديات داخل منطقة عازلة بطول ١٠ أمتار من مسار نهر الليطاني الأدنى) وكانت تلك المخالفات من قبل أنواع مختلفة من المنشآت الترفيهية في ٢٨ موقعا في سبع أقضية تغطي ١١ في المئة من طول النهر أو طول اجمالي يبلغ ٩,٥ كيلومتر.
- يعتبر ضغط التلوث الناجم عن ٣٨٤ مخيم غير رسمي تأوي ٢,٠٠٥ لاجئ ضمن حوض الليطاني الأدنى منخفضًا في جميع مناطق منطقة الدراسة.
- يرجع المصدر الرئيسي لمصادر التلوث غير الثابتة في المنطقة إلى الأنشطة الزراعية التي تشكل أحد الأنشطة الاقتصادية الرئيسية في حوض الليطاني الأدنى. أهم مكونات الجريان السطحي الزراعي وتسرب المياه هي المواد الكيميائية الزراعية (الأسمدة) ومبيدات الآفات غير القابلة للتحلل والتي ينتهي بها الأمر في المجاري المائية مع تدفقات الري أو الترشيح العميق. يرجع أحد مصادر القلق الرئيسية إلى استخدام مبيدات الآفات حيث يتم استخدام العديد من مبيدات الآفات بكميات تتجاوز الكميات والمعدلات الموصى بها.

الاستجابات المحتملة وتدابير التخفيف

١٢. يوصى باتباع نهج قائم على الأولويات لمعالجة مصادر التلوث، ويمكن تحديد أولوية ضغط من ضغوط التلوث بناءً على تأثيره الذي يتجلى في جودة المياه والرواسب. بناءً على الدراسات المتاحة والتي قُيّمت تعتبر النفايات الصلبة ومياه الصرف الصحي مصادر التلوث الأكثر إلحاحاً، وتليها المنشآت الصناعية (معاصر الزيتون ومناشر الصخور وغسل الرمل) والزراعة المروية. لذلك يجب تقييم تدابير التخفيف الموضوعة عين الاعتبار تقييماً دقيقاً حسب القطاع (النفايات الصلبة، مياه الصرف الصحي، المخيمات غير الرسمية، إلخ) وحسب المنطقة.

١٣. من المتوقع أن تساهم الاستثمارات في البنية التحتية المخصصة في القانون رقم ٢٠١٦/٦٣ إسهاماً مباشراً (من خلال مياه الصرف الصحي) وغير مباشر في تحسين الظروف البيئية لنهر الليطاني الأدنى، ويلخص الجدول رقم ١ أدناه تكاليف التدابير المقترحة.

الجدول رقم ١: تكاليف التدابير المقترحة في جميع المناطق

القطاع	التكلفة الاجمالية (بالدولار الأمريكي)
النفايات الصلبة البلدية	٢٤,٢٠٤,٢٥٠
مياه الصرف الصحي البلدية	٣٤,٣٤١,٠٠٠
مياه الصرف الصناعي	٢,٦٢٢,٠٠٠
التحسين الزراعي	٢,٥٧٠,٠٠٠
التدابير العابرة للقطاعات والحوكمة	١٢,٣٠٠,٠٠٠
الإجمالي (بالدولار الأمريكي)	**٧٦,٠٣٧,٢٥٠**

النفايات الصلبة

١٤. لا بد من التطرق إلى وظيفة أي من مكبات النفايات (المنطقة رقم ٥ كأولوية) التي تسهم في تغيير ضفاف نهر الليطاني، ويجب بالتالي تشجيع تطوير وتنفيذ مبادرات وبدائل واقعية ومناسبة لإدارة النفايات. لحسن الحظ تتوفر حاليًا مبادرات لإدارة النفايات الصلبة في المناطق من ١ إلى ٥، ولكن هناك حاجة إلى المزيد من المطامر الصحية. كجزء من مخطط إدارة النفايات الصلبة الأول (SWAM I) الممول من الاتحاد الأوروبي والخطة الجارية لحماية الموارد البحرية وتنميتها المستدامة في لبنان (PROMARE)، هناك مشاريع قيد التنفيذ في حين أن بعضها لا يزال غير ممول بعد إلغاء مشاريع المرحلة الثانية من مخطط إدارة النفايات الصلبة (SWAM II) (الجدول رقم ٢).

الجدول رقم ٢: المشاريع المخطط لها لإدارة النفايات الصلبة في المناطق من ١ إلى ٥

المنطقة	وصف المشروع	مصدر التمويل	المبلغ التقديري	الحالة
المنطقتين الثالثة والرابعة	إنشاء مطمر صحي في النبطية	غير متوفر	٢١٧٧٠٠٠ يورو	المشروع قيد الانتظار بعد إلغاء المرحلة الثانية من مخطط إدارة النفايات الصلبة (SWAM II)
	إنشاء منشأة فرز وتسبيخ (تحويل النفايات الى أسمدة) لمنطقتي بنت جبيل ومرجعيون	غير متوفر	٢١٣٥٠٠٠ يورو	المشروع قيد الانتظار بعد إلغاء المرحلة الثانية من مخطط إدارة النفايات الصلبة (SWAM II)
	بناء مطمر صحي لمنطقتي بنت جبيل ومرجعيون	غير متوفر	٢٤٧١٠٠٠ يورو	المشروع قيد الانتظار بعد إلغاء المرحلة الثانية من مخطط إدارة النفايات الصلبة (SWAM II)
المنطقة الخامسة	إعادة تأهيل مكب النفايات راس العين في صور	غير متوفر	٤٤٢٤٠٠٠ يورو	المشروع قيد الانتظار بعد إلغاء المرحلة الثانية من مخطط إدارة النفايات الصلبة (SWAM II)
	إنشاء منشأة فرز وتسبيخ (تحويل النفايات الى أسمدة) في ساحل الزهراني	مشروع حماية الموارد البحرية وتنميتها المستدامة في لبنان (PROMARE) (الاتحاد الأوروبي)	غير معروف	ما زال المشروع قيد الدراسة وفي مرحلة التخطيط

١٥. يقدم الجدول رقم ٣ أدناه الاستجابات الإضافية المقترحة لإدارة ضغوط التلوث الناتج عن النفايات الصلبة في المستقبل في كل منطقة من مناطق حوض الليطاني الأدنى. مع ذلك يجب حظر إلقاء النفايات والتخلص منها مباشرة في النهر حظراً كاملاً من خلال تطبيق القانون وأنشطة التوعية على المستوى المحلي.

الجدول رقم ٣: الاستجابات المقترحة لإدارة النفايات الصلبة في المناطق من ١ إلى ٥

المنطقة	الاستجابة المقترحة	المبلغ التقديري
المنطقتين الأولى والثانية	تشغيل وصيانة مجمع جب جنين لإدارة النفايات الصلبة	١,٢ مليون دولار لتكاليف التشغيل والصيانة السنوية
	وقف التخلص من النفايات في مكبات مجدل بلحيص وسحمر وعين التينة وريحان وجزين ونقل النفايات إلى مطمر جب جنين الصحي الجديد	٧١,٥٠٠ دولار أمريكي
	أو اغلاق المكبات المذكورة أعلاه (حفرها وتسويتها وتغطيتها وإغلاقها)	٣٤,٠٠٠ دولار أمريكي
المنطقتين الثالثة والرابعة	إنشاء مطمر صحي للنفايات لقضاء النبطية (بسعة ٧٥ طن في اليوم) لتكملة منشأة الفرز والتسبيخ في الكفور	٦,٧٨ مليون يورو
	إنشاء مجمع للإدارة المتكاملة للنفايات الصلبة لبنت جبيل ومرجعيون يتضمن منشأة للفرز والتسبيخ (بسعة ٢٥٠ طن في اليوم) ومطمر صحي للنفايات بسعة ١٠٠ طن في اليوم	
	التوقف عن التخلص من النفايات في مكبات يحمر (النبطية) وعدشيت القصير وبني حيان وكونين ودير سريان وحولا ورب الثلاثين، ونقل النفايات إلى مطامر النبطية أو بنت جبيل مرجعيون الصحية عند تنفيذها.	١٣٣,٥٠٠ دولار أمريكي
	أو اغلاق المكبات المذكورة أعلاه (حفرها وتسويتها وتغطيتها وإغلاقها)	٧٦,٥٠٠ دولار أمريكي
المنطقة الخامسة	إنشاء مطمر صحي للنفايات في قضاء صور وإنشاء مجمع جديد للإدارة المتكاملة للنفايات الصلبة لساحل الزهراني يتضمن منشأة للفرز والتسبيخ (سعة ١٥٠ طن في اليوم) ومطمر صحي للنفايات (بسعة ٧٥ طن في اليوم)	١٤,٦ مليون دولار
	وقف التخلص من النفايات في مكبات برج رحال وبدياس ودير قانون النهر ومعروب والحميري وسير الغربية وصريفا ونقل النفايات إلى مطامر رأس العين أو سهل الزهراني الصحية فور تنفيذها	١٣٩,٠٠٠ دولار أمريكي
	أو اغلاق المكبات المذكورة أعلاه (حفرها وتسويتها وتغطيتها وإغلاقها)	١٠٢,٥٠٠ دولار أمريكي

المنطقة	الاستجابة المقترحة	المبلغ التقديري
	الفرز السليم للنفايات الطبية لتقليل حجم النفايات المعدية، وإرسال النفايات المعدية معزولة للتخلص منها في مركز العباسية للتعقيم	-

الصرف الصحي (المياه المبتذلة)

١٦. يمكن تحديد أكبر ضغوط من مياه الصرف الصحي عبر تقاطع الضغط السكاني مع قدر وجود مصادر إمدادات المياه سواء لأغراض الشرب أو الري أو الترفيه. الأولوية القصوى للاستجابة هي في الواقع استثمارات البنية التحتية لمياه الصرف الصحي البلدية (الجدول رقم ٤).

الجدول رقم ٤: الاستثمارات المقترحة في البنية التحتية لأنظمة الصرف الصحي

المنطقة	وصف المشروع	رأس المال المستثمر (الدولار الأمريكي)
المنطقة الأولى	إعداد دراسات الجدوى / دراسات التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع لمحطة معالجة مياه الصرف الصحي في زلايا ومنطقة مجدل بلحيص التي تخدمها هذه المحطة	٨,٥٧٣,٠٠٠
المنطقة الثانية	تقييم التغطية والحالة التشغيلية وفعالية المعالجة لأنظمة معالجة مياه الصرف الصحي في ريحان والعيشيه	١٦٠١٣٠٠٠
	إنشاء شبكات في سجد وربطها بمحطات المعالجة في ريحان أو العيشيه	
	تقييم جدوى نظم جمع ومعالجة مياه الصرف الصحي في بلدات شبيل ومزرعة داريا والقطراني.	
	إنشاء شبكات في المناطق غير المخدومة وهي الجديدة ودبين وبلاط والبويضة وقلايا وبرج الملوك وربطها بمحطة المعالجة في مرجعيون	
	تقييم الوضع التشغيلي وفعالية المعالجة في محطة كوكبة واستكمال تغطية الشبكة في كوكبا	
	إعداد دراسات الجدوى / دراسات التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع في عرمتى وكفر حونة ليخدمها نظام منطقة الصرفند. كما يمكن خدمة منطقة زوطر الغربية في المنطقة الثالثة من خلال نظام منطقة الصرفند.	
	إعداد دراسات الجدوى / دراسات التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع في وادي الجرمق	

المنطقة	وصف المشروع	رأس المال المستثمر (الدولار الأمريكي)
	إعداد دراسات الجدوى / التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع للسريري لخدمة منطقة السريري والدلافة وبرغس وقلايا من المنطقة الأولى.	
المنطقة الثالثة	إعداد دراسات الجدوى / التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع لكفر رومان وكفر تبنيت وأرنون كجزء من نظام معالجة مياه الصرف الصحي في النبطية.	١٨٩٠٠٠٠
	تقييم التغطية والوضع التشغيلي وفعالية المعالجة لمحطة المعالجة في دير ميماس وتقييم توسعة الشبكة لتشمل كفر كلا والحورة ومزرعة دمياط	
	تقييم جدوى شبكات التجميع في زوطر الغربية ومزرعة الحمراء والربط مع محطة المعالجة الموجودة في زوطر الشرقية أو مع محطة منطقة الصرفند. إنشاء وتشغيل وصيانة عمليات معالجة مياه الصرف الصحي ونظام جمعها في زوطر.	
المنطقة الرابعة	التعرف على وتحديد مناطق الخدمة لنظم إدارة مياه الصرف الصحي في وادي السلوقي وبريقع	٤٠٤٠٠٠٠
	إعداد دراسات الجدوى / التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع لمارون الراس عيترون وبليدا وكونين وبيت ياحون ومحيبيب وشقرا وميس الجبل وحولا والصوانة وقلويه، مع ربط هذه القرى بمحطة قعقعية الجسر المزمع إنشاؤها	
	إنشاء شبكات لجمع مياه الصرف الصحي في طيري وعيناتا وربطها بمحطة المعالجة الموجودة في بنت جبيل	
	استكمال شبكات جمع مياه الصرف الصحي في السلطانية وجميجمة وربطها بمحطة المعالجة الموجودة في تبنين	
المنطقة الخامسة	توسيع التغطية الشبكية لنظام معالجة مياه الصرف الصحي في صور من خلال ربطها بالمناطق المتبقية من معروب وبرج رحال وعين أبو عبد الله ودير قانون النهر وجناتا وبدياس وأرزون والبلدات الجديدة التالية: بستيات ودردغيا وشحور وسير الغربية وكفر دونين والحلوسية وطير فلساي والحميري وصريفا.	٢٨٠٠٠٠٠
	إعداد دراسات الجدوى / التصميم وإنشاء / تشغيل نظام معالجة مياه الصرف الصحي وشبكات التجميع لنظام معالجة مياه الصرف الصحي في منطقة الصرفند	

المنطقة	وصف المشروع	رأس المال المستثمر (الدولار الأمريكي)
	استكمال الشبكات في منطقتي زرارية والخرايب	
	التحقق من حالة الشبكة في كفر صير وربط الشبكة بمحطة معالجة كفر صير القائمة.	

١٧. أما بالنسبة لمياه الصرف الصناعي، فالضغوط موسمية ولكن لها تأثيرات خطيرة على جودة مياه النهر وبالتالي على الحياة المائية. إن غالبية الصناعات المولدة للمياه المبتذلة في مستجمعات مياه نهر الليطاني الأدنى لها حجم إنتاجي صغير ولا يمكنها تحمل عبء معالجة مياه الصرف الصحي بشكل فردي بسبب قيود المساحة والصعوبات المالية. يحدد قرار وزارة البيئة رقم ١/٨ الصادر عام ٢٠٠١ معايير تصريف المياه المبتذلة في شبكة الصرف الصحي التي يجب على الصناعات المختلفة التقيد بها. لتحقيق ذلك، يتعين على الصناعات معالجة النفايات السائلة الصناعية (معالجة أولية) لتخفيف حمل التلوث إلى مستوى مقبول بحيث يمكن من بعدها معالجة هذه المياه المبتذلة في محطة معالجة بيولوجية. يقدم الجدول رقم ٥ تقديرات تكلفة المعالجة الأولية للمياه المبتذلة من الصناعات ذات الأولوية رقم ١.

الجدول رقم ٥: تقدير تكلفة المعالجة الأولية للنفايات السائلة من الصناعات ذات الأولوية

المنطقة	صناعات الأولوية رقم ١	العمليات الرطبة (التي تصرف النفايات السائلة)	تكلفة المعالجة الأولية (دولار أمريكي)	تكاليف التشغيل والصيانة (دولار أمريكي)	تكاليف الدراسات (دولار أمريكي)
المنطقة الأولى	١١	معاصر الزيتون (٩)، مناشر الحجارة (٢)	٦٠٠٠٠٠	٩٠٠٠٠	٥٧٠٠٠
المنطقة الثانية	١	صناعة مشتقات الحليب (١)	٦٠٠٠٠	٩٠٠٠	٥٠٠٠
المنطقة الثالثة	١١	معاصر الزيتون (١١)	٥٢٠٠٠٠	٧٨٠٠٠	٤٢٠٠٠
المنطقة الرابعة	٩	معاصر الزيتون (٧)، مناشر الحجارة (١)، صناعة مشتقات الحليب (١)	٥١٥٠٠٠	٧٧٢٥٠	٤١٠٠٠
المنطقة الخامسة	١٤	معاصر الزيتون (٩)، مناشر الحجارة (٤)، صناعة الشوكولاتة (١)	٨٠٥٠٠٠	١٢٠٧٥٠	٧٢٠٠٠
الإجمالي	**٤٦**		**٢٥٠٠٠٠٠**	**٣٧٥٠٠٠**	**٢١٧٠٠٠**

١٨. أنشأت وزارة البيئة مشروع مكافحة التلوث البيئي في لبنان الذي يهدف إلى مساعدة الشركات الصناعية اللبنانية على الحد من التلوث والامتثال لقانون حماية البيئة اللبناني رقم ٤٤٤ لعام ٢٠٠٢ من خلال تزويدها بالمساعدة الفنية والقروض المدعومة للاستثمار في المعالجة عند المصب ومنع التلوث.

١٩. مشروع مكافحة التلوث البيئي في لبنان هو مبادرة مشتركة بين وزارة البيئة ووزارة المالية ومصرف لبنان والبنك الدولي والتعاون الإيطالي لإنشاء آلية لتمويل الحد من التلوث الصناعي في المؤسسات الصناعية المستهدفة وتوفير ما يلزم من المساعدة الفنية لضمان تنفيذ واستدامة هذه التدخلات.

٢٠. بالإضافة إلى ما سبق، تمثل القطاعات الأخرى الموجودة في حوض الليطاني الأدنى أيضًا مصادر ضغط تلوث على نهر الليطاني، ويعرض الجدول رقم ٦ موجزاً بشأن هذه القطاعات إضافة إلى التدابير المقترحة للحد من أو منع تأثير التلوث.

الجدول رقم ٦: الاستجابات المقترحة للقطاعات المختلفة

المنطقة	الاستجابات المقترحة	التكلفة (دولار أمريكي)
الرعاية الصحية	• دعم مؤسسات الرعاية الصحية من أجل إنشاء أنظمة منفصلة لجمع النفايات والمياه المبتذلة والحد بشكل صارم من تصريف السوائل الخطرة إلى المجاري. • تقديم المشورة لمؤسسات الرعاية الصحية بشأن أنظمة المعالجة المسبقة (المعالجة الأولية والثانوية والثالثية والتطهير والهضم اللاهوائي للحمأة) قبل تصريفها إلى شبكة الصرف الصحي البلدية. • يجب أن تضمن مؤسسات الرعاية الصحية أن إدارة النفايات الخاصة بها تمنع بشكل فعال تصريف كميات كبيرة من المواد الكيميائية السامة والأدوية والنويدات المشعة (radionuclides) والأدوية السامة للخلايا والمضادات الحيوية في مجاري تصريف المياه من خلال إجراء المعالجة اللازمة. • وضع برامج مراقبة روتينية لرصد النفايات السائلة في مؤسسات الرعاية الصحية (درجة الحرارة والأس الهدروجيني (pH) ومجموع المواد الصلبة الصلبة واختبار الخمسة أيام للأوكسجين الحيوي الممتص (BOD5) والطلب على الاكسجين الكيميائي (COD) والنترات وإجمالي الفوسفور والعصيات القولونية (E. Coli)) لضمان الالتزام بمعايير التصريف المعمول بها.	١٠٠,٠٠٠
المنشآت غير الصناعية المصنفة وغير المصنفة	• على السلطات المحلية ضمان الالتزام البيئي والإشراف على أنشطة تشغيل المؤسسات • التدريب لبناء قدرات المسؤولين المحليين والشرطة بشأن القوانين والأنظمة البيئية. • أحداث إعلامية تركز على التجارة ومساعدة فنية موجهة من أجل رفع مستوى الوعي بشأن تدابير النظافة العامة الأساسية وتدابير الحفاظ على الموارد.	٢٥٠,٠٠٠
المقالع	• إنفاذ التشريعات ذات الصلة لضمان أن أنشطة المقالع لا تسبب ضررًا غير مبرر لأطراف ثالثة وللحياة النهرية	--
المنشآت الترفيهية	• الاتفاق على حدود الأملاك النهرية العامة بين كل من المديرية العامة للتنظيم المدني ووزارة الطاقة والمياه والمصلحة الوطنية لنهر الليطاني، ومنع التعدي عليه • تطبيق قواعد التراجع حيثما تنطبق ويتم ذلك من خلال طلب ثم تنفيذ هدم الإنشاءات المبنية التي تتعدى على الأملاك العامة ومسارات النهر وروافده، خاصة عندما تغير هذه التعديات أنظمة تدفق النهر. • وضع مبادئ توجيهية ومعايير تشغيلية للمرافق الترفيهية بمختلف الأحجام والأنشطة الواجب اتباعها في إدارة مياه الصرف الصحي والنفايات الصلبة • مراقبة تنفيذ هذه التدابير من خلال عملية الوصاية على عملية التصريف حيث يطلب من المرافق التعاقد للحصول على خدمات جمع النفايات والمياه المبتذلة لنقل النفايات والمياه المبتذلة الناتجة منها إلى أقرب مرفق معالجة مع الاحتفاظ بالسجلات وتطبيق الالتزام من قبل البلديات.	٥٣٠٠٠٠

المنطقة	الاستجابات المقترحة	التكلفة (دولار أمريكي)
	• تنفيذ سياسة صارمة لمنع تصريف النفايات الصلبة ومكافحة رمي القمامة والمياه المبتذلة في مياه النهر وتطبيق العقوبات اللازمة	
المخيمات غير الرسمية	• التأكد من أن تصريف النفايات والمياه المبتذلة موجه بشكل صحيح إلى أنظمة الجمع والمعالجة الرسمية الموجودة. • يجب على وكالات الإغاثة التأكد من أن تلتزم المخيمات غير الرسمية بالتشريعات الوطنية والمحلية وتنسيق الجهود مع السلطات المحلية والهيئات الحكومية لتجنب خلق عبء تنظيف النفايات وانتهاك حقوق الملكية.	--

القطاع الزراعي

٢١. أظهر التحليل أن الزراعة لا تشكل ضغط تلوث كبير على حوض نهر الليطاني الأدنى، غير أنه لوحظ الإفراط في استخدام مبيدات الآفات والأسمدة على جميع المحاصيل، وفي النهاية ستساهم تدفقات العائدات الزراعية في تلوث النهر وكذلك تلوث المياه الجوفية والتربة.

٢٢. من شأن معالجة التلوث الناجم عن الزراعة أن تحسن نوعية المياه السطحية بمرور الوقت، الأمر الذي سيكون له آثار إيجابية على تحسين نوعية مياه الري. الاستجابات المقترحة لمعالجة التلوث الناتج عن الممارسات الزراعية هي استجابات عامة وتنطبق على جميع المناطق. يمكن تنفيذ العديد من الاستجابات للحد من ضغوط التلوث الزراعي والتي تشمل على سبيل المثال لا الحصر تلك المبينة في الجدول رقم ٧. كما تؤدي إعادة التأهيل البيئي وتأهيل الأراضي (الغابات، المراعي، المقالع، مكبات النفايات، والأراضي الزراعية) إلى الحد من انجراف التربة والجريان السطحي للمياه، مما يخفف بشكل غير مباشر من تلوث المياه السطحية بمياه الجريان الملوثة.

الجدول رقم ٧: الاستجابات المقترحة المختارة لمعالجة ضغوط التلوث الزراعي

الاستجابات المقترحة	التكلفة (دولار أمريكا)
تطوير مناهج الإدارة/المكافحة المتكاملة للآفات للمحاصيل الهامة في المنطقة	١٨٠,٠٠٠ (بما في ذلك التقييمات ذات الصلة: الممارسات الحالية والآفات الحالية وأعدائها الطبيعيين)
إدخال أصناف / أنواع جديدة مقاومة للأمراض ومسببات الأمراض	
تعريف المزارعين بالتقنيات والأدوات المختلفة المستخدمة في المكافحة المتكاملة للآفات	٨٠,٥٠٠
إنشاء نظام لجمع والتخلص من عبوات المبيدات الفارغة ومخزونات المبيدات المنتهية الصلاحية/ غير المستخدمة: تدريب المزارعين، جمع العبوات المستخدمة، والتخلص من خلال إعادة التدوير	١٨٠,٥٠٠
إعداد عقارات للتجارب في مناطق عدة من الحوض الأدنى لليطاني والتدريب على الممارسات الزراعية الجيدة بما فيها المكافحة المتكاملة للآفات	٢١٩,٠٠٠
الترويج للمنتجات المزروعة باستخدام تقنيات المكافحة المتكاملة للآفات والممارسات الزراعية الجيدة	-

الاستجابات المقترحة	التكلفة (دولار أمريكا)
التدريب على التعامل السليم مع الأسمدة والمبيدات الزراعية وتطبيقها وتخزينها	٢٢,٥٠٠
أداء اختبارات بقايا/آثار مبيدات الآفات بشكل منتظم على منتجات المكافحة المتكاملة للآفات المعتمدة طوال موسم الإنتاج	١٥٣,٠٠٠
تقدير أحمال التلوث عن طريق أخذ عينات التربة ومياه الري بشكل متكرر وتحليلها	٨٤،٥٠٠ + ٩٩،٥٠٠
تدريب ميداني على إدارة المياه وميزانيات المياه والجدولة الزمنية واستخدام بيانات الأرصاد الجوية الزراعية	٢٢,٥٠٠
تحديد المناطق التي قد تكون معرضة والمعروفة بالمناطق المعرضة للنترات (Nitrate Vulnerable Zones – VNZs) وتقييد المزارع داخل المناطق المعرضة للنترات فيما يتعلق بكمية الأسمدة النيتروجينية التي يمكن استخدامها على الأرض.	١٠٨,٠٠٠
تقدير التغيرات في استخدام الأراضي والغطاء الأرضي بين خريطتي أساس أو صور جوية (مثلاً ٢٠٠٥ و٢٠٢٠)، بالإضافة إلى صافي الإنتاجية الأولية (Net Primary Productivity) والكربون العضوي في التربة (Soil Organic Carbon)	٦٩,٠٠٠
تقييم إيكولوجي عبر فصول عدة مبني على أخذ عينات بشكل تكتيكي من النواة ومقاطع من منطقة الدراسة على مدى ٣ سنوات	٣٥,٠٠٠
مسح توبوغرافي للمقالع ودراسات هندسية لتحديد متطلبات إعادة التأهيل باستخدام نفايات البناء والهدم، ودراسات تقييم الأثر البيئي المطلوبة لذلك	٥٧٥,٠٠٠

٢٣. بالإضافة إلى التدابير المذكورة أعلاه، من شأن قيام وزارة الزراعة بوضع نظام جيد لتسجيل مبيدات الآفات أن يساعد على ضبط توزيع واستخدام المبيدات الزراعية.

التدابير العابرة للقطاعات والتدابير المتعلقة بالحوكمة

٢٤. يعرض الجدول رقم ٨ التدابير الشاملة المقترحة عبر عدة قطاعات والتدابير المتعلقة بالحوكمة في حوض الليطاني الأدنى والجهات المسؤولة والميزانية التقديرية والأنشطة ذات الصلة الحالية والمخططة.

الجدول رقم ٨: التدابير العابرة للقطاعات وتدابير الحوكمة

وصف الإجراءات المقترحة	الجهة المسؤولة (الجهة التنسيقية)	الميزانية التقديرية	الأنشطة الحالية والأنشطة المخطط لها
تعزيز إجراءات الحوكمة وإجراءات إنفاذ القانون لضمان تنفيذ التدابير الفنية بفعالية	المصلحة الوطنية لنهر الليطاني والمحاكم (جميع الجهات المعنية)	٢٠٠٠٠٠ دولار أمريكي	تنفيذ خارطة طريق لنهر الليطاني الأعلى المدعون البيئيون الضابطة البيئية

وصف الإجراءات المقترحة	الجهة المسؤولة (الجهة التنسيقية)	الميزانية التقديرية	الأنشطة الحالية والأنشطة المخطط لها
			تدريب الشرطة البلدية
تنظيم وتوحيد إدارة البيانات لقياس وتوثيق وفهم كيف وأين تؤدي إجراءات التخفيف إلى تحقيق تحسينات. إنشاء غرفة / نظام بيانات موحد مشترك حول جميع ضغوط التلوث في الحوض	المصلحة الوطنية لنهر الليطاني (جميع الجهات المعنية)	٢٠٠٠٠٠٠ دولار أمريكي	لا توجد
تحسين إدارة الإدارة العامة والتنسيق بين الوكالات لتنفيذ الإجراءات المقترحة من خلال بناء القدرات	مجلس الوزراء (جميع الجهات المعنية)	٢٠٠٠٠٠٠ دولار أمريكي	لا توجد
أنظمة المراقبة الفيزيائية والكيميائية لجودة المياه وتوازن المياه وخط أساس النظام البيئي في النهر (river ecology baseline)	المصلحة الوطنية لنهر الليطاني (وزارة الطاقة والمياه ووزارة البيئة)	١٠٠٠٠٠٠ دولار أمريكي	لا توجد
المخطط التوجيهي لحوض الليطاني الأدنى وإنشاء / تحديث تصنيف الأراضي التي تحدد حدود مجرى النهر وروافده والاستخدامات المسموح بها للأراضي (جميع الأنشطة الاقتصادية) التي يمكن أن تضمن سلامة مسار النهر (التراجعات) والحماية من التعديات	المديرية العامة للتنظيم المدني (السلطات المحلية والمصلحة الوطنية لنهر الليطاني والوزارات التنفيذية)	٥٠٠٠٠٠٠ دولار أمريكي	المخطط التوجيهي لحوض الليطاني الأعلى

SOMMAIRE

INTRODUCTION

25. Earth Link and Advanced Resources Development s.a.l. (ELARD) a été engagée en sous-traitance par le Conseil de Développement et de Reconstruction (CDR), représentant le Gouvernement Libanais (notamment le Ministère de l'Environnement), dans le but de fournir des services de conseil pour l'élaboration d'un Plan d'Affaires pour Lutter Contre la Pollution dans le Bassin Inférieur du Litani (BIL) au Liban. Ce plan est fondé sur la loi No. 63 de 2016 qui budgétise des provisions pour l'exécution de projets visant à réduire la pollution, avec des expropriations y afférent dans le bassin du Litani, et ce, de la source à l'embouchure. La loi sert d'instrument pour la mise en œuvre de la feuille de route de lutte contre les sources de pollution du cours supérieur du Litani. Cette loi se base sur le « Plan d'Affaires pour Lutter Contre la Pollution dans le Bassin Supérieur du Litani » datant de 2011. Afin de compléter ce projet, ce rapport a été établi, comprenant le repérage des sources de pollution dans le BIL et des mesures d'atténuation, sous forme d'un plan d'affaires. Ce rapport inclut des données recueillies sur dossier et sur le terrain, ainsi que des analyses et des assimilations, avec l'implication des parties prenantes. Le Plan d'Affaires, tout comme le plan du Cours Supérieur du Litani, préconise des solutions adaptées qui serviront pour la prise de décisions éclairées.

26. L'objectif ultime de ce Plan d'Affairesest de documenter et proposer une approche globale pour remédier durablement aux sources de pollution dans le Bassin Inférieur du Litani et ainsi le protéger à long terme.

CARACTERISTIQUES DU SECTEUR D'ETUDE DU BASSIN INFERIEUR DU LITANI

27. Le BIL s'étend sur une surface de 637,20 km^2, du mur du barrage du lac Qaraoun jusqu'à l'embouchure du fleuve. Il traverse quatre gouvernorats (le Mont-Liban, la Békaa, Nabatiye et le Liban Sud), ainsi que 10 districts (cazas).

28. Au total, 99 municipalités et 7 maires (mokhtars - dans les villages sans municipalités) ont compétence sur les 132 communautés et villages compris dans le secteur d'étude. La plupart des villages au sein du BIL ont des municipalités regroupées en 11 unions. Le secteur d'étude du BIL recouvre une surface de 791,56 km^2. Ce secteur a été élargi au-delà des frontières de la zone de partage des eaux (watershed) pour inclure toute l'étendue cadastrale des villages, de manière à mettre l'accent sur le rôle des municipalités dans le contrôle des sources de pollution dans leurs zones de compétences. La Figure 1 ci-dessous montre la couverture administrative du secteur d'étude.

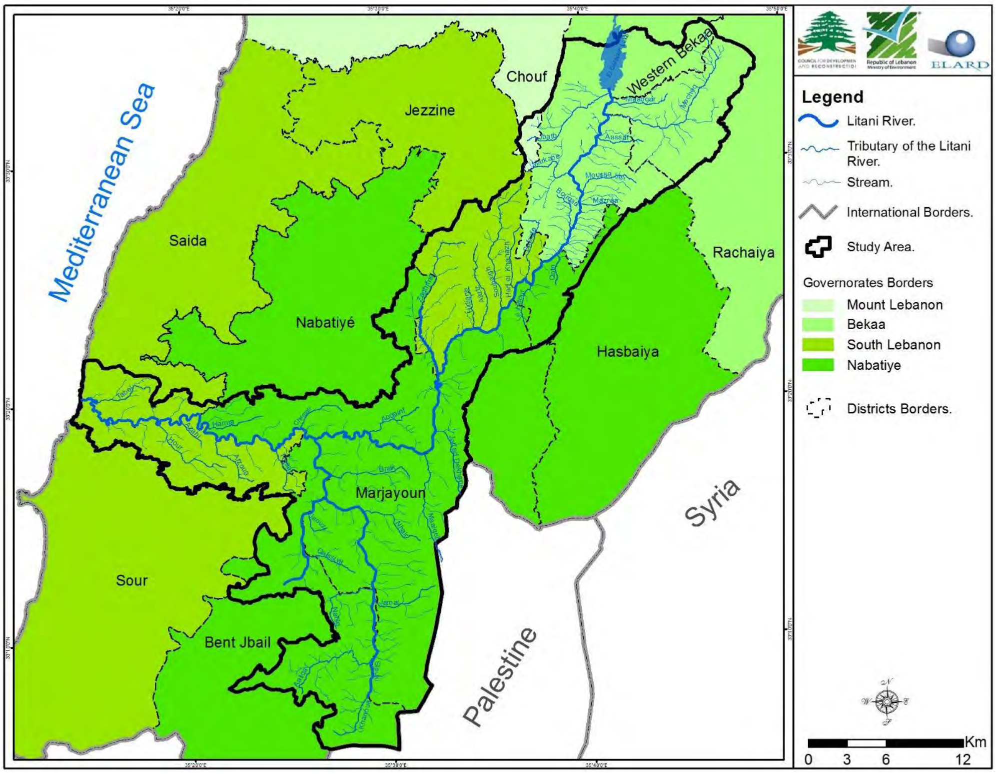


Figure 1 - Carte administrative du Bassin Inférieur du Litani

29. Au sens de ce Plan d'Affaires, le secteur d'étude est divisé en 5 zones de sous-bassins drainés par les affluents du Litani ; et par l'étendue cadastrale des localités (Figure 2).

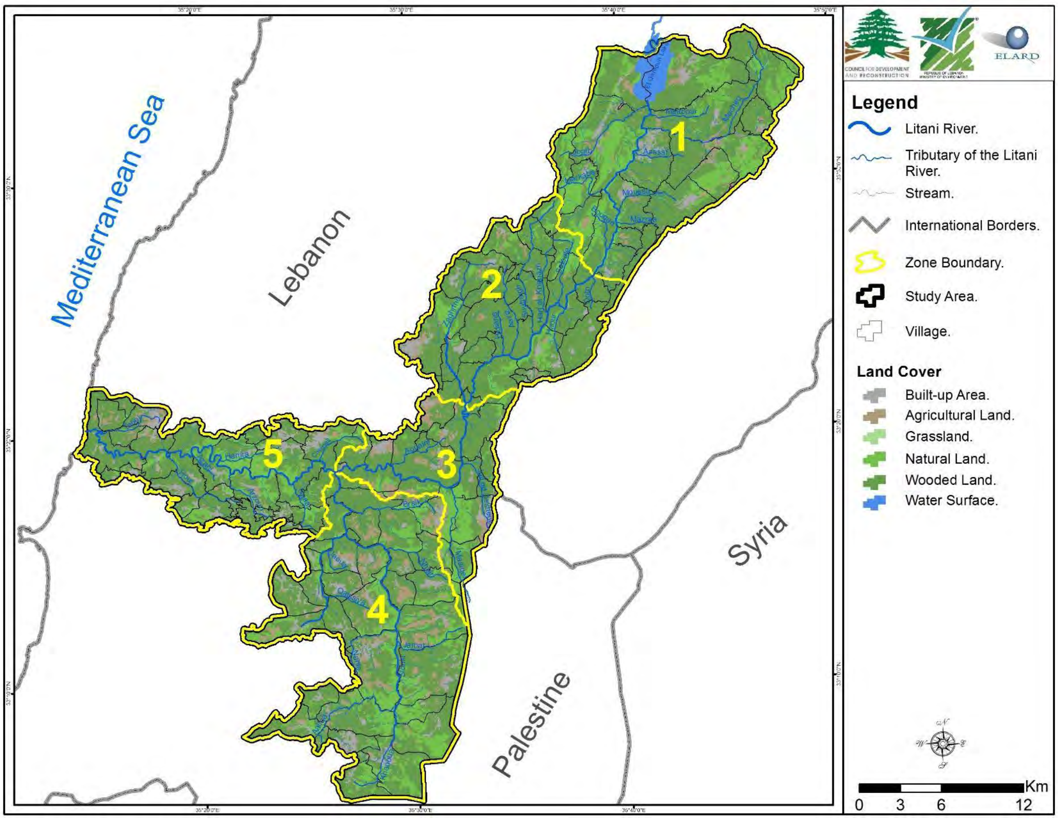


Figure 2 - Zones d'étude du secteur d'étude du BIL

PRESSIONS DE POLLUTIONS, ETAT DE L'EAU DU FLEUVE ET QUALITE DES SEDIMENTS ET ANALYSE DE LA SITUATION

30. Le secteur compris dans l'étude a été divisé en une multitude de zones, afin de pouvoir examiner et évaluer – de manière cohérente - les pressions existantes et la qualité de l'eau et des sédiments. Ceci permet de mettre en place un plan de gestion efficace et réactif qui prend en compte les caractéristiques cadastrales et administratives préexistantes des localités du BIL.

31. Les informations sur les pressions de pollution dans le secteur d'étude du BIL ont été recueillies en menant une enquête municipale approfondie et à partir de données officielles fournies par des institutions publiques ou des études officielles. L'état de l'eau du fleuve et la qualité des sédiments ont été cernés en examinant les campagnes de documentation et d'études antérieures, ainsi qu'en menant un échantillonqge limité d'eau et de sédiments. Les résultats ont montré un mauvais état biologique et une mauvaise qualité physico-chimique de l'eau du fleuve. Ils ont également révélé la présence de métaux lourds et de composés organiques dans les sédiments dépassant souvent les moyennes mondiales.

32. Les sources de pollution existantes qui impactent l'état du fleuve varient : l'élimination des déchets solides dangereux et non dangereux, l'évacuation des eaux usées des usines et des municipalités et les activités agricoles et récréatives. Le Conflit de 2006 a aussi été une source potentielle de métaux dans le sol et par consequent dans les eaux à cause des armes utilisées .

33. La Figure 3 représente un résumé des pressions de pollution.

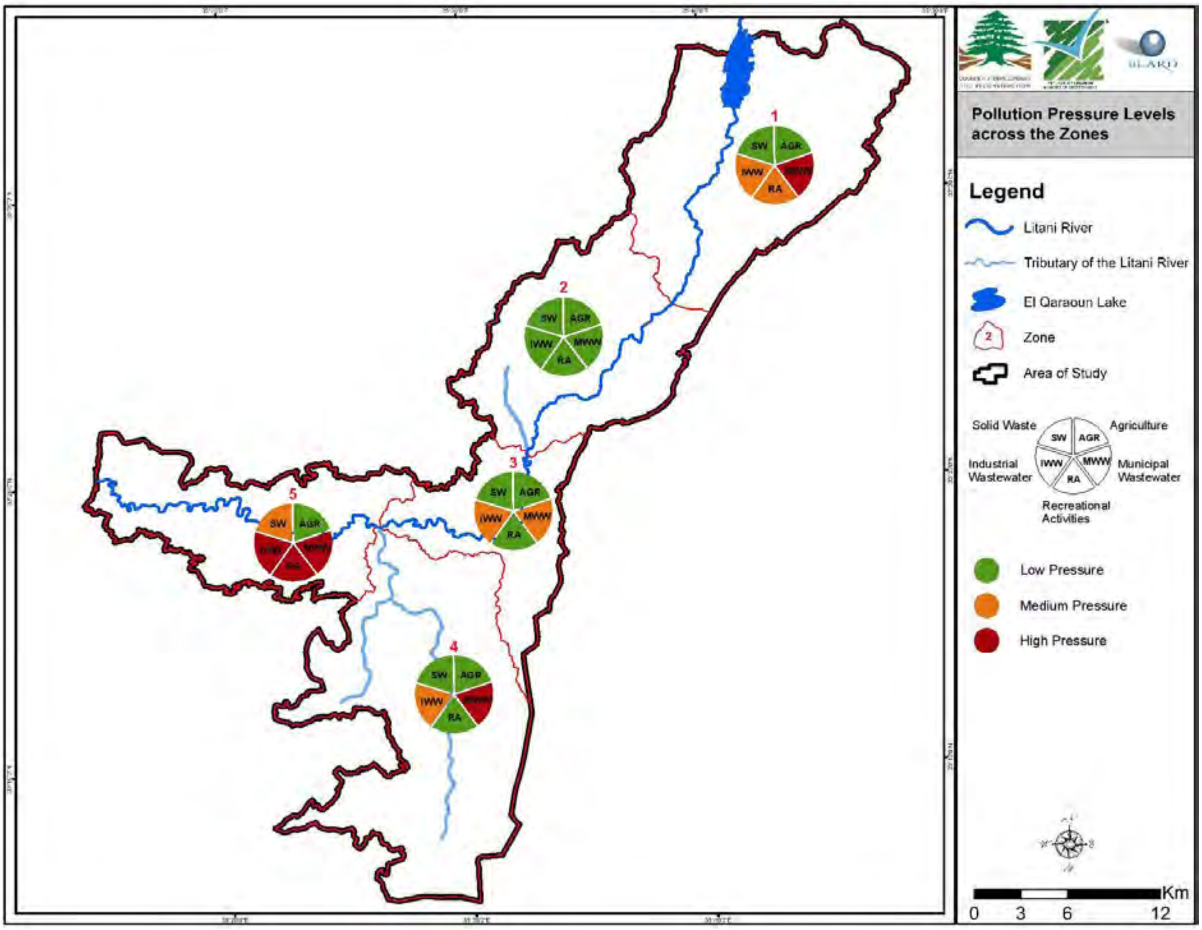


Figure 3 - Niveaux de pressions de pollution dans les différentes zones du secteur d'étude

34. Toutes les pressions de pollution abordées peuvent avoir une incidence sur la santé du fleuve et de la ligne de partage (watershed) des eaux. Ceci se produit lorsque l'intensité et la charge de pollution avec le temps dépassent la capacité du fleuve à « se nettoyer ». Les données étudiées étaient constituées de 3854 entrées de concentration sur les paramètres de qualité de l'eau. Ces résultats ont été comparés avec différentes lignes directrices nationales et internationales sur la qualité de l'eau au niveau des différents paramètres et pour différentes utilisations finales de l'eau. Ceci comprend le maintien de la vie aquatique, la baignade, l'eau potable et l'irrigation. Les résultats des sédiments du fleuve ont également été comparés aux moyennes mondiales de référence et aux valeurs d'intervention danoises pour le sol et les sédiments.

35. Le bilan ci-dessous résume les pressions de pollution dans le BIL :

- Les pratiques de gestion des déchets ont été évaluées : les pratiques d'élimination des déchets aux niveaux municipal, industriel et médical ont été analysées au niveau des cinq zones, afin d'évaluer la menace que représente la gestion des déchets solides pour le cours inférieur du Litani et ses eaux de surface affluentes[1]. Les mauvaises pratiques de gestion, qui comprennent la combustion à ciel ouvert de déchets dangereux (les déchets industriels, agricoles et médicaux, ainsi que les déchets ménagers dangereux) et non dangereux (les déchets ménagers), entraînent des émissions non maîtrisées dans l'air, le sol et l'eau, ce qui représente une menace pour la qualité de l'eau du fleuve et pour l'écologie à cause des effets de la lixiviation.

- Les pratiques de gestion des eaux usées sont le plus important contributeur à la qualité de l'eau du cours inférieur du Litani. De plus, l'infrastructure de collecte et de traitement des eaux usées dans les zones urbaines est inadéquate et représente la plus grande menace pour la qualité d'eau du cours inférieur du Litani. Les eaux usées provenant des établissements médicaux sont d'une qualité similaire à celle des eaux usées urbaines, mais elles peuvent également contenir différents composants potentiellement dangereux. Il existe quatre hôpitaux (3 publics et 1 privé) dans le secteur d'étude qui doivent être recensés/audités pour vérifier que leurs flux de déchets et d'eaux usées ne contiennent pas de substances dangereuses. Pour ce qui est des eaux usées industrielles, la zone d'étude comprend des usines (principalement des moulins à huile d'olives, la taille de pierre et la fabrication de parpaings) qui produisent des effluents chargés de polluants organiques évacués jusqu'à l'eau de surface sans aucun traitement préalable, via les affluents voisins ou les réseaux d'égouts existants. Les établissements non industriels, classés ou non classés, qui déversent leurs déchets et leurs eaux usées, sont surtout des petites entreprises telles que des stations-services, des fermes, des garages, des stations de lavage et des boucheries qui produisent des déchets et des eaux usées. Viennent s'ajouter à la liste les carrières (surtout les carrières de sable) situées à proximité (à moins de 500 m) des cours du Litani et de ses affluents, notamment en zone 2. De plus, les établissements de récréation, consistant surtout de restaurants, se trouvent le long du fleuve, sur une distance totale de 5,7 km, suivis des fermes. Les principaux flux de polluants provenant des établissements de récréation sont constitués d'ordures et d'eaux usées municipales ou domestiques. 145 empiètements (dans une zone tampon de 10 mètres du cours du BIL) par plusieurs types d'établissements de récréation ont été enregistrés dans 28 localités de sept districts, recouvrant 11% de la longueur du fleuve ou 9,5 km au total.
- La pression de pollution provenant des 384 implantations sauvages abritant 2005 réfugiés, qui se situent dans le BIL, est considérée basse dans toutes les zones du secteur d'étude.
- Les activités agricoles représentent une source de pollution principale non ponctuelle. Elles sont l'une des activités économiques principales du BIL. Les principaux composants du ruissellement agricole et des infiltrations d'eau sont les produits chimiques agricoles (les engrais) et les pesticides non dégradables qui finissent dans les cours d'eau à cause de surplus d'irrigation ou de percolation profonde. Une préoccupation principale est due à l'utilisation de pesticides, où plusieurs pesticides sont utilisés en quantités qui dépassent les dosages recommandés.

RÉPONSES ET MESURES D'ATTÉNUATION POSSIBLES

36. Une approche axée sur les priorités est recommandée pour remédier aux sources de pollution. La priorité de la pression de pollution peut être déterminée en fonction de son impact qui se traduit dans la qualité de l'eau et des sédiments. Selon les documents disponibles et les études examinées, les déchets solides et les eaux usées sont les sources les plus préoccupantes, suivies des déchets industriels (moulins à huile d'olives, taille de

pierre et lavage de sable) et de l'agriculture irriguée. Par conséquent, les mesures d'atténuation considérées doivent être soigneusement évaluées par secteur (déchets solides, eaux usées, implantations sauvages, etc.) et par zone.

37. Les investissements dans l'infrastructure, alloués en vertu de la loi No. 63/2016, devraient contribuer directement (eaux usées) et indirectement à l'amélioration des conditions environnementales dans le cours inférieur du Litani. Les coûts des mesures proposées sont résumés dans le Tableau 1 ci-dessous.

Tableau 1 - Coûts des mesures proposées dans les zones

Secteur	Coût total (en USD)
Déchets solides municipaux	24 204 250
Eaux usées municipales	34 341 000
Eaux usées industrielles	2 622 000
Amélioration de l'agriculture	2 570 000
Interventions intersectorielles et liées à la gouvernance	12 300 000
Total (en USD)	**76 037 250**

LES DÉCHETS SOLIDES

38. Il est essentiel de s'intéresser au fonctionnement de tous les sites de décharge (en considérant la zone 5 prioritaire) qui contribuent à l'altération des rives du Litani. D'où l'incitation à mettre en place et en œuvre des initiatives et des alternatives réalistes et adéquates pour la gestion des déchets. Heureusement, il existe déjà des initiatives en place ou en cours de construction pour la gestion des déchets solides dans les zones 1 à 5, mais il manque des décharges sanitaires supplémentaires. Dans le cadre du programme SWAM I financé par l'UE (Programme de Gestion des Déchets Solides) et du programme PROMARE (Protection et Développement Durable des Ressources Maritimes) en cours, certains projets sont en cours, tandis que d'autres manquent de financement après l'annulation des projets du SWAM II (Tableau 2).

Tableau 2 - Projets prévus pour la gestion des déchets solides dans les zones 1 à 5

Zone	Description du projet	Source de financement	Montant estimé	Situation
3 et 4	Construction d'une décharge sanitaire à Nabatiye	Non disponible	2 177 000 €	Projet en attente suite à l'annulation de SWAM II
	Construction d'une installation de tri et de compostage pour Bent Jbayl et Marjaayoun	Non disponible	2 135 000 €	Projet en attente suite à l'annulation de SWAM II
	Construction d'une décharge sanitaire pour Bent Jbayl et Marjaayoun	Non disponible	2 471 000 €	Projet en attente suite à l'annulation de SWAM II
5	Réhabilitation de la décharge de Ras el Ain à Tyr	Non disponible	4 424 000 €	Projet en attente suite à l'annulation de SWAM II

Zone	Description du projet	Source de financement	Montant estimé	Situation
	Construction d'une installation de tri et de compostage à Sahel El Zahrani	PROMARE (UE)	Non disponible	Projet en cours d'étude et de planification

39. Les réponses supplémentaires proposées afin de gérer les pressions de pollution résultant des déchets solides dans chaque zone du BIL sont présentées dans le Tableau 3. Cependant, les déversements et l'évacuation directs des déchets dans le fleuve doivent être complètement interdits par les forces de l'ordre en parallèle avec des activités de sensibilisation au niveau local.

Tableau 3 - Réponses proposées pour la gestion des déchets solides dans les zones 1 à 5

Zone	Réponse proposée	Montant estimé
1 et 2	Exploitation et entretien du complexe de gestion des déchets solides de Joub Jannine.	1,2 millions de Dollars pour l'exploitation et l'entretien annuels
	Cesser le déversement des déchets dans les décharges de Majdel Balhis, Sohmor, Ain Et Tineh et Rihane Jezzine et transporter les déchets à la nouvelle décharge sanitaire de Joub Jannine	71 500 $
	Ou fermer les décharges mentionnées ci-dessus (déterrer, doubler, recouvrir et fermer)	34 000 $
3 et 4	Construction d'une décharge sanitaire pour le district de Nabatiye (capacité de 75 tonnes par jour) en complément de l'installation de tri et de compostage de Kfour	6,78 millions €
	Construction d'un complexe pour la gestion intégrée des déchets solides pour Bent Jbayl et Marjaayoun, y compris une installation de tri et de compostage (capacité de 250 tonnes par jour) et une décharge sanitaire (capacité de 100 tonnes par jour).	
	Cesser le déversement des déchets dans les décharges de Yohmor (Nabatiye), Aadchit el Qoussair, Bani Haiyane, Kounine, Deir Siriane, Houla et Rabb Et-Talatine et transporter les déchets aux décharges sanitaires de Nabatiye ou Bent Jbayl/Marjaayoun après leur mise en œuvre	133 500 $
	Ou fermer les décharges mentionnées ci-dessus (déterrer, doubler, recouvrir et fermer)	76 500 $
5	Construction d'une décharge sanitaire dans le district de Tyr et construction d'un nouveau complexe pour la gestion intégrée des déchets solides pour Sahel El Zahrani, y compris une installation de tri et de compostage (capacité de 150 tonnes par jour) et d'une décharge sanitaire (capacité de 75 tonnes par jour).	14,6 millions $
	Cesser le déversement des déchets dans les décharges de Borj Rahhal, Bedias, Deir Qanoun En-Nahr, Maaroub, Hmairi, Sir El Gharbiyeh et Srifa ; et transporter les déchets aux décharges sanitaires de Ras El Ain ou Sahel El Zahrani après leur mise en œuvre	139 000 $
	Ou fermer les décharges mentionnées ci-dessus (déterrer, doubler, recouvrir et fermer)	102 500 $
	Séparation adéquate des déchets médicaux, afin de réduire le volume de déchets infectieux ; Envoi des déchets infectieux séparés au centre de stérilisation d'Aabbassiyeh	-

LES EAUX USÉES

40. Les principales pressions de pollution ont été identifiées en croisant la pression de la population avec l'existence de sources d'approvisionnement en eau, que ce soit pour l'eau potable, l'irrigation ou des fins récréatives. La priorité absolue en termes de réponse est en effet celle des investissements dans l'infrastructure des eaux usées municipales (Tableau 4).

Tableau 4 - Investissements Proposés dans l'Infrastructure des Systèmes des Eaux Usées

Zone	Description du projet	Investissement en capital (USD)
1	Mener des études de faisabilité/conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour la station Zilaya d'épuration des eaux usées et pour la zone de service de Majdel Balhis	8 573 000
2	Evaluer l'étendue, l'état de fonctionnement et l'efficacité de traitement des systèmes de traitement des eaux usées de Rihane et Aaychiyeh	16 013 000
	Mettre en place des réseaux à Sejoud et les raccorder aux usines de traitement de Rihane et Aaychiyeh	
	Etudier la faisabilité de systèmes de collecte et de traitement des eaux usées pour les localités de Chbail, Mazraat Daraya et Qatrani	
	Mettre en place des réseaux dans les secteurs non desservis de Jdaideh, Dibbine, Blat, Bouyada, Qlaiaa et Borj El Mlouk et les raccorder à l'usine de Marjaayoun	
	Evaluer l'état de fonctionnement et l'efficacité de traitement de l'usine de Kaoukaba et compléter la couverture du réseau à Kaoukaba	
	Mener des études de faisabilité/conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour Aaramta et Kfar Houneh qui seront desservis par le système Sarafand. La localité de Zaoutar El Gharbiyeh dans la zone 3 peut être desservie par le système Sarafand.	
	Mener des études de faisabilité/ conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour Wadi El Jarmaq	
	Mener des études de faisabilité/ conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour Srayri, afin de desservir Srayri, Dellafi, Bourghos et Qelaya dans la zone 1	
3	Mener des études de faisabilité/ conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour Roummane, Kfar Tibnit et Arnoun, dans le cadre du système de traitement des eaux usées de Nabatiye	1 890 000
	Evaluer la couverture, l'état de fonctionnement et l'efficacité de traitement de l'usine Deir Mimas et évaluer l'élargissement du réseau jusqu'à Kfar Kila, Houra et Mazraat Doumiat	
	Etudier la faisabilité des réseaux de collecte à Zaoutar El Gharbiyeh et Mazraat El Hamra et le raccord à l'usine de traitement qui existe à Zaoutar Ech-Charqiyeh ou à l'usine de traitement de Sarafand. Construire, exploiter et entretenir le système de traitement et de collecte des eaux usées à Zaoutar	

Zone	Description du projet	Investissement en capital (USD)
4	Identifier les zones de service des systèmes de traitement des eaux usées de Wadi Slouki et Braiqeaa	4 040 000
	Mener des études de faisabilité/ conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour Maroun Er Ras, Aaytaroun, Blida, Kounine, Beit Yahoun, Mhaibib, Chaqra, Meiss Ej Jabal, Houla, Souaneh et Qalaouiyeh, ainsi que le raccordement de ces villages à l'usine de traitement prévue à Qaaqaaiyet El Jisr	
	Mettre en place des réseaux de collecte des eaux usées à Tiri et Aaynata et les raccorder à l'usine de traitement qui existe à Bent Jbayl	
	Compléter les réseaux de collecte des eaux usées à Soultaniyeh et Jmaijmeh et les raccorder à l'usine de traitement qui existe à Tibnine	
5	Elargir la couverture du réseau du système de traitement des eaux usées de Tyr, en le raccordant aux secteurs restants de Maaroub, Borj Rahhal, Ain Abou Abdallah, Deir Qanoun En-Nahr, Jennata, Bedias, Arzoun et les nouvelles localités de Bestiyat, Derdaghaiya, Chehour, Sir El Gharbiyeh, Kfar Dounine, Halloussiyeh, Tayr Falsay, Hmairi et Srifa	2 800 000
	Mener des études de faisabilité/ conception et construire/exploiter le système de traitement des eaux usées et les réseaux de collecte pour le système de traitement des eaux usées à Sarafand	
	Compléter les réseaux dans les deux localités de Zrariyeh et Kharayeb	
	Vérifier l'état du réseau à Kfar Sir et raccorder le réseau à l'usine de traitement qui existe à Kfar Sir	

41. Quant aux eaux usées industrielles, les pressions sont saisonnières, mais elles ont cependant un grand impact sur la qualité d'eau du fleuve et, par conséquent, sur la vie aquatique. La majorité des industries qui produisent des eaux usées dans le BIL produisent à petite échelle et n'ont pas les moyens de traiter leurs eaux usées de manière individuelle, en raison de manque d'espace et de finances. La décision No. 8/1/2001 du Ministère de l'Environnement définit les normes de déversement des eaux usées dans le système d'égouts quxauelles les industries doivent se conformer. Afin d'y parvenir, les industries doivent (pré-)traiter leurs effluents industriels pour réduire la charge polluante jusqu'à un niveau acceptable. Les eaux usées peuvent par la suite être traitées dans une usine de traitement biologique. Le Tableau 5 présente les estimations des coûts de (pré-)traitement des effluents provenant des industries prioritaires.

Tableau 5 - Estimations des coûts de (pré-)traitement des effluents provenant des industries prioritaires

Zone	Industries prioritaires	Procédés par voie humide (décharge des effluents d'eaux usées)	Coût de (pré-)traitement (en USD)	Coût d'exploitation et d'entretien (en USD)	Coût des études (en USD)
Zone 1	11	Moulin à huile d'olives (9), taille de pierre (2)	600 000	90 000	57 000
Zone 2	1	Industrie laitière (1)	60 000	9 000	5 000
Zone 3	11	Moulin à huile d'olives (11)	520 000	78 000	42 000
Zone 4	9	Moulin à huile d'olives (7), taille de pierre (1), industrie laitière (1)	515 000	77 250	41 000

Zone	Industries prioritaires	Procédés par voie humide (décharge des effluents d'eaux usées)	Coût de (pré-)traitement (en USD)	Coût d'exploitation et d'entretien (en USD)	Coût des études (en USD)
Zone 5	14	Moulin à huile d'olives (9), taille de pierre (4), industrie chocolatière (1)	805 000	120 750	72 000
Total	**46**		**2 500 000**	**375 000**	**217 000**

42. Le Ministère de l'Environnement a mis en place le Projet LEPAP (Projet de Réduction de la Pollution Environnementale au Liban) qui vise à aider les entreprises industrielles libanaises à réduire la pollution et se conformer à la loi No. 444/2002 pour la protection de l'environnement, en leur apportant une aide technique et des prêts bonifiés, leur permettant ainsi d'investir dans le traitement en aval et la prévention de la pollution.

43. Le projet LEPAP est une initiative commune entre le Ministère de l'Environnement, le Ministère des Finances, la Banque du Liban, la Banque Mondiale et la Coopération Italienne pour mettre en place un mécanisme permettant de financer la réduction de la pollution industrielle dans les entreprises industrielles ciblées et de fournir l'aide technique nécessaire pour garantir la réalisation et la durabilité de ces interventions.

44. En outre, d'autres secteurs dans le BIL sont également des sources de pression de pollution sur le fleuve Litani. Le Tableau 6 présente un résumé de ces secteurs et des mesures proposées pour minimiser ou éviter leurs effets polluants.

Tableau 6 - Réponses proposées pour les différents secteurs

Zone	Réponses proposées	Coût (en USD)
Santé	• Soutenir les établissements de santé en mettant en place des systèmes séparés pour la collecte des déchets et des eaux usées et en limitant strictement le déversement de liquides dangereux dans les égouts. • Conseiller les établissements de santé sur les systèmes de prétraitement (le traitement primaire, secondaire et tertiaire, la désinfection et la digestion anaérobie des boues) avant le déversement dans le réseau municipal d'eaux usées. • Les établissements de santé doivent faire en sorte que leur gestion des déchets évite de manière efficace le déversement de grandes quantités de produits chimiques toxiques, de produits pharmaceutiques, de radionucléides, de substances cytotoxiques et d'antibiotiques dans les égouts, en effectuant le traitement nécessaire • Mettre en place un programme de contrôle régulier des effluents dans les établissements de santé (la température, le pH, les matières en suspension, la demande biochimique en oxygène, la demande chimique en oxygène, les nitrates, le phosphore total et la bactérie E. coli) pour vérifier la conformité avec les normes de décharge en vigueur.	100 000
Etablissements non industriels classés et non classés	• Les autorités locales devraient contrôler la conformité environnementale et surveiller les activités opérationnelles des établissements	250 000

Zone	Réponses proposées	Coût (en USD)
	• Formation et développement des capacités pour les fonctionnaires locaux et la police locale en matière de réglementation sur l'environnement. • Evènements médiatiques axés sur le commerce et aide technique ciblée, afin de sensibiliser le public sur l'hygiène publique simple et les mesures de conservation des ressources.	
Carrières	• Application de la législation pertinente, afin de s'assurer que les activités des carrières ne causent aucun préjudice indu à des tiers et à l'écologie du fleuve.	--
Etablissements de récréation	• Clarification du domaine public du fleuve auprès de la Direction Générale de l'Urbanisme, le Ministère de l'Energie et de l'Eau et la LRA (Autorité du Fleuve Litani) et prévention des transgressions • Application des règles des distances de recul, le cas échéant, en demandant et ensuite imposant la démolition des structures bâties qui empiètent sur le domaine public et sur les cours du Litani et de ses affluents, notamment lorsque ces structures altèrent le régime d'écoulement du fleuve. • Mettre en place des lignes directrices et des paramètres opérationnels pour les établissements de récréation de différentes tailles et activités, à suivre dans la gestion des eaux usées et des déchets solides • Surveiller la mise en œuvre de ces mesures par un procédé de détention des décharges, dans le cadre duquel les installations doivent engager des services de collecte de déchets et d'eaux usées pour transporter leurs déchets et eaux usées aux installations de traitement les plus proches. Les municipalités doivent tenir des registres et imposer la conformité avec ce procédé . • Mettre en œuvre une politique stricte de non décharge de déchets solides, de déchets sauvages et d'eaux usées dans le fleuve, avec un système de sanctions.	530 000
Implantations sauvages	• S'assurer que les décharges de déchets et d'eaux usées sont correctement dirigées vers les systèmes de collecte et de traitement officiels et existants. • Les organismes humanitaires vérifient la conformité des implantations sauvages avec les lois nationales et locales et coordonnent les efforts avec les autorités locales et les organismes gouvernementaux pour éviter la charge de nettoyage des déchets et la transgression sur les droits de propriété.	--

LE SECTEUR AGRICOLE

45. L'analyse a montré que l'agriculture ne représente pas une pression importante sur la pollution du fleuve dans le BIL. Cependant, une surutilisation de pesticides et d'engrais a été constatée dans toutes les récoltes. Ainsi, les rejets agricoles contribuent éventuellement à la pollution du fleuve et à la pollution des nappes phréatiques et du sol.

46. En s'intéressant à la pollution résultant de l'agriculture, la qualité de l'eau de surface s'améliorerait avec le temps, ce qui aurait des conséquences positives sur la qualité de

l'eau d'irrigation. Les réponses proposées pour lutter contre la pollution résultant des pratiques agricoles sont d'ordre général et s'appliquent à toutes les zones. Plusieurs réponses peuvent être mises en œuvre pour limiter les pressions de pollution résultant de l'agriculture. Elles comprennent, à titre d'exemple, celles présentées dans le Tableau 7. La réhabilitation écologique et des terrains (forêts ; pâturages ; carrières ; décharges de déchets ; terrains agricoles) permettrait de controler l'érosion des sols et le ruissellement de surface, ce qui diminuerait indirectement la contamination des eaux de surface par les ruissellements contaminés :

Tableau 7 - Quelques réponses proposées aux pressions de pollution résultant de l'agriculture

Réponse proposée	Coût (en USD)
Elaboration de programmes d'études pour la gestion intégrée des ravageurs (GIR) des récoltes de la région	180 000 (y compris les évaluations pertinentes : les pratiques courantes, les ravageurs existants et leurs ennemis naturels)
Introduction de nouvelles variétés/cultivars qui résistent aux maladies et aux pathogènes	
Familiarisation des agriculteurs avec les différentes techniques et les outils utilisés pour la gestion intégrée des ravageurs (GIR)	80 500
Etablir un système de collecte et d'élimination pour les conteneurs vides et les stocks périmés / non utilisés de pesticides : formation des agriculteurs ; collecte des conteneurs utilisés ; et recyclage :	180 500
Etablir des lots de démonstration dans plusieurs régions à travers le BIL ; et formation sur les Bonnes Pratiques Agricoles ; y compris la gestion intégrée des ravageurs (GIR)	219 000
Promotion des produits cultivés en adoptant les techniques de gestion intégrée des ravageurs et les bonnes pratiques agricoles	-
Formation sur les bonnes pratiques de manipulation, d'application et de conservation des produits agrochimiques	22 500
Réalisation de tests réguliers des résidus de pesticides sur les produits certifiés GIR (IPM), au cours de la saison de production	153 000
Estimation des charges de pollution en effectuant des échantillonnages et des analyses de sol et d'eau d'irrigation	84 000 + 99 500
Formation pratique sur la gestion de l'eau, l'hydrologie et la programmation de l'eau et l'utilisation des données agro-météorologiques	22 500
Identification des zones potentiellement sensibles, soit les zones vulnérables aux nitrates, et mise en place de restrictions pour les fermes à l'intérieur de ces zones quant à la quantité d'engrais azotés pouvant être utilisés	108 000
Estimation des changements dans l'utilisation et la couverture des sols entre deux cartes de base ou images satellites (ex: 2005 et 2020) ; de la productivité primaire nette ; et du carbone organique dans le sol	69 000
Evaluation écologique multi-saisonnière basée sur l'échantillonage tactique (quadrats et transectes du centre et des bords) sur une période allant jusqu'à 3 ans	35 000
Relevés topographiaues des carrières et études techniques afin de déterminer les exigences de réhabilitation des carrières en utilisant les déchets de construction et de démolition ainsi que les études d'impact environnemental liées	575 000

47. En plus des mesures ci-dessus, la mise en place d'un programme performant pour l'enregistrement des pesticides par le Ministère de l'Agriculture aiderait à contrôler la distribution et l'utilisation de pesticides.

MESURES INTERSECTORIELLES ET DE GOUVERNANCE

48. Le Tableau 8 présente les mesures intersectorielles et de gouvernance proposées pour le BIL, en fonction des entités responsables, du budget estimé et des activités actuelles et futures.

Tableau 8 - Mesures intersectorielles et de gouvernance proposées

Description de la mesure proposée	Entité responsable (entité de coordination)	Budget estimé	Activités actuelles et futures
Renforcement des procédures de gouvernance et d'imposition des dispositions des lois, de sorte à garantir la mise en œuvre efficace des mesures techniques.	La LRA et les Cours de Justice (toutes les parties prenantes)	2 000 000 $	Mise en œuvre d'une feuille de route pour le cours supérieur du Litani Procureurs spécialisés en causes relatives à l'environnement Police de l'environnement Formation de la police municipale
Systémisation et normalisation de la gestion des données, afin de bien mesurer, documenter et comprendre comment et où les mesures d'atténuation entraînent des améliorations. Mise en place d'une salle ou d'un système communs unifiés pour les données concernant toutes les pressions de pollution dans le bassin	La LRA (toutes les parties prenantes)	2 000 000 $	Aucune
Amélioration de la gestion de l'administration publique et de la coordination inter-agences, afin de réaliser les mesures proposées en développant les capacités.	Conseil des Ministres (toutes les parties prenantes)	2 000 000 $	Aucune
Systèmes de surveillance physiques et chimiques pour une base de référence pour la qualité de l'eau, l'équilibre de l'eau et l'écologie du fleuve	La LRA (Ministère de l'Energie et de l'Eau et Ministère de l'Environnement)	1 000 000 $	Aucune
Plan directeur pour le BIL et mise en place/mise à jour d'un zonage territorial qui déterminera les limites du fleuve et des affluents, ainsi que l'utilisation autorisée des terres (toutes les activités	La Direction Générale de l'Urbanisme (autorités locales, LRA et ministères de tutelle)	5 000 000 $	Plan directeur pour le cours supérieur du Litani

Description de la mesure proposée	Entité responsable (entité de coordination)	Budget estimé	Activités actuelles et futures
économiques) qui peuvent garantir l'intégrité du cours du fleuve (distances de recul) et la protection contre l'empiètement			

1. INTRODUCTION

1.1 CONTEXT AND GOAL OF THE CONSULTANCY

49. Earth Link and Advanced Resources Development s.a.l. (ELARD) signed a contract with the Council for Development and Reconstruction (CDR) to provide consultancy services for the preparation of a Business Plan for Combating Pollution in the Lower Litani River Basin (LLB), Lebanon.

50. In the year 2016, the Parliament adopted Law No. 63 on budgeting provisions for the execution of pollution-curbing projects – and their associated expropriations – in the Litani River basin from its source to mouth. The execution of these projects serves to implement the roadmap for combating sources of pollution of the Litani River, from its source to Lake Qaraaoun, and which resulted from the preparation of the Business Plan for Combating of the Upper Litani River Basin and the Qaraaoun Lake in 2010-2011. The Business Plan for Combating Pollution in the Lower Litani River Basin complements the 2011 study.

51. The aim of this consultancy is to provide technical support for effective desk and field data collection and analysis, and stakeholder engagement, leading to the design and preparation of a Business Plan for Combating Pollution of the Lower Litani River Basin.

52. The Consultant shall assist the Government of Lebanon, represented by the Council for Development and Reconstruction and the Ministry of Environment, in identifying the pollution sources in the Lower Litani River Basin – and recommending well-fitted solutions in the form of this Business Plan that will serve as a tool for informed decision making.

1.2 OBJECTIVES AND STRUCTURE OF THE BUSINESS PLAN REPORT

53. This Business Plan Report:

- describes background information on the Study Area from the administrative, geographical, geological and hydrogeological, and hydrological perspectives;
- presents the complete findings from the desktop and field data collection on the pollution pressures and sources in the Lower Litani Basin Study Area in the form of tables and maps;
- diagnoses identified pressures and pollution sources based on thorough analyses of collected data and analysis of the overall quality of the River water;
- outlines the existing institutional/administrative, legal, and financial enabling environment, along with the current and prospective initiatives towards pollution abatement;
- presents sector-specific responses tailored to the identified pressures in the Study Area while presenting the existing and planned projects, which are proposed to be complemented by the suggested measures; and
- gives a roadmap for the prioritized and staged implementation of the proposed measures to be used as a decision-making tool.

54. Appendices are included in this Business Plan Report for further elaboration on the methodologies and background data used to arrive at the analyses in all sections of this document, and comprise:

- Geological and water resources map of the Lower Litani Basin Study;
- Municipal, Farmers', and Agricultural Input Suppliers' Questionnaires;
- Socio-economic and Environmental Profiles of Study Zones;
- Operating Industrial & Classified Establishments in the Study Area;
- Types, Application Rates, and Assessment of Pesticide and Fertilizer Use in Study Area;
- Methodology for Analysis of the Data in the Database of Past River Water and Sediment Analysis Results + Summary of Data Analysis;
- Confirmatory and Complementary Sampling Plan and Analysis of Results;
- Legal Mandates and Roles of Different Public and Private Stakeholders;
- Sources of National and Donor Funding;
- Cost Calculations.

2. LLB STUDY AREA CHARACTERISTICS

55. This section presents a description of the Lower Litani River Basin (LLB) in terms of its administrative, geographic, geologic-hydrogeological and hydrological characteristics, in addition to the annexures added to the LLB, and the LLB Study Zones, all making up the LLB Study Area.

2.1 ADMINISTRATIVE EXTENT

56. The Litani River, which is the largest and the longest river in Lebanon, rises from the Olleiq village, 10 km southwest of the city of Baalbeck, and flows 170 km in a south-western direction, passing through the Bekaa valley and the Qaraaoun Reservoir before it reaches the Mediterranean Sea in the area of Qasmiyeh in Tyre (Sour).

57. The Lower Litani Basin (LLB) extends over an area of 637.20 km^2, extending from the Qaraaoun Lake Dam wall to the River mouth, is distributed among the four Governorates of Mount Lebanon, Bekaa, Nabatiye and South Lebanon, and comprises: 10 Districts (or Cazas): Chouf (at Niha Mountain); West Bekaa; Rachaiya; Hasbaiya; Marjaayoun; Nabatiye; Bent Jbayl; Jezzine; Saida; and Tyre. A total of 99 municipalities and 7 mokhtars in villages without municipalities have jurisdiction over the 132 localities or villages within the Study Area. Most villages within the LLB have municipalities that are grouped into Unions:

- Union of Municipalities of Higher Chouf:	Niha
- Union of Municipalities of the (Qaraaoun) Lake (El Bouhayra):	Ain Et Tineh, Aaytanit, Baaloul, Libbaya, Loussia, Machghara, Maydoun, Qaraaoun, Qelaya, Sohmor, Yohmor, Zilaya
- Union of Municipalities of Jabal El-Sheikh:	Kaoukaba Bou Aarab, Kfar Michki (incl. Nabi Safa), Majdel Balhis, Rachaiya
- Union of Municipalities of Qalaaet El-Istiklal:	Mhaiydseh, Rafid
- Union of Municipalities of Jabal El-Rihane:	Aaramta, Aaychiyeh (incl. Mahmoudiyeh, Mazraat Ouazaaiyeh, Mazraat Zighrine), Jarmaq (incl. Demachqiyeh, Mazraat El Aarqoub, Mazraat Tamra), Rihane (incl. Mazraat Khallet Khazen, Mazraat Louzid (Louayziyeh), Mazraat Qrouh, Ouardiyeh), Sejoud
- Union of Municipalities of Al-Hasbani:	Bourghos, Dellafi, Hasbaiya, Kaoukaba, Mimess
- Union of Municipalities of Jabal Aamel:	Aadaysseh, Aadchit (Qoussair), Bani Haiyane, Blida, Borj Qalaouiyeh, Deir Siriane, Ghandouriyeh, Houla, Majdel Selm, Markaba, Meiss Ej Jabal, Qabrikha, Qantara, Rabb Et Talatine, Souaneh, Talloussa, Taybeh, Touline
- Union of Municipalities of El-Qalaa:	Jmaijmeh, Kfar Dounine, Qalaouiyeh, Safad El Battikh, Soultaniyeh
- Union of Municipalities of El-Chqif:	Aali Et Taher, Arnoun, Braiqeaa, Zaoutar Ech Charqiyeh (incl. Mazraart El Hamra); Kfar Roummane, Kfar Sir, Kfar Tibnit, Qaaqaaiyet Ej Jisr, Qsaibeh, Sir El Gharbiyeh, Yohmor, Zaoutar El Gharbiyeh
- Union of Municipalities of Bent Jbayl:	Aaytaroun, Aaynata, Baraachit, Beit Yahoun, Bent Jbayl, Chaqra, Kounine, Maroun Er Ras, Tiri

- Union of Municipalities of Higher Chouf:	Niha
- Union of Municipalities of Tyre (Sour) Caza:	Aabbassiyeh, Ain Abou Abdallah, Arzoun, Bedias, Borj Rahhal, Chehour, Deir Qanoun En-Nahr, Derdaghaiya, Halloussiyeh, Hmairi Sour, Jennata, Maaroub, Srifa (incl. Marnaba, Mazraat Tayr Semhat and Niha), Tayr Falsay & Touyari

58. The LLB Study Area was extended beyond the borders of the watershed area to include the full cadastral extent of villages, in order to emphasize the role of municipalities in regulating the sources of pollution in their areas of jurisdiction. The administrative and cadastral extents of the LLB Study Area are presented in Figure 2-1 and Figure 2-2. The LLB Study Area has a surface area of 791.56 km^2.

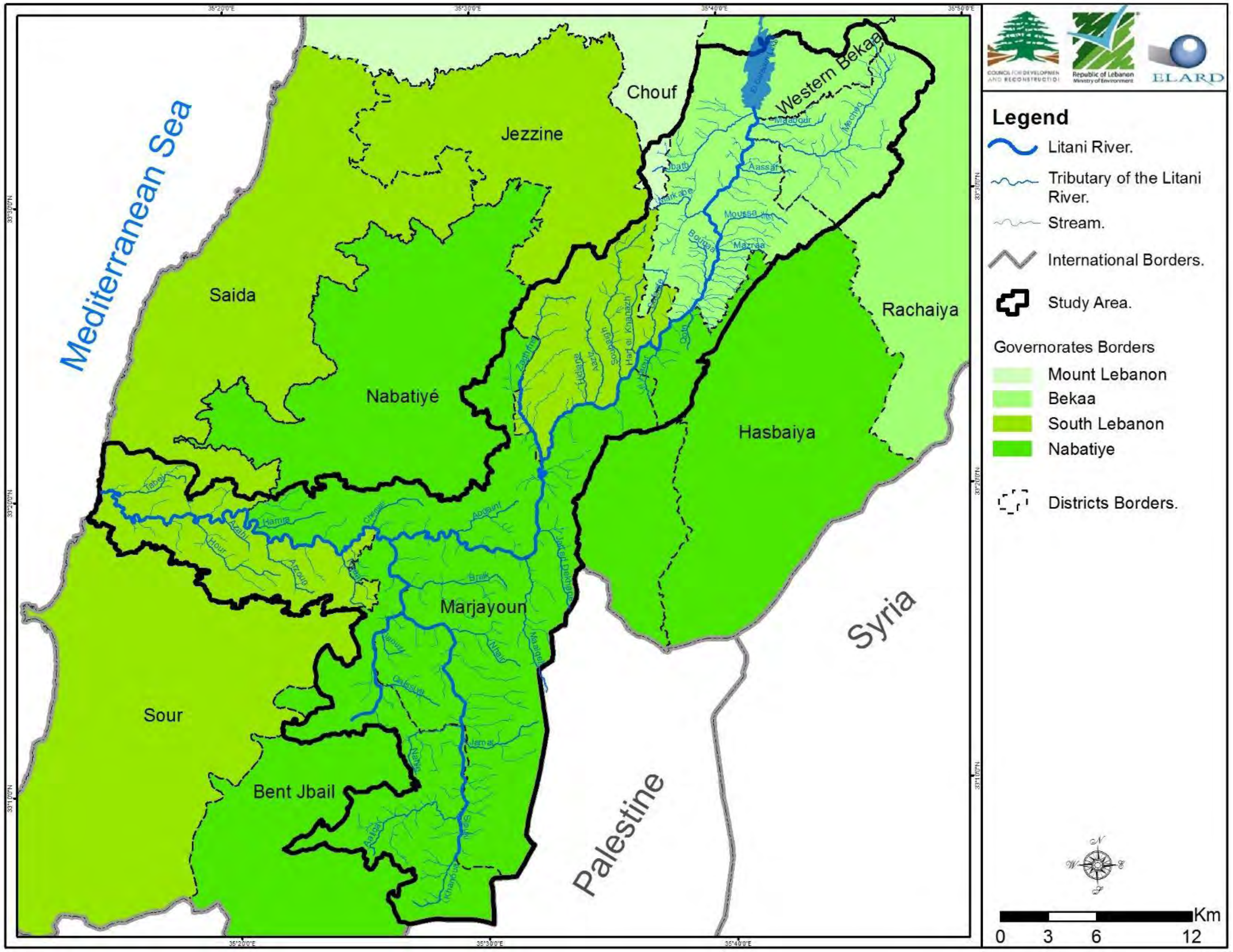


Figure 2-1. Administrative Map of the Lower Litani River Basin

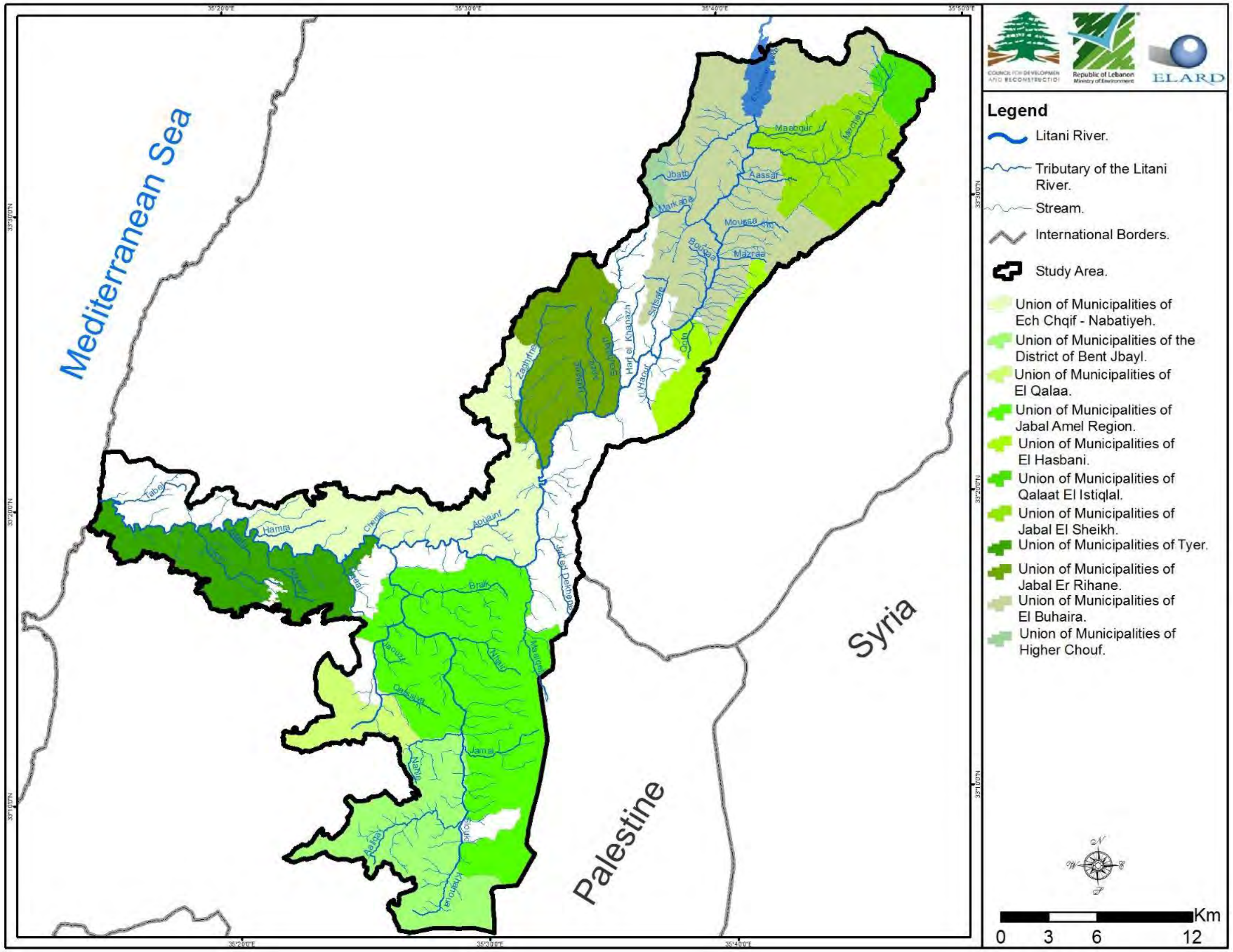


Figure 2-2. Unions of Municipalities within the Lower Litani River Basin

2.2 PHYSICAL GEOGRAPHY

59. The Lower Litani River is the central and southern extent of the Litani River starting at the Qaraaoun Dam and reaching the Mediterranean Sea at Qassmiyeh. The damming of the Litani River at Qaraaoun in 1959, led to the creation of the Qaraaoun Reservoir and interruption of the River's flow in its natural course south of the dam. Hence the River course beyond Qaraaoun dam is largely dry during the dry months, and is fed by tributaries and springs in the wet months of the year. Unlike the Upper Litani River, the Lower Litani River passes through steep valleys in the West Bekaa, Jezzine, Hasbaiya and Marjaayoun districts. As it flows past the Nabatiye and Marjaayoun districts, the terrain becomes flatter, and the River course is almost at sea level in the Tyre and Saida districts. The terrain through which the Lower Litani River meanders is shown in Figure 2-3.

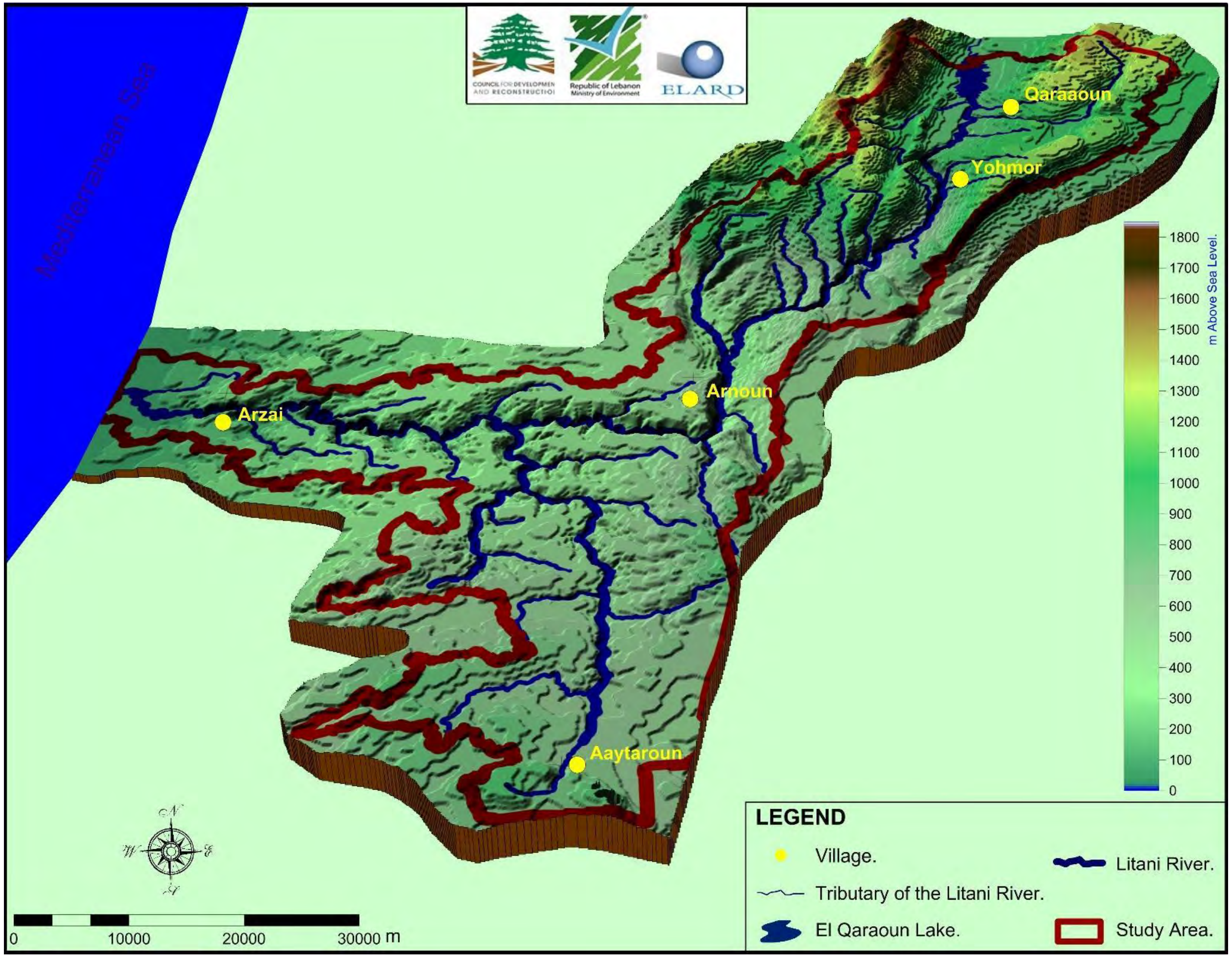


Figure 2-3. The Lower Litani River Basin in 3-D

2.3 LOWER LITANI RIVER BASIN & SUB-WATERSHEDS

60. The Lower Litani River Basin (LLB) was delineated on the basis of the surface watershed boundary of the Litani River, using 10 m contour lines for elevation and a Digital Elevation Model (DEM). The watershed area was further divided into 11 sub-watersheds containing one or more tributaries, based on different physical and administrative criteria, as shown in Figure 2-4.

61. The LLB receives water from various tributaries along its path. Each of the tributaries has its own drainage basin which was also delineated based on the topography and the use of a Digital Elevation Model (DEM). Tributaries' drainage basins were considered to form the boundaries of the sub-watersheds of the LLB. The sub-watersheds, their respective surface areas, and the tributaries draining each sub-watershed, are presented in Table 2-1 below. The total area drained by the Lower Litani River until it reaches the Mediterranean Sea at Qasmiyeh is 637.20 km^2.

62. It is to be noted that the terms basin, watershed, catchment, and drainage areas are used interchangeably throughout this document and refer to "an area surrounded by a continuous ridge within which all runoff is expected to join in a single stream"[1].

[1] Wilson, W.E & Moore, J.E. (ed.). 1998. "Glossary of Hydrology". American Geological Institute, Virginia, USA.

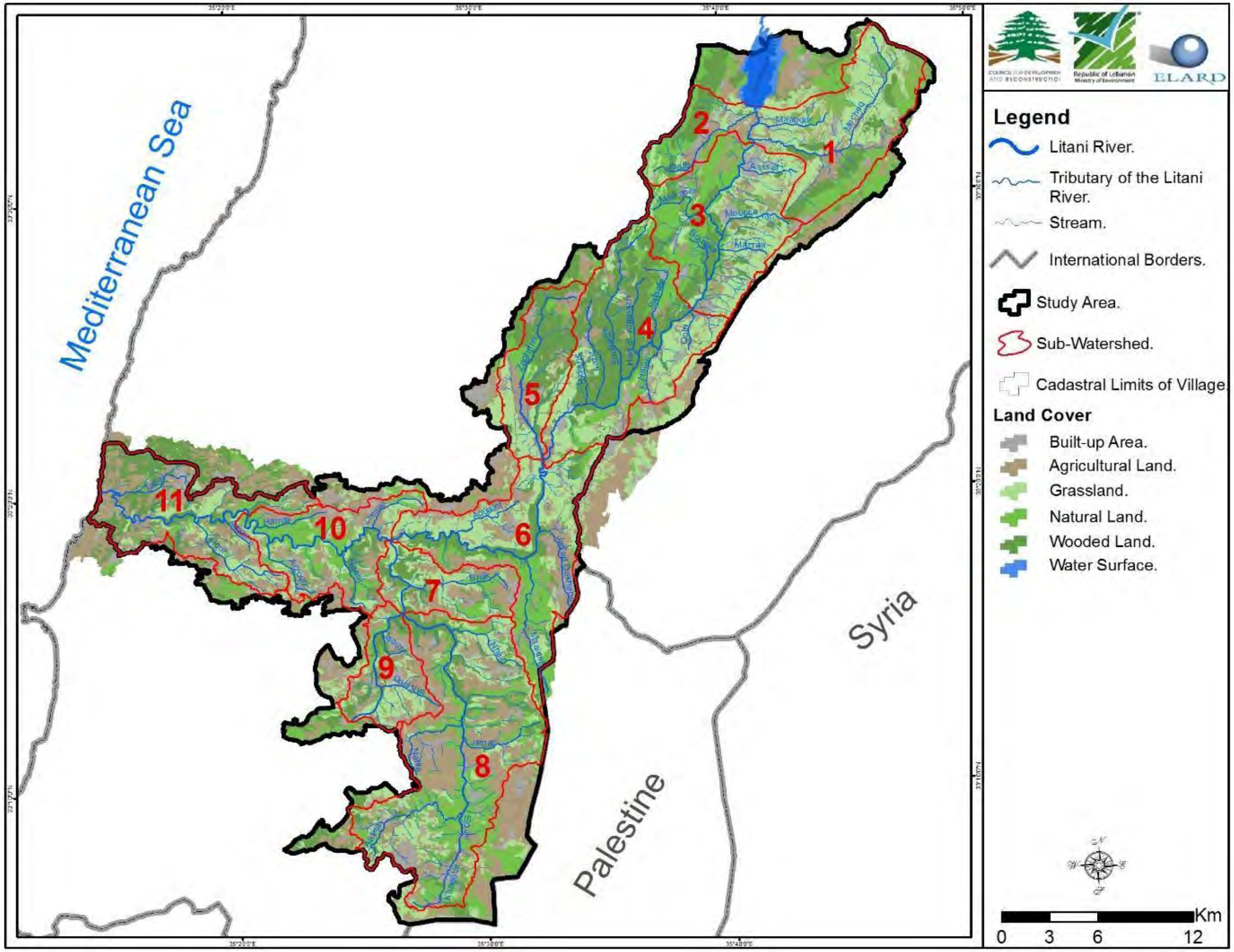


Figure 2-4. The Lower Litani River Basin, Sub-watersheds, Tributaries and Streams

Table 2-1. LLB Sub-Watersheds and their Respective Surface Areas and Tributaries

Sub-watershed	Sub-watershed Surface area (km^2)	Tributary name draining the Sub-watershed (*)
1	62.63	Maabour, Mecheq
2	20.93	Jbatb
3	71.55	Aassaf, Markabe, Moussa, Mazraa, Bouqaa
4	84.89	Qotn, Haour, Safsafe, Harf el Khanazh, Soubaigh, Aaziz, Hidiane
5	34.88	Zaghrfne
6	74.75	Jall ed Dekhene, Maaiqel, Aouainal
7	29.05	Braik
8	122.45	Khanoua, Slouki, Aaliqa, Jamal, Nahle, Nhair
9	27.85	Qalssiya, Jaouz
10	47.59	Chemali, Nqaai, Arzoun, Hamra
11	60.63	Azahi, Hour, Tabel

* Names of tributaries extracted from the Lebanese Army topographic maps of scale 1:20,000

63. At the northern and eastern limits of LLB, the surface watershed area boundary was extended further north, east and south to overlap with the area extent of the Eocene e2b geological Formation and aquifer where the e2b boundary falls outside the surface watershed, as shown in Figure 2-5. This is because groundwater in the e2b aquifer flows toward southeast on its western side and toward southwest in its eastern side because of its synclinal structure even when outside the surface watershed.

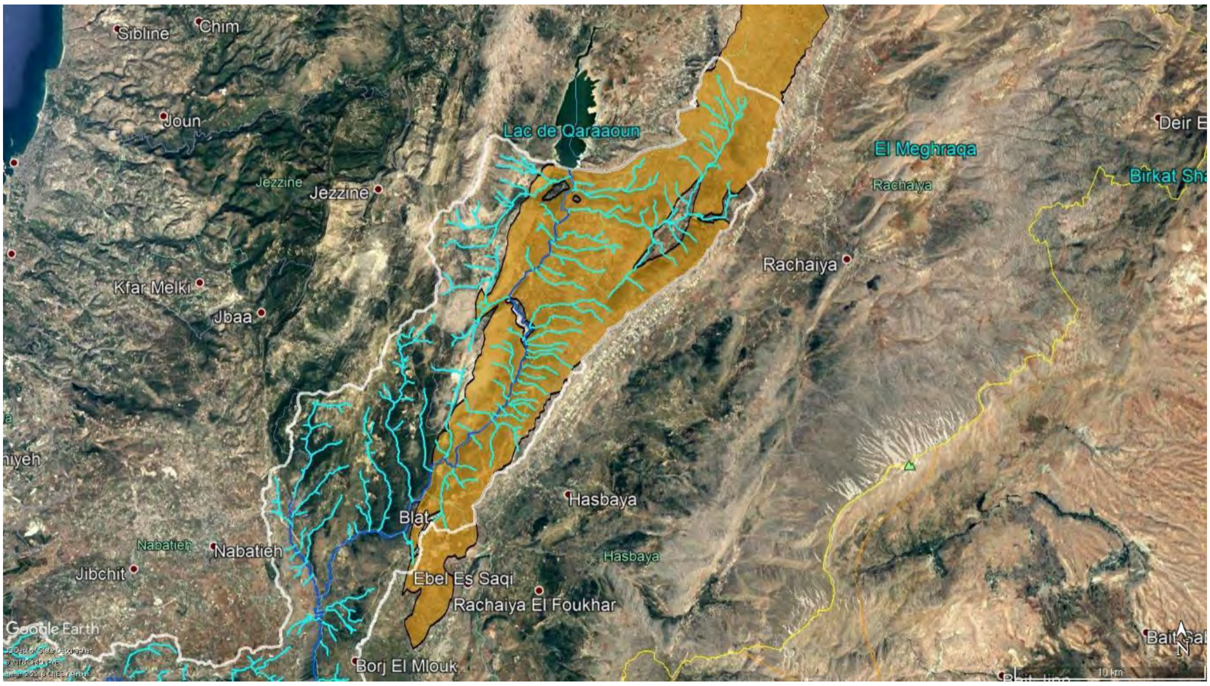


Figure 2-5. Google Earth Satellite Image showing Southern Eocene Bekaa Basin (4) in yellow shading and the Lower Litani River Hydrogeological Study Area Limit outlined in white

64. For the remainder of the LLB, the surface water divide mostly coincides with groundwater basin boundaries except for Naqoura-Sarafand Cretaceous Basin (19a) where groundwater flows towards southwest (Figure 2-6). This implies that the area up-gradient from where the Litani River cuts across Basin 19a extends mostly northeast and beyond the surface water divide between the Litani River and Abou Assouad River, which forms the adjacent watershed north of the Litani. However, groundwater in this portion of Basin 19a flows southwest and drains from the springs of Rachidiyeh and Tyre (Sour) rather than into the Litani River itself. This is supported by the fact that no significant springs are reported along the stretch of the Litani crossing Basin 19a between Ghandouriyeh in the east and Qasmiyeh Sea Mouth in the west; any small springs located on the right bank of the River are very likely to have small catchment areas falling within the surface watershed of the River. The Litani River is a losing stream across this section of its watershed whereby river water is recharging groundwater rather than the opposite as supported by historical river flow data, that are laid out in Section 2.4.3.

65. The total area of the Lower Litani River Basin, along with its extended areas, due to hydrogeological influences, measures 637.20 km².

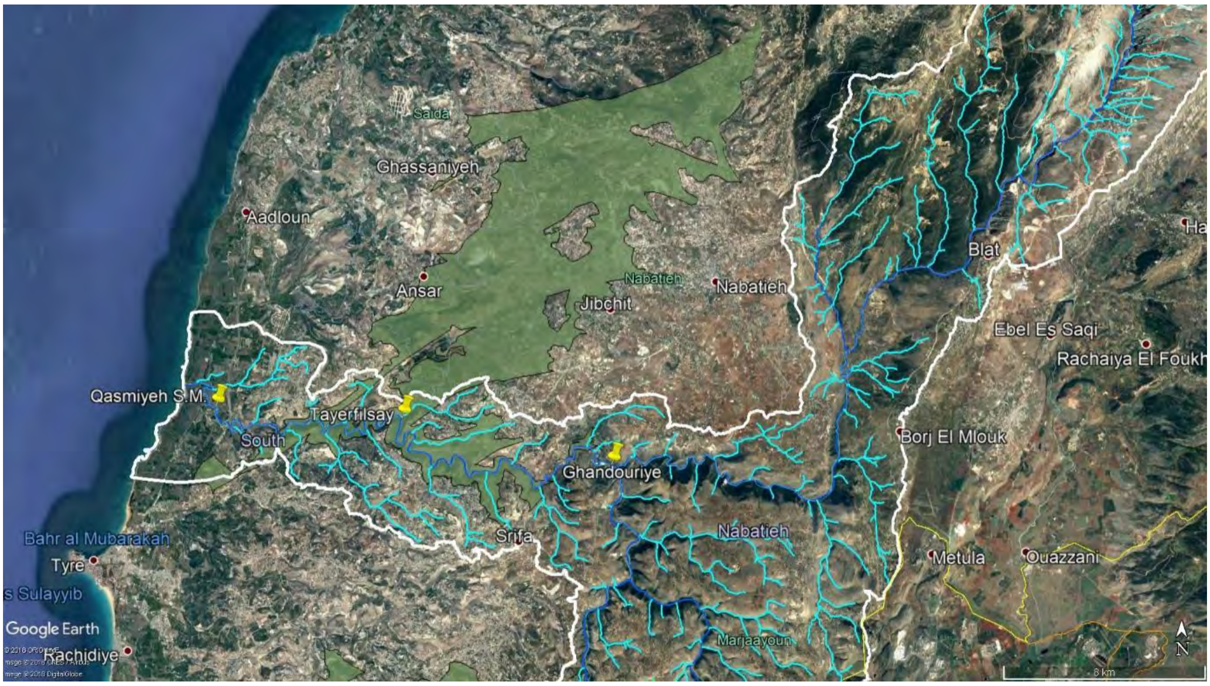


Figure 2-6. Google Earth Satellite Image showing Basin 19a in green shading, the Lower Litani River Hydrogeological Study Area boundary outlined in white, and three gauging stations along Litani River (Ghandouriyeh, Tayr falsay, and Qasmiyeh S.M))

The final surface area of the LLB Study Area, taking into consideration surface hydrology, hydrogeological infleunces, and administrative boundaries, is 791.56 km².

2.4 HYDROLOGY

66. This sub-section presents a brief highlight of the hydrology of the Lower Litani River and its watershed, based on a desk review of past hydrological studies and data collected during previous studies undertaken by ELARD related to the Litani River.

2.4.1 Water Inputs

2.4.1.1 Physical Data of the Watershed

67. The hypsometric curves of the LLB as well as of the different sub-watersheds were determined and illustrated in Figure 2-7. The highest point of the watershed is at around 1,800 masl in Machghara at the boundary of Niha (Chouf). Peaks that are above 1,400 masl, where snow constitutes a noteworthy water equivalent that contributes to the total precipitation volume (Aouad-Rizk *et al.*, 2005; UNDP, 2014), cover no more than 1.2% of the total LLB area. These peaks are contained in a single sub-watershed (SW-02), which has 24% of its surface area peaking above 1,400 masl. Snow is thus not a significant source of water in the LLB.

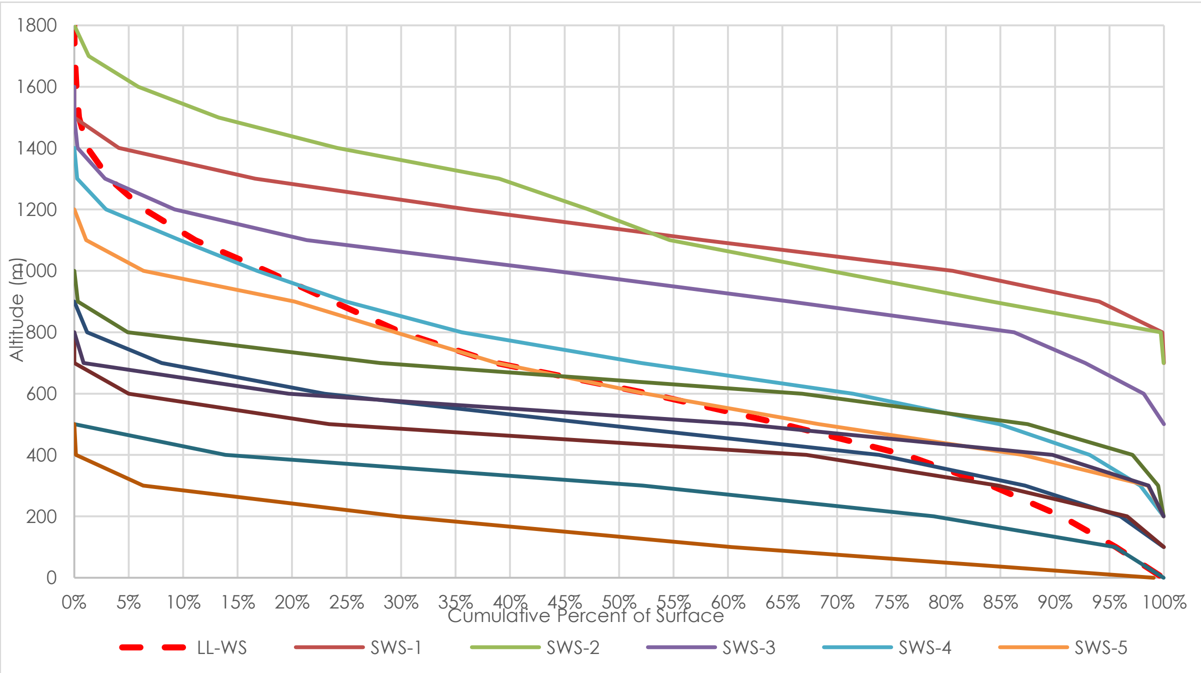


Figure 2-7. Hypsometry of the LLB and the 11 Sub-Watersheds

2.4.1.2 Tributaries

68. Lower Litani River receives flow from several small tributaries flowing from both sides of the main river course at several locations, as listed in Table 2-1 and shown in Figure 2-4.. The major tributary contributing to the Lower Litani is the Wadi Slouki/Wadi El Qalaouani tributary. Originating from Marjaayoun and Bent Jbayl and flowing in the north direction along the administrative border of these two districts. The Wadi Slouki tributary collects the Wadi Qalaouani tributary at Ghandouriyeh (Bent Jbayl) and continues north to join the main river course at Qaaqaaiyet Ej Jisr.

2.4.1.3 Springs

69. Additional flow is added to the Lower Litani River from about 150 springs discharging either directly into its watercourse or through a drainage stream. Ain ez Zarqa is the spring with the largest known discharge capacity in the Lower Litani Basin. It is noteworthy however that Ain ez Zarqa water is diverted from the river watercourse to supply water to nearby villages and to join the water flowing out of the Markaba / Abed el Aal Hydropower Plant and into the Jezzine Tunnel. Water from the Markaba / Abed El Aal Hydropower Plant is received from the Qaraaoun Reservoir through the Markaba Tunnel. Water in the Jezzine Tunnel is thus essentially water from the Qaraaoun Reservoir combined with water from Ain ez Zarqa. Jezzine Tunnel channels this flow to Anan Reservoir and the Awali Hydropower Plant.

70. During low river flow seasons, and when the flow to the Qassmiyeh/Ras El Ain Irrigation Scheme is reduced, the Litani River Authority opens a valve at the Jezzine Tunnel bypass (806 m downstream of Ain ez Zarqa) to let a controlled volume of water from the Qaraaoun Reservoir and Ain ez Zarqa flow from the Jezzine Tunnel and into the Litani River course.

71. South of Ain ez Zarqa there are around 130 springs feeding into the Lower Litani River, most of which are seasonal, and dry up during the summer months.

2.4.2 River Flow Regime

72. The temporal patterns of high and low flows are referred to collectively as a river's flow regime. The flow regime plays a key role in regulating geomorphic processes that shape river channels and floodplains, ecological processes that govern aquatic life, and is a major determinant of the biodiversity found in river ecosystems. River classification provides the foundation for comparing the hydrologic regimes of rivers and development of hydro-ecological relationships to inform environmental flow management and river restoration.

73. There are flow components that characterize the flow regime and factors that impact it. The characterizing flow components are as follows:

1. Magnitude: the total amount of flow at any given time
2. Frequency: how often flow exceeds or is below a given magnitude
3. Duration: how long flow exceeds or is below a given magnitude
4. Predictability: regularity of occurrence of different flow events
5. Rate of change or flashiness: how quickly flow changes from one magnitude to another

74. The flow-impacting factors are as follows:

1. Precipitation:

75. The amount and type of rainfall will affect a river's discharge. When precipitation comprises snow, infiltration and sublimation count more than surface runoff and the alimentation of the river is made progressively, except for when there is a sudden rise in temperature. When precipitation only comprises rain, which is the case of the LLB

that does not peak to high altitudes, the surface runoff is more abundant and will overflow onto land and reach the rivers. Floods may occur when the rain is heavy. Antecedent rainfall which is rain that has already happened in the same season, can make the earth become saturated so further rain will then flow as surface run-off towards the river. Heavy continual rain, or melting snow, means more water flowing into the river.

2. Land Use/Cover:

76. Trees and plants intercept and stop some of the rain from reaching the ground. Deforestation means less interception, so rain reaches the ground faster. The ground is likely to become saturated and surface run-off will increase. Bare soil and rocks speed up run off and reduces time lag. In urban areas, surfaces like roads are impermeable, where water cannot soak into the ground. Instead, it runs into drains, gathers speed and joins rainwater from other drains, eventually spilling into the river. In rural areas, ploughing up and down (instead of across) hillsides creates channels which allow rainwater to reach rivers faster increasing discharge.

3. Weather Conditions:

77. Temperature affects the form of precipitation. If it is very cold, which occurs at high altitudes, precipitation will form as snow. Hot dry weather can bake the soil, so that when it rains the water cannot soak in. Instead, it will run off the surface, straight into the river. High temperatures increase evaporation rates from water surfaces, and transpiration from plants, thus reducing discharge. Long periods of extreme cold weather can lead to frozen ground, so that water cannot soak in.

4. Slopes:

78. Steep slopes cause rapid surface runoff so water will reach the rivers quickly. Flat and gently sloping land may lead to water sinking into the soil. Steep slopes mean that rainwater is likely to run straight over the surface before it can infiltrate. On more gentle slopes infiltration is more likely.

79. While water surface profiles are influenced by the channel slope, flow profiles are also classified by the water surface slope. When the flow is uniform and steady these slopes are the same. Since critical and normal depths vary with flow, the slope classification is a function of change slopes classifications between mild, steep and critical slopes as streamflow changes.

5. Soil type:

80. Impermeable rocks are more closely packed and thus will not allow water to sink into the ground so it will speed up the runoff so that water reaches the river more quickly. Permeable soil, on the contrary, allow infiltration of water into the bedrock and absorb water easily which slows delivery of water into surface drainages and surface runoff is rare.

81. Pervious rocks (like limestone) allow water to pass through joints, and porous rocks (similar to chalk) have spaces between the rock particles. At watershed level, deep,

permeable soils watersheds will be able to absorb more precipitation than watersheds with thin, impermeable soils, and will thus tend to have less flashy floods of lower magnitude and longer duration.

6. Human intervention:

82. Dams and reservoirs are the biggest human interventions in river regimes. By holding back the discharge they reduce the downstream flow of water. Even though natural flow regimes can be somewhat variable between nearby watersheds, rivers in regions with similar climate, geology, and topography tend to have similar flow regimes. For example, rivers draining high mountains, such as the Mount Lebanon Western Slope Rivers, tend to have relatively infrequent, high magnitude, long duration, and predictable flood events that have a slow rate of change. In contrast, rivers in arid regions are often characterized by high magnitude, short duration floods of low predictability and high flashiness such as the streams in the Northern Beqaa.

83. Although general patterns in flow regime can be determined from watershed characteristics, yearly variation in precipitation patterns means that many years of flow monitoring will be required to fully characterize the flow regime of individual rivers.

84. Based on the different cited factors influencing the flow regime, that of the Lower Litani River will be studied to the extent possible.

2.4.2.1 <u>Precipitation</u>

85. Lebanon exhibits a temperate climate with heavy rain in the winter season, and dry and hot conditions during the rest of the year which is a typical pattern for the western shores of the Mediterranean. Nevertheless, these conditions vary along the country due to its topography (FORWARD, 2003). Accordingly, the Litani River catchment area, due to its spatial extent, has abundant water resources, a variety of microclimates, and different hydrologic characteristics. This is related to the diverse physical setting of the region, mainly the collection bowl formed by the Beqaa depression between the two chains of Mount Lebanon and the Anti-Lebanon Mountains (IDRC, 2007), in addition to the influence of the Syrian Desert to the North. This depression receives a considerable amount of the captured water directly from precipitation (rainfall and snow) on the mountain chains, mainly between December and February.

86. A substantial portion of the Litani River and its tributaries' freshwater sources, mainly in the upper catchment area, are stored temporarily in the form of snow. The upper part of the River and the springs flowing in the Beqaa are fed by snowmelt from the surrounding mountain chains. The Beqaa is characterised by the accumulation of a considerable amount of snow on the mountain peaks; above altitudes of 1,400 m, snowfall exceeds 60 days/year and is retained for several months. On the contrary, in the lower part, snow contribution is practically negligible.

87. Rainfall, Snow Water Equivalent, total Precipitation, Surface Runoff, direct Evapotranspiration and Infiltration estimation for four consecutive water cycles within the

Litani and the Lower Litani River Catchment are summarised in Table 2-2 as reported in the UNDP 2014 study.

Table 2-2. Hydrological Parameters for Four Water Cycles

		Litani River				Lower Litani River			
Area (Km^2)		**2,090**				**608**			
Year		**2008-2009**	**2009-2010**	**2010-2011**	**2011-2012**	**2008-2009**	**2009-2010**	**2010-2011**	**2011-2012**
Rainfall	**mm**	606	666	549	815	730	737	635	958
Snow		132	137	105	118	2	4	2	3
Precipitation		738	804	653	933	732	740	637	961
Runoff		132	231	142	219	128	232	168	249
Real Evapotranspiration		160	154	153	147	156	134	129	120
Infiltration		446	418	358	567	448	375	340	592
Rainfall	**Mm^3**	1,266	1,392	1,146	1,702	444	448	386	582
Snow		275	287	219	247	1	2	1	2
Precipitation		2,279	2,483	2,019	2,882	445	450	387	584
Runoff		275	483	297	458	78	141	102	151
Real Evapotranspiration		335	323	321	307	95	81	79	73
Infiltration		932	874	748	1184	272	228	206	360
Infiltration Rate	%	60	52	55	61	61	51	53	62

2.4.2.2 Land Use/Cover

88. The Land Cover/Use in the Lower Litani River Watershed is shown in Table 2-3.

89. Most of the watershed is covered by dense and clear natural wooded land (47%). Around 9% is covered by field crops in medium to large fields and around 8% by olive trees.

Table 2-3. Land Use/Cover of the Lower Litani Catchment Area

Type	Area (m^2 & % of watershed)	
Rock outcrop	114,396,740	17.95%
Citrus fruit trees	10,847,761	1.70%
Fruit trees	7,744,487	1.22%
Dense broadleaved wooded land	143,710	0.02%
Dense mixed wooded land	79,827	0.01%
Banana	7,345,708	1.15%
Port basin	45,812	0.01%
Field crops in medium to large fields	57,775,657	9.07%
Field crops in small fields/terraces	13,856,527	2.17%
Urban extension and/or construction site	469,073	0.07%
Clear broadleaved wooded land	38,099,029	5.98%
Dense oak forest	12,909,104	2.03%
Dense coniferous wooded land	979,245	0.15%
Sparse coniferous wooded land	6,575,203	1.03%
Clear mixed wooded land	8,733,445	1.37%
Dense mixed forest	6,335,393	0.99%
Large structures	324,495	0.05%
Large sports or leisure structures	72,097	0.01%
Hill Lake	144,989	0.02%
Urban sprawl on open field crop	15,431,545	2.42%
Urban sprawl on sparse forest	238,016	0.04%
Urban sprawl on field crops	12,164,341	1.91%
Urban sprawl on scrubland	613,305	0.10%
Olives	49,682,169	7.80%
Beaches	373,225	0.06%
Bare rocks	7,371,562	1.16%
Archaeological site	10,561	0.00%
Under shelter	1,709,116	0.27%
Abandoned farmland	6,964,520	1.09%
Vacant urban land	31,236	0.00%
Dense urban fabric	452,426	0.07%
Informal urban fabric moderately dense	173,422	0.03%
Low density informal urban fabric	37,360	0.01%
Moderately dense urban fabric	17,294,665	2.71%
Low density urban fabric	11,051,130	1.73%
Tree vegetation	5,077,967	0.80%
Scrubland with some dispersed bigger trees	218,664,416	34.32%
Vineyards	2,510,901	0.39%
Industrial or commercial zone	472,888	0.07%

Type	Area (m² & % of watershed)	
Grand Total	**637,203,071**	**100.00%**

2.4.2.3 *Weather Conditions*

90. Average air temperature varies considerably in the Lower Litani Watershed from coastal part to mountainous and internal zones.

91. Monthly average temperature levels recorded between 2004 and 2011 at the stations operated by the Lebanese Meteorological Department in different locations in the watershed are summarized in Table 2-4 and illustrated in Figure 2-8.

Table 2-4. Monthly Average Temperatures Recorded at Different Locations in the Watershed

	Qaraaoun	Jezzine	Sour	Qassmieh	Saida
Jan	4.14 °C	4.81 °C	9.06 °C	12.34 °C	12.25 °C
Feb	5.27 °C	5.09 °C	9.49 °C	13.71 °C	12.48 °C
Mar	7.73 °C	7.46 °C	10.75 °C	14.39 °C	14.29 °C
Apr	10.31 °C	10.58 °C	13.01 °C	16.43 °C	16.41 °C
May	13.32 °C	13.44 °C	15.65 °C	20.39 °C	19.10 °C
Jun	17.23 °C	17.07 °C	19.32 °C	24.46 °C	22.32 °C
Jul	19.32 °C	19.24 °C	22.66 °C	27.15 °C	25.03 °C
Aug	19.54 °C	19.92 °C	23.55 °C	27.26 °C	25.93 °C
Sept	17.53 °C	17.30 °C	21.66 °C	25.92 °C	25.23 °C
Oct	14.43 °C	15.16 °C	18.12 °C	21.49 °C	21.45 °C
Nov	8.70 °C	10.31 °C	12.63 °C	16.32 °C	16.86 °C
Dec	5.42 °C	6.57 °C	10.41 °C	13.38 °C	14.10 °C

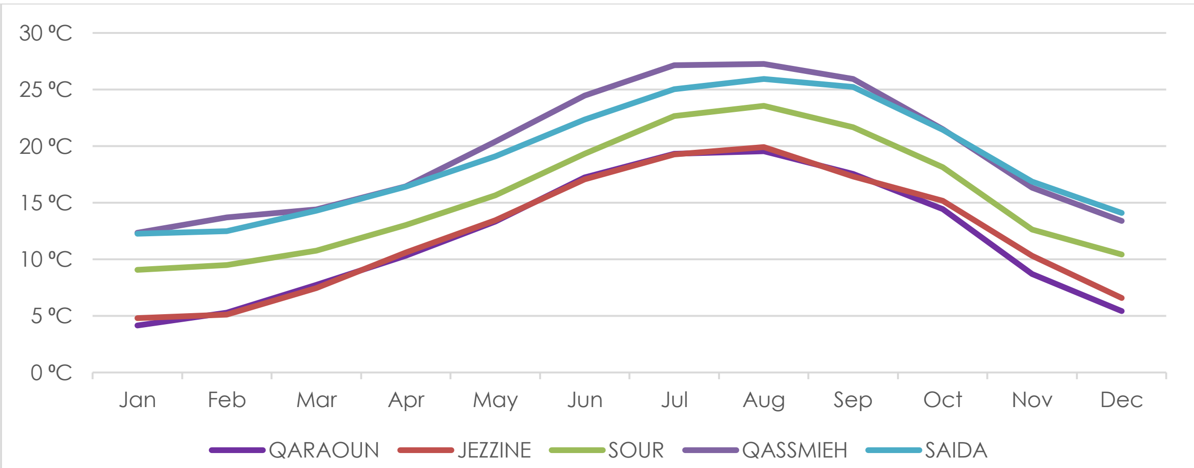


Figure 2-8. Monthly Average Temperatures Recorded at Different Locations in the Watershed

2.4.2.4 *Slope*

92. Slopes are divided into types ranging from type 1 (0 to 12% or 0° to 7°) to type 5 (more than 50% or 45°) as detailed in Table 2-5.

Table 2-5. Types of Slopes

Type	Percentage Range	Degrees Range
1	0-12%	0-7°
2	13-20%	7-12°
3	21-35%	12-20°
4	36-50%	20-45°
5	>50%	>45°

2.4.2.4.1 Main Litani River Course

93. The average slope of the main watercourse is around 1% along the 86.8 km of its total length varying from 0% to 70% in some short and specific parts as illustrated in Figure 2-9 and detailed in Figure 2-10.

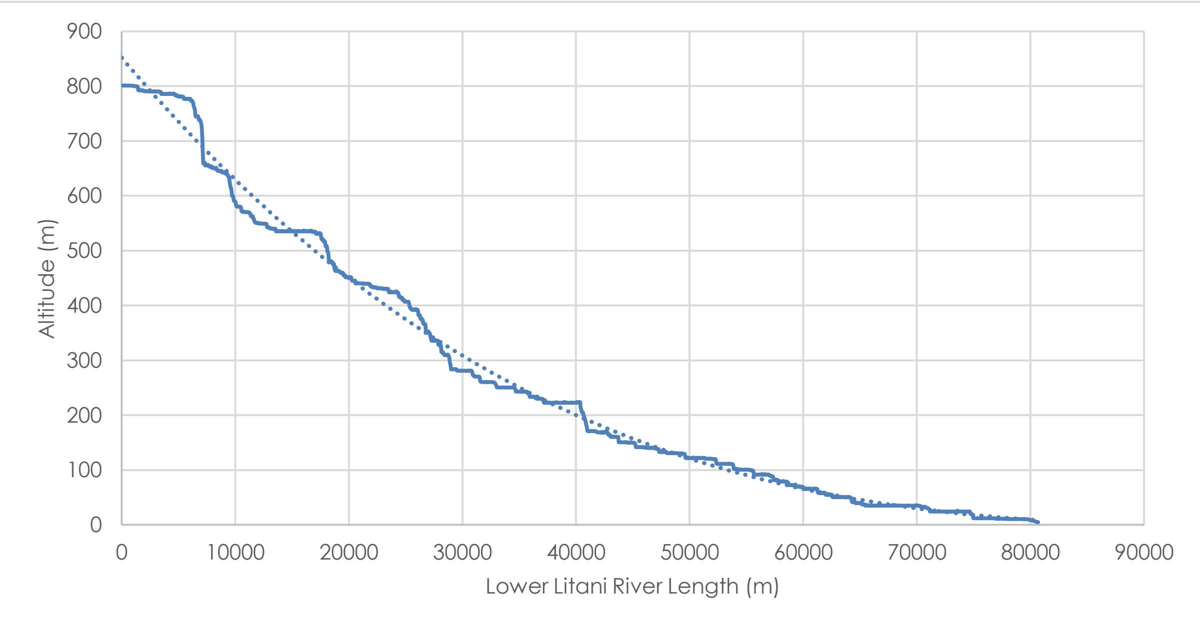


Figure 2-9. Profile of the Lower Litani Main River Course

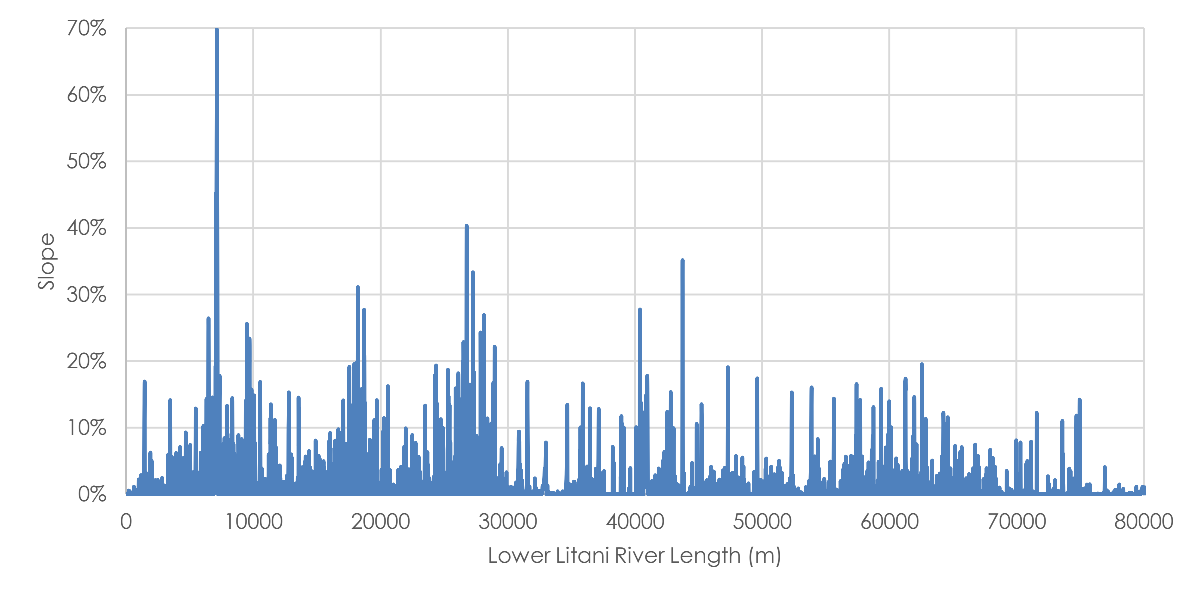


Figure 2-10. Lower Litani Main River Course Slopes

94. The section going from the coordinates (35.66639; 33.49986; 698.69) till (35.66640; 33.49952; 674.87) at the border of Yohmor and Machghara, along 40 m presents the steepest slope of the Lower Litani River, reaching around 70% (Type 5) as detailed in Table 2-6 and Figure 2-11.

Table 2-6. Type 5 Slope Segment of the Lower Litani

Point	Slope	Long	Lat	Z
773	53.08%	35.66639	33.49986	698.69
774	59.45%	35.66639	33.49978	693.1
775	69.83%	35.66640	33.49969	686.52
776	68.85%	35.66640	33.49961	680.04
777	54.95%	35.66640	33.49952	674.87

Figure 2-11. Location of Type5 Slope Segment of the Lower Litani

95. Another section is intercepted between two sections located between the coordinates (35.66637; 33.50028; 717.36) and (35.66636; 33.49929; 662.38), of length of around 40 m presenting less steep slope with an average of 40% as detailed in Figure 2-7 and Figure 2-12.

Table 2-7. Type 4 Slope Segments of the Lower Litani

Point	Slope	Long	Lat	Z
768	45.19%	35.66637	33.50028	717.36
769	37.13%	35.66637	33.50020	714.21
770	42.12%	35.66638	33.50011	710.63
771	40.97%	35.66638	33.50003	707.16
772	46.71%	35.66638	33.49994	703.2
778	49.63%	35.66641	33.49944	670.2
779	45.72%	35.66641	33.49935	665.9
780	37.40%	35.66636	33.49929	662.38

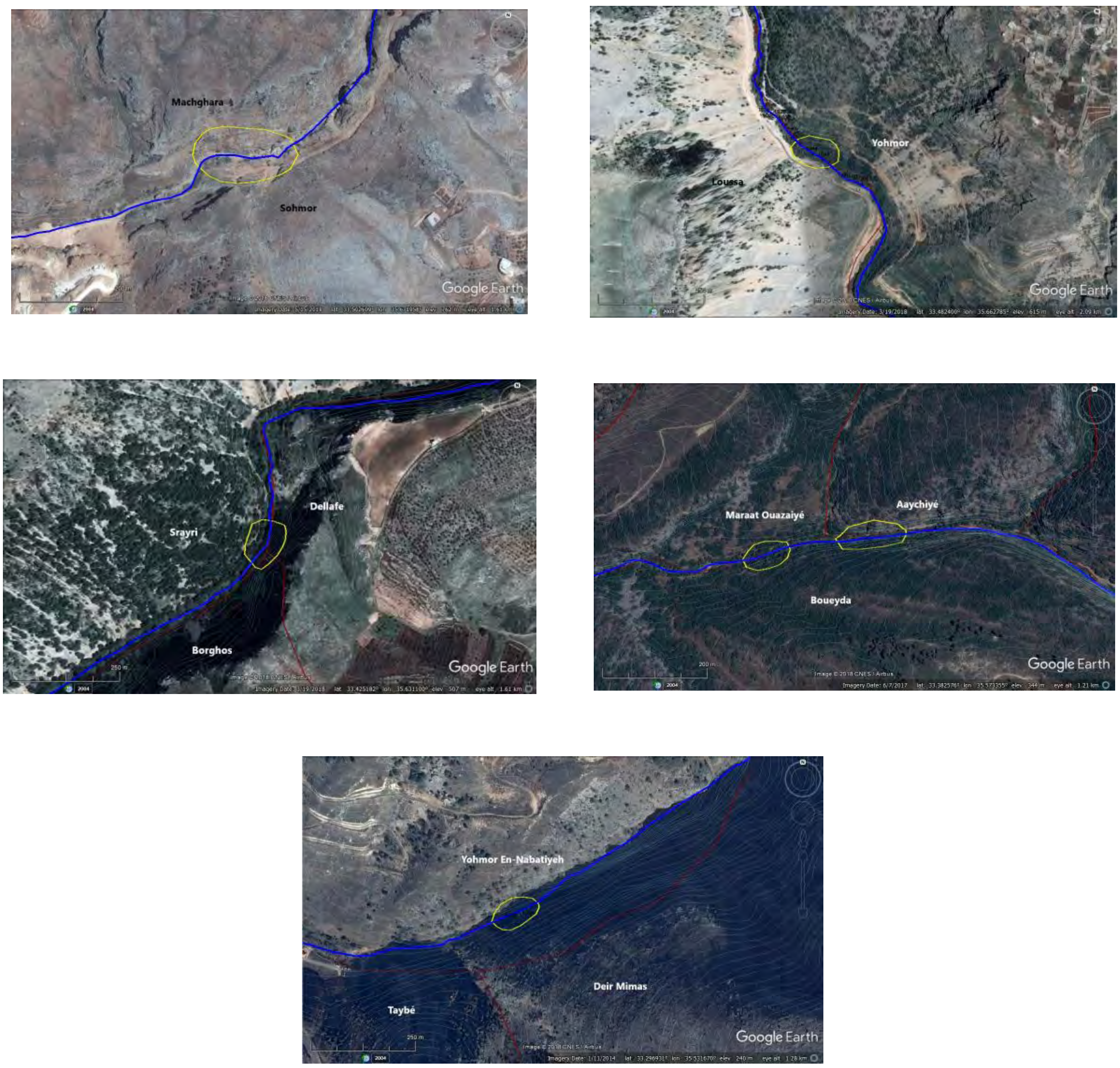


Figure 2-12. Location of Type 4 Slope Segment of the Lower Litani

96. Six other sections varying from 20 to 30 m of length located between Machghara and Sohmor, between Yohmor and Loussa, between Srayri and Bourghos, between Aaychiyeh and Bouayda and between Mazraat Ouazaiye and Bouayda in addition to a strip between Yohmor and Deir Mimas, as shown in Table 2-8 present slope of Type 3. Nine other sections varying from 30 to 70 m present slope of Type 2 as detailed in Table 2-9.

97. The remaining parts of the river flow at gentle slopes from the first type of less than 12%.

Table 2-8. Type 3 slope segments of the Lower Litani

Point	Slope	Long	Lat	Z
703	24.37%	35.67150	33.50281	753.63
704	26.42%	35.67140	33.50281	751.16
705	26.21%	35.67130	33.50281	748.72
706	23.41%	35.67120	33.50280	746.53
1044	23.38%	35.66138	33.48271	603.95
1045	22.87%	35.66148	33.48269	601.79
1046	21.00%	35.66156	33.48264	599.81
1970	29.55%	35.63087	33.42527	490.29
1971	31.11%	35.63081	33.42519	487.18
1972	29.81%	35.63076	33.42512	484.2
1973	24.35%	35.63070	33.42505	481.76
3000	24.29%	35.57412	33.38261	333.4
3001	20.17%	35.57402	33.38261	331.6
3002	20.17%	35.57392	33.38261	329.81
3029	25.42%	35.57127	33.38234	322.08
3030	26.91%	35.57118	33.38233	319.49
3031	24.71%	35.57108	33.38232	317.12
4342	25.23%	35.53083	33.29696	220.03
4343	26.13%	35.53074	33.29691	217.76
4344	27.74%	35.53066	33.29686	215.35
4345	20.64%	35.53058	33.29681	213.55

Table 2-9. Type 2 slope segments of the Lower Litani

Point	Slope	Long	Lat	Z
762	12.34%	35.66636	33.50078	730.87
763	12.10%	35.66635	33.50070	729.69
764	19.29%	35.66636	33.50062	727.82
765	12.13%	35.66636	33.50053	726.64
1024	19.75%	35.66000	33.48385	625.17
1025	18.73%	35.66007	33.48379	623.62
1026	16.86%	35.66015	33.48373	622.23

Point	Slope	Long	Lat	Z
1027	13.08%	35.66022	33.48368	621.16
1059	12.85%	35.66261	33.48199	596.83
1060	13.57%	35.66271	33.48198	595.49
1061	15.58%	35.66281	33.48197	593.95
1062	15.71%	35.66291	33.48195	592.41
1063	12.38%	35.66301	33.48194	591.19
1134	13.08%	35.66431	33.47787	576.53
1135	14.43%	35.66439	33.47783	575.13
1136	16.87%	35.66448	33.47778	573.49
1137	14.93%	35.66456	33.47774	572.3
1938	13.95%	35.63103	33.42782	513.45
1939	19.55%	35.63096	33.42776	511.71
1940	18.51%	35.63089	33.42769	510.06
1941	13.54%	35.63090	33.42761	508.86
1956	14.99%	35.63105	33.42639	504.2
1957	19.55%	35.63106	33.42630	502.36
1958	19.75%	35.63106	33.42622	500.5
1959	16.94%	35.63106	33.42614	498.9
2814	12.44%	35.59070	33.38148	388.94
2815	17.25%	35.59060	33.38147	387.23
2816	18.16%	35.59050	33.38146	385.43
2817	18.04%	35.59041	33.38145	383.64
2818	15.12%	35.59031	33.38144	382.15
3105	12.15%	35.56453	33.38061	305.89
3106	12.34%	35.56450	33.38052	304.74
3107	13.97%	35.56448	33.38044	303.44
3108	16.68%	35.56445	33.38036	301.89
3109	15.67%	35.56440	33.38029	300.43
3110	15.81%	35.56434	33.38023	298.95
3111	16.39%	35.56427	33.38017	297.41
3112	13.59%	35.56420	33.38011	296.13
6577	13.64%	35.37473	33.30510	64.22
6578	16.97%	35.37466	33.30504	62.71
6579	15.58%	35.37457	33.30503	61.31
6580	17.36%	35.37447	33.30504	59.76

2.4.2.4.2 Wadi Slouki/Wadi El Qalaouani Tributary Watercourse

98. Wadi Slouki/Wadi El Qalaouani tributary are at around 1.7% of homogeneous slope over the 35 km of combined length (25.7 km for Wadi Slouki and 9.3 for Wadi El Qalaouani) as illustrated in Figure 2-13.

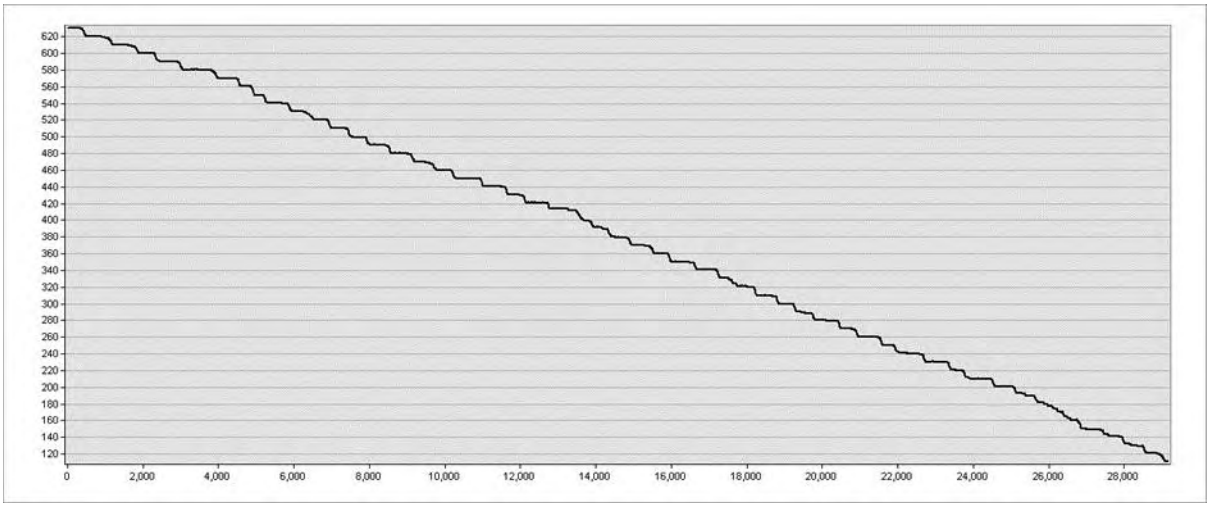


Figure 2-13. Profile of the Wadi Slouki/Wadi El Qalaouani Tributary Watercourse

2.4.2.5 <u>Soil Type</u>

99. The soil types prevalent in the Lower Litani River Watershed are detailed in Table 2-10.

100. More than 60% of the watershed soil is made of three soil types:

- Anthropic Regosols which can be used for capital-intensive irrigated farming but the most common land use is low volume grazing. Regosols in mountain areas are best left under forest.
- Humi-Eutric Cambisols which are developed in medium and fine-textured materials derived from a wide range of rocks, mostly in alluvial, colluvial and aeolian deposits, can make good agricultural land and are intensively used. Cambisols in temperate climates are among the most productive soils on earth.
- Lithic Leptosols which are very shallow soils over hard rock or highly calcareous material or a deeper soil that is extremely gravelly and/or stony. Leptosols are unattractive soils for rainfed agriculture because of their inability to hold water, but may sometimes have potential for tree crops or extensive grazing. Leptosols are best kept under forest.

Table 2-10. Soil Types of the Lower Litani Basin

Soil Type	Codes	Depth (cm)	% of Watershed Area
Lake	Lake		0.00%
Hypereutric Vertisols	VReuh	60-150	0.01%
Calcaric Cambisols	CMca	54-150	0.04%
Calcaro-Mollic Leptosols	LPmo-ca	20-35	0.04%

Soil Type	Codes	Depth (cm)	% of Watershed Area
Hypocalcaric Fluvisols and Haplic Vertisols	FLcaw/VRha	70-130	0.05%
Eutric Fluvisols and Eutric Vertisols	FLeu/VReu	42-180	0.06%
Rhodic Vertisols	VRro	90-150	0.08%
Luvic Calcisols	CLlv	130-150	0.10%
Andic Cambisols	CMan	65-100	0.15%
Cliffs	Cliffs		0.16%
Eutric Luvisols	LVeu	60-140	0.17%
Hyperskeletic Leptosols	LPhk	0-65	0.19%
Vertic Cambisols	CMvr	40-150	0.20%
Calcaric Fluvisols	FLca	65-150	0.20%
Calcaric Luvisols	LVca	120-160	0.22%
Haplic Luvisols and Leptic Luvisols	LVha/LVle	20-120	0.36%
Hypercalcaric Fluvisols and Hypereutric Vertisols	FLcah/VReuh	60-150	0.37%
Haplic Fluvisols	FLha	25-100	0.52%
Rendzic Leptosols	LPrz	0-65	0.67%
Haplic Calcisols	CLha	30-150	0.86%
Eutric Fluvisols	FLeu	60-180	0.95%
Lithic Leptosols, Leptic Luvisols and Eutric Luvisols	LPli/LVle/LVeu	0-140	0.99%
Leptic Andosols	ANle	0-45	1.07%
Calcaric Regosols and Rendzic Leptosols	RGca/LPrz	0-190	1.32%
Eutric Regosols	RGeu	30-150	1.33%
Eutric Gleysols	GLeu	80-150	1.69%
Calcaro-Hortic Anthrosols	ATht-ca	38-120	1.92%
Areno-Eutric Leptosols	LPeu-ar	0-50	3.31%
Leptic Luvisols	LVle	20-40	4.18%
Eutric Arenosols	AReu	60-150	4.40%
Calcaric Leptosols	LPca	0-45	5.17%
Calcaric Regosols	RGca	30-190	6.45%
Lithic Leptosols	LPli	0-30	16.17%
Humi-Eutric Cambisols	CMeu-hu	60-100	19.78%
Anthropic Regosols	RGah	50-100	26.81%
Grand Total			**100.00%**

2.4.2.6 Human Intervention

101. Besides the Qaraaoun Dam, there are currently two small dams along the Lower Litani River and a further two dams are planned for construction.

2.4.2.6.1 Qaraaoun Dam and Reservoir

102. Hydrologically, the Qaraaoun Lake has shown to be a dynamic system, as it receives major input from the Litani River and a minor inflow from underlying groundwater along extended faults and fractures in the Qaraaoun basin. Oxygen-18 and deuterium isotopes were used to investigate the interrelation between lake water and underlying groundwater. These two isotopes coupled with geochemical parameters have been used to determine the percentage of recharge and its areal extent, which is limited to the proximity of the dam in a southeast direction. As a result, Qaraaoun Lake was classified as monomictic with summer stratification. Nitrate enrichment in the bottom cold and dense lake water is a result of the stratification process in the summer season. Piezometers located far from the dam showed a gradual decrease in lake water seepage content (Saad *et al.*, 2009).

103. The Qaraaoun Dam characteristics are summarised in Table 2-11 (FORWARD, 2003; MENBO 2007, and Saad *et al.*, 2005).

Table 2-11. Qaraaoun Lake and Dam Characteristics

Designation	Value
Total length	1,090 meters
Height (from ground level)	62 meters
Altitude water level surface	858 meters
Maximum volume of the Lake	420 Mm^3
Useful volume of the Lake	220 Mm^3
Water used in irrigation and hydropower	160 Mm^3
Area	12.3 km^2
Width at top	6 meters
Width at bottom	162 meters
Concrete mask area	50,000 m^2

2.4.2.6.2 Ain ez Zarqa

104. Downstream of the Abed El Aal Hydropower Plant, and at the discharge point of Ain ez Zarqa, a dam was built (see Figure 2-14) to divert Ain ez Zarqa water into the Jezzine Tunnel, and to be distributed as drinking and service water to nearby villages. The presence of this dam prevents Ain ez Zarqa water to flow into the Lower Litani river course.

Figure 2-14. Dam at Ain ez Zarqa

2.4.2.6.3 LRA projects (Hydro-electrical Plants and Tunnels)

105. Some of the water stored in the Qaraaoun Reservoir is channeled through a series of tunnels to generate hydropower at three plants: Markaba / Abed El Aal Plant, Awali or Paul Arqash Plant and Joun or Charles Helou Plant.

106. Water is conveyed from the Qaraaoun Reservoir through the Markaba Tunnel, which extends 6,400 m underground along the right river bank. The tunnel has a maximum capacity of 22 m^3/sec. Water is used to generate power at the Abed El Aal Plant which has an overall power supply capacity of 34 MW.

107. On exit from the Abed El Aal Station turbines, water from the Qaraaoun Reservoir is conveyed through the Jezzine or Awali Tunnel, where it is joined with the water from Ain ez Zarqa. The 17-km tunnel crosses under Jabal Niha, and receives an annual average of 1 m^3/sec of water infiltrating from the tunnel ceiling. The water is collected in the Anan Lake which has a capacity ranging from 150,000 to 170,000 m^3, and then flows in a 400 m waterfall to the Awali Station to generate 108 MW of power.

108. Water discharged by the turbines of the Awali Plant, in addition to water flowing from Bisri River are collected in the Awali Pond which has a capacity of 300,000 m^3. Water is then conveyed from the Awali Pond through the 6,800 m Joun Tunnel to the Bisri or Charles Helou Plant that has an overall power capacity of 48 MW.

109. The hydroelectric plants are connected to the national power transmission grid.

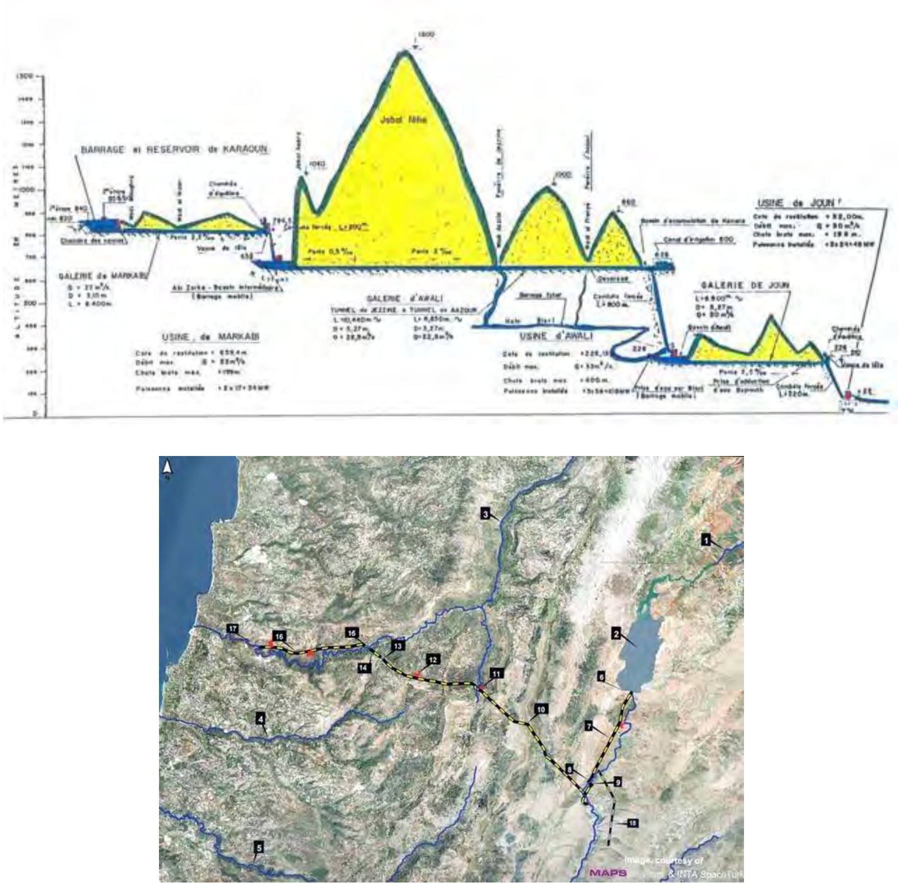


Figure 2-15. Qaraaoun Reservoir Water Diversion through Tunnels for Hydroelectric Power Generation

Source: LRA, 2013

2.4.2.6.4 LRA Irrigation (Qassmieh-Ras El Ain)

110. The Qassmieh/Ras El Ain (QRA) is an open channel irrigation scheme working on demand. It has been executed and operated since 1942. The irrigation network starts at Zrariyeh where there is a small dam, called the Main Dam, that diverts the river water into a 9 km main distribution channel called Qassmieh Channel that splits into two branches at the coastal junction. The northern system, which is 25 km in length, serves the coastal agricultural areas in Saida. The southern system, 9 km in length, serves the Tyre coastal agricultural areas. Nowadays the Qassmieh/Ras El Ain operates under the control of the LRA. The maximum discharge capacity of the irrigation scheme is 4.5 m^3/sec.

111. In the post-war period, the scheme was rehabilitated in 1999. The rehabilitation plan led to an improvement in the water delivery performance through the addition of a new regulation system. Furthermore, the irrigation consumption module was found to decrease about 45% with the rehabilitation plan, compared with situation in the pre-rehabilitation period.

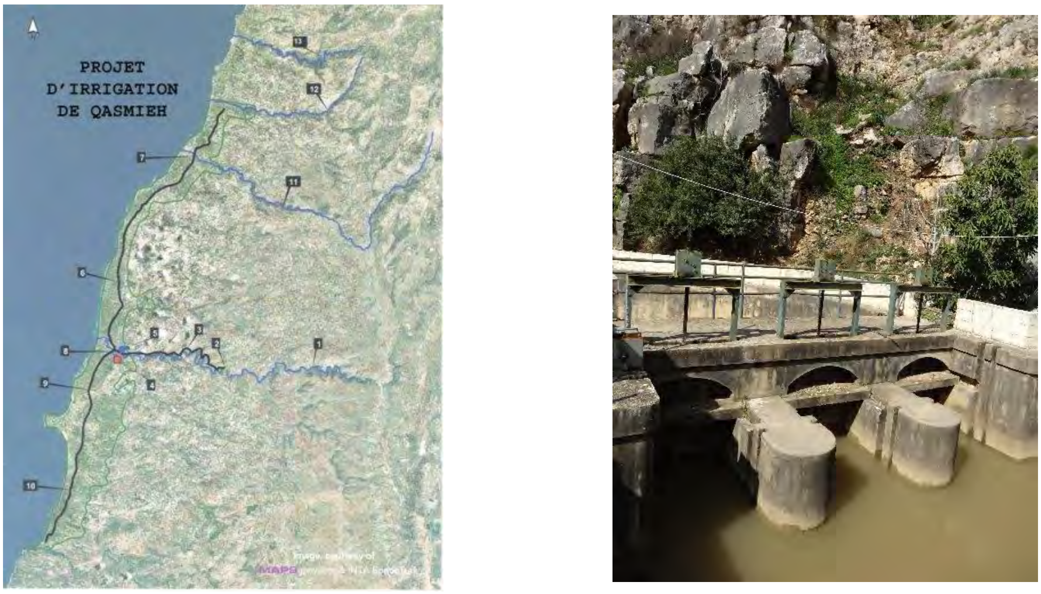


Figure 2-16. Qasmieh-Ras El Ain Irrigation Scheme (Left) starting at the Main Dam in Zrariyeh (Right)

Source: LRA, 2012

2.4.2.6.5 Canal 900

112. The current scheme with 2,000 ha irrigated area is the first phase development of the 8,600 ha lands to be serviced by the C900 irrigation scheme on the left bank of the Litani River. Conceived in the early 70s, the Canal 900 became operational only in 2000. It provides only irrigation water. It is sited at 900m altitude and has 18 km of length (the first part). A main pumping station feeds the canal by 30 Million m^3 of water from the Qaraaoun Reservoir as well as four wells giving 75 Million m^3. Secondary pumps send water to large reservoirs situated at a higher level. Water is distributed to farmers in underground pressurized canals with 3.5-4 kg/cm^2 of pressure. Most of the agricultural ownerships serviced by the scheme are less than 2 ha.

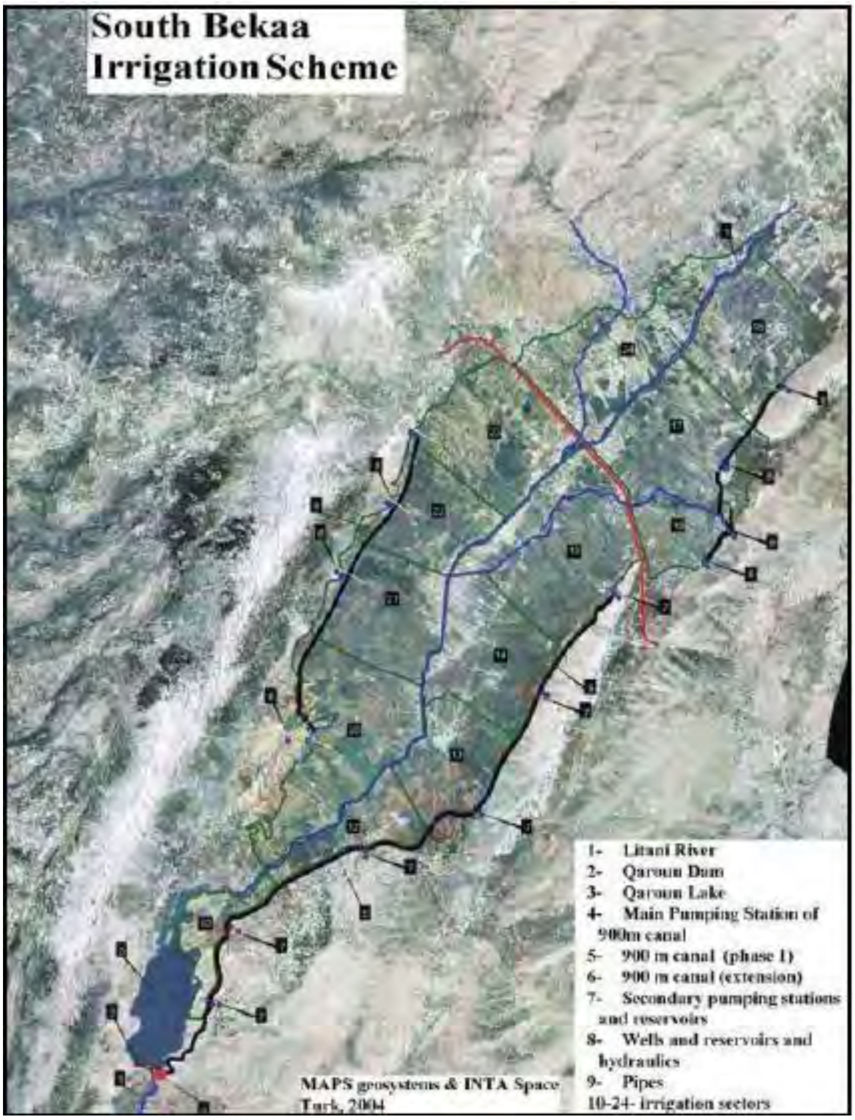


Figure 2-17. Canal 900 Irrigation Scheme

Source: LRA, 2012

2.4.2.6.6 Taybeh Pumping Station and Water Treatment Plant

113. Water from the Litani River is pumped via the Taybeh Pumping Station, which is located within the cadastral area of the village of Taybeh (33.295556, 35.526111) at an elevation of approximately 203 meters, to the Taybeh WTP, located at an altitude of 704 masl. The pumping capacity of the Taybeh pumping station is 18,000 m^3/day, however, the capacity is rarely reached due to technical challenges with the pumps and the high suspended solids content of the intake water where the pumping is stopped to avoid damaging the pumps. The pumping station intake is estimated at 520 m^3/h.

114. The Taybeh Water Treatment Plant was first built in 1962, and later expanded. It receives water from the Litani River through the Taybeh Pumping Station and from the Wazzani Spring. There are two treatment systems currently operational in the WTP – old and new. The total treatment capacity is 25,000 m^3/day. The WTP serves the following villages: Deir Mimas, Deir Siriane, Kfar Kila, Taybeh, Qousseir, Adchit, Almane, Qantara, Bani Haiyane,

Qabrikha, Tamirieh, Touline, El Souwanet, Majdal Silm, Khirbet Selm, Kfar Dounine, Chehabiyeh, Jouaiya, Markaba, Talloussa, and Chaqra.

Figure 2-18. Litani River Water Intake at the Taybeh Pumping Station during Normal (top) and Turbid Flows (bottom)

2.4.2.6.7 Recreational Activities

115. Recreational uses of the Lower Litani River include resthouses and restaurants along the river shores at Ain ez Zarqa, Qaaqaaiyet Ej Jisr, Khardali Bridge, Wadi El Hujeir, Chehour, Tayr Falsay, and the coastal area from Zrariyeh towards Qassmieh. Resthouse and restaurant operators tend to create small ponds within or on the river banks to encourage swimming and water dipping, and there are some water sport activities such as kayaking along some stretches. These activities are seasonal at best, however many of the structures along the river banks are in public lands infringing on the river domain.

Figure 2-19. Recreational Activities along the Lower Litani River

2.4.2.6.8 Khardali Dam

116. A dam was proposed at Khardali Bridge area, at the boundary of Marjaayoun and Nabatiye districts, in the middle of the Lower Litani River Basin, at the foot of Beaufort

Castle, at an elevation varying from 180 to 233 m above sea level. The road connecting Nabatiye to Marjaayoun passes on the north bank of the area.

117. A single or multiple dam system is still under study. The system is intended to store a minimum volume of water of 80 Mm^3 with a minimum height of 70 m. The dam system aims at generating hydro power and securing water for domestic, drinking and irrigation needs. The purpose from water storage is to fulfil the need for supplying irrigation water to Nabatiye district and Jezzine western slopes area between the levels of 100 and 650 masl, and complementing the supply from Canal 800 for the purpose of increasing available irrigated cropland. It also aims at meeting increased regional potable water demand and generation of energy for pumping water to irrigated lands to be served.

118. The prospective flooded area will thus vary according to the chosen location from 200 ha to 300 ha with a water level varying from 200 to 300 masl covering parts of Kfar Tibnit, Arnoun, Blat, Deir Mimas and Qlaiaa administrative boundaries as shown in Figure 2-20.

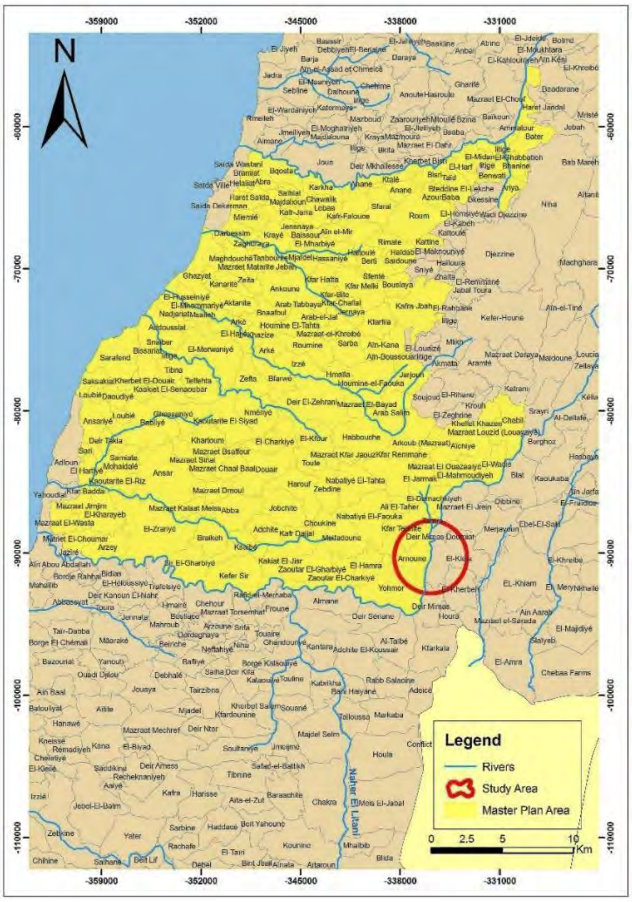


Figure 2-20. Schematic Localization of the Kharadli Dam Study Area and the Irrigation Master Plan Area

2.4.2.6.9 Kfar Sir/Choumariyeh Dam

119. A dam was proposed at Choumariyeh area, located under and north of the Choumariyeh hill, approximately 23 km to the northeast of the city of Tyre and south of Nabatiye, at an

elevation of 110 masl. The project area is located in the South Litani River Basin, after the turn of the Litani River towards the Mediterranean Sea. The Choumariyeh Dam lies downstream of Qaraaoun and prospective Khardali dams.

120. The Choumariyeh Dam is still under study. It is intended to store a total volume of around 28 Mm^3 and the area expected to be inundated is approximately 130 ha.

121. The proposed location for the dam axis, lies approximately 4 km to the east of Marnaba, 2 km to the southwest of Zaoutar Ech Charqiyeh and 1 km northeast of Aalmane. A schematic showing the location of the project area is provided in Figure 2-21.

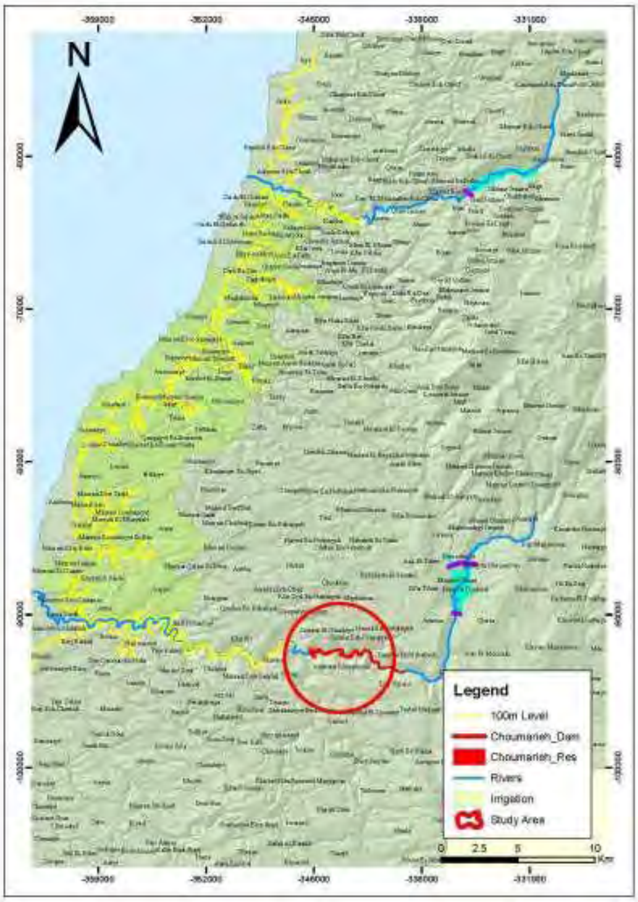


Figure 2-21. Schematic Localization of the Choumariyeh Dam and Irrigation Areas

2.4.2.6.10 Canal 800

122. Canal 800 area was militarily occupied until 2000. In 2001, the LRA launched a call for proposals for the design of the Canal and in 2006 a call for proposal for the execution of construction works was floated. Execution started in 2012.

123. This project is constituted of a main canal of 51 km in length and 56 km of secondary canals for distribution. It allows the irrigation of the region situated between the Litani River course and the south Lebanese border covering 1500 ha. The total cost of the C800 scheme is estimated at US$ 217M. The quantity of water transmitted by this project is 120

Mm^3 of which 90 MCM will be for irrigation. This project's construction is expected to take 5 years. A 6 MW hydropower plant is also a component of the C800 project.

Figure 2-22. Canal 800 Layout

2.4.3 Litani River Discharges

124. The Litani River, which is the largest and the longest river in Lebanon has an estimated annual discharge rate of 770 Mm^3 (FORWARD, 2003 and AUB, 2008) of which 75% are discharged in winter. However, this discharge is not constant and varies with precipitation levels (Comair, 1998 as cited in Amery, 2000).

125. In fact, measurements of water discharge along the Litani River show large fluctuations over time, with a variance of about 2 m^3/s (Abd el Al, 1953). This fluctuation is attributed to the temperature change that affects the snowmelt (IDRC, 2007). The highest discharge values are recorded during February and March (MENBO, 2007). These variations have led to different discharge values in various references. Some studies reported an annual discharge of about 700 Mm^3, while others estimate it to be 360 Mm^3/year (MENBO, 2007; IDRC, 2007). Other studies consider that the total running water in the Litani River reaches 964 Mm^3 (UNDP, 1970) and that its annual average flow is 9.34 m^3/s with an average annual discharge estimated at 920 Mm^3 (Saad *et al.*, 2006). The average discharge in El Mansoura and Qaraaoun stations are 295 and 411 Mm^3 respectively (IDRC, 2007).

126. A flow data summary is provided in Figure 2-12 for the Lower Litani River at the gauging stations of Ghandouriyeh, Tayr Falsay, and Qassmieh Sea Mouth with Ghandouriyeh being the most upstream station. River flow decreases between Ghandouriyeh and Qassmieh even when comparing winter months when no withdrawals from the river for irrigation purposes are expected.

127. Historical river flow data show that the gauging station of Ghandouriyeh, which is at the upstream side of this Litani section historically has a larger flow even during winter months than the downstream gauging stations of Tayr Falsay and Qassmieh. This suggests loss of water along the river course.

Table 2-12. Summarized Litani River flow data at three Gauging Stations of Ghandouriyeh, Tayr Falsay, and Qassmieh Sea Mouth

Gauging Station / Altitude (masl[1])	Average Yearly Discharge before the Year 1975 (Mm^3/y)	Average Yearly Discharge after the Year 1990 (Mm^3/y)
Ghandouriyeh / 115	427.1	261.6
Tayr Falsay / 40	NA[2]	233.7
Qassmieh Sea Mouth / 3	418.0	216.4

Notes:
1 Meter above sea level
2 Not Available

Source: LRA, 2018

128. In addition, public wells data from wells close to the river suggest that piezometric groundwater levels in the Cenomanian-Turonian Sannine-Maameltein karstic Limestone aquifer (C4-C5) crossed by the river in this section are lower than the elevation of the river; this also suggests that river water would be lost in favor of groundwater.

129. Last but not least, the Cenomanian Aquifer outcropping along this section of the Litani has been reportedly identified and known since the UNDP 1970 study (and updated in the UNDP 2014 study) as being part of the catchment basin feeding Al Ain and Rachidiyeh springs in Sour (Basin 19a – Naqoura-Sarafand Cretaceous Basin); this also supports the same statement that the Litani River is recharging the Cenomanian-Maameltein C4-C5 aquifer in its lower section.

130. Based on data provided by LRA, purged and used in the UNDP (2014) study, yearly average discharges of the River in different gauging stations from year 1998 till 2013 are reported in Table 2-13. Monthly averages for the same period are reported in Table 2-14 and their relative hydrographs are illustrated in Figure 2-24.

Table 2-13. Annual Average Flows from 1998 till 2013 at different Gauging Stations on the Lower Litani River

Station / Year	Joub Jannine	Ain ez Zarqa Spring	Qelaya	Khardali	Wadi Ghandoriye	Qassmieh	El Zghir	El Maidane Spring	Wadi El-Hujeir
					MCM				
1998-1999	73.19					47.54			
1999-2000	102.03					90.46			
2000-2001	85.91	38.93		84.56	77.64	62.38		1.47	
2001-2002	139.96	56.16		166.57	160.39	178.67		1.70	
2002-2003	645.90	79.21		792.75	1090.24	991.55		3.83	
2003-2004	318.35		113.29	243.12	261.20	271.38	6.31	2.35	
2004-2005	307.64	66.78	52.51	162.95	182.60	208.42	4.88	1.46	
2005-2006	193.25		37.15	147.60	166.68	157.14			
2006-2007	159.29		37.39	125.15	147.36	111.32			
2007-2008	130.44		34.74	113.77	125.22	104.37			
2008-2009	180.68		71.18	159.61	192.84	146.00			
2009-2010	204.20			238.93	330.04	190.46		2.17	
2010-2011	213.11			226.65	224.21	174.47		2.26	1.24
2011-2012	301.73	98.89	33.82	333.38	359.34	354.41		2.96	3.50
2012-2013	300.01	98.53	64.77	256.95	255.79	216.32		1.87	5.56

Source: LRA, 2018

Table 2-14. Monthly Average Flows from 1998 till 2013 at different Gauging Stations on the Lower Litani River

Station / Month	Joub Jannine	Ain ez Zarqa Spring	Qelaya	Khardali	Wadi Ghandoriye	Qassmieh	El Zghir	El Maidane Spring	Wadi El-Hujeir
	m³/s								
Jan AW	11.94	3.26	1.80	8.62	9.22	11.80	0.17	0.08	0.02
Feb AW	23.07	4.25	3.34	19.90	22.13	23.88	0.57	0.19	0.07
Mar AW	19.00	3.67	4.43	20.44	20.66	23.21	0.64	0.17	0.33
Apr AW	13.41	3.15	2.37	10.76	11.12	14.36	0.44	0.07	0.31
May AW	5.02	2.41	1.10	5.56	9.49	5.37	0.21	0.06	0.12
Jun AW	1.85	2.10	1.16	3.74	4.01	1.68	0.04	0.05	0.03
Jul AW	0.43	1.75	1.16	3.41	4.10	0.57	0.00	0.05	0.02
Aug AW	0.19	1.52	1.55	3.65	4.28	0.44	0.00	0.05	0.01
Sept AW	0.35	1.41	1.48	3.52	3.53	0.38	0.01	0.04	0.00
Oct AW	1.02	1.38	1.22	3.07	3.14	0.58	0.00	0.04	0.00
Nov AW	2.74	1.50	0.69	2.92	2.90	2.06	0.03	0.04	0.00
Dec AW	7.35	2.37	0.97	4.66	5.16	5.93	0.03	0.05	0.00

Source: LRA, 2018

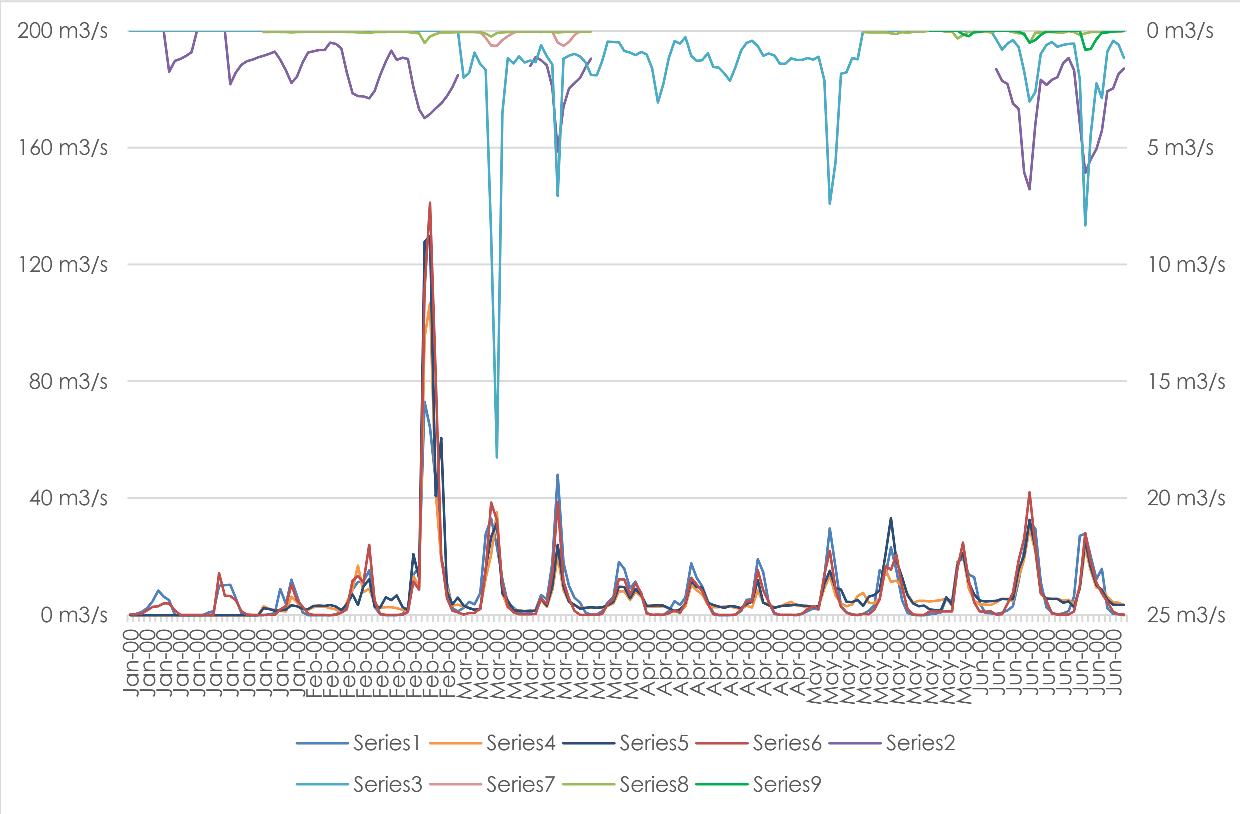


Figure 2-23. Hydrographs of Daily Flows from 1998 till 2013 at different Gauging Stations on the Lower Litani River

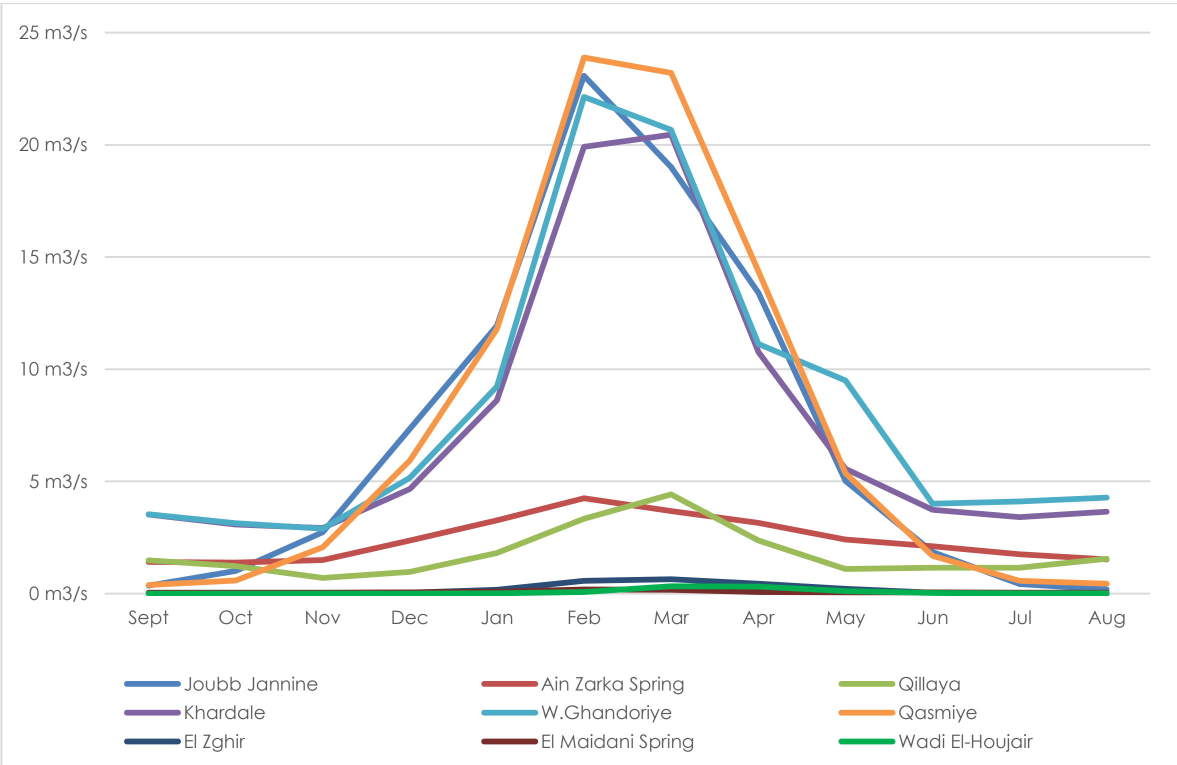


Figure 2-24. Hydrographs of Average Monthly Flows from 1998 till 2013 at different Gauging Stations on the Lower Litani River

Table 2-15. Distribution of the Gauging Results measured from 1998 till 2013 at different Gauging Stations on the Lower Litani River

Station	Joub Jannine	Ain ez Zarqa Spring	Qelaya	Khardali	Wadi Ghandoriye	Qassmieh	El Zghir	El Maidane Spring	Wadi El-Hujeir
[0.00m^3/s-0.05m^3/s]	20.57%	0.14%	0.08%	45.15%	43.41%	11.29%	NDDA	NDDA	NDDA
[0.05m^3/s-0.10m^3/s]	2.68%	-	-	-	0.00%	7.65%	NDDA	NDDA	NDDA
[0.10m^3/s-0.50m^3/s]	7.63%	-	17.86%	-	0.21%	17.53%	NDDA	NDDA	NDDA
[0.50m^3/s-1.00m^3/s]	8.92%	0.27%	22.43%	0.48%	0.79%	5.18%	NDDA	NDDA	NDDA
[1.00m^3/s-10.0m^3/s]	35.77%	99.18%	59.16%	45.15%	43.41%	39.15%	NDDA	NDDA	NDDA
[10.0m^3/s-50.0m^3/s]	23.12%	0.27%	0.39%	8.19%	9.13%	16.73%	NDDA	NDDA	NDDA
[50.0m^3/s-100m^3/s]	1.30%	0.14%	0.08%	1.02%	3.05%	2.47%	NDDA	NDDA	NDDA
Total	100%	100%	100%	100%	100%	100%			

NDDA: No Daily Data Available

Source: LRA, 2018

131. Water of the Litani River is used for irrigation and power generation. A total of 420 Mm^3/year is used to generate 600 kWh in the Litani River's three hydroelectric power plants: Markaba, Awali, and Joun. The largest single withdrawal from the Litani is the diversion of 236 Mm^3 annually through the Markaba tunnel to the Awali River for hydroelectric generation to supply Beirut and other coastal areas.

132. Regarding irrigation, Canal 900 is designed to deliver 30 Mm^3 per year. The main pump delivering water from Lake Qaraaoun to the south end of Canal 900 delivers water at an average flow of 4.5 m^3/s. Then, three pump stations deliver water to regulating reservoirs that subsequently service laterals at rates ranging from 0.17 to 0.89 m^3/s. Water from the laterals irrigates adjacent cropland totalling approximately 2,000 ha. Although not currently operational, the total delivery capacity of water from the five wells at the north end of the Canal is 0.275 m^3/s. Water is delivered from May to September. The Canal is dry for the remaining seven months of the year (BAMAS 2005 - Canal 900 Algae Control Testing & Validation).

133. During the dry season, 30 Mm^3/year of water is channelled from the Jezzine or Awali Tunnel to help meet the needs of the Qassmieh irrigation project (Amery, 2000).

2.5 GEOLOGY AND HYDROGEOLOGY

134. As explained in the sub-sections above, the LLB Study Area was defined based on the surface watershed of the Litani River where it coincides with the groundwater divide or based on the latter where it falls outside the surface watershed but with groundwater flow toward and into the Litani River watershed. The Cenomanian-Turonian aquifer outcropping along the lower and western portion of the Litani River close to the sea is an exception; hence, only the portion falling inside the surface catchment was considered despite extending up-gradient and down gradient outside the surface water catchment. This is because groundwater originating from the areas upstream and outside the surface watershed is considered to be flowing deeper than the Litani River where aquifer rocks are crossed by the Litani River. Accordingly, the Litani River is considered to be a losing stream whereby its water recharges the Sannine-Maameltein aquifer and not vice versa whereas groundwater is known to flow southwest until it drains from the main springs of Rachidiyeh and Tyre as well as in submarine springs in that area.

135. The geological maps of Lebanon (scale 1:50,000) by Dubertret (1955) and UNDP (2014) were used as basis to derive the geological and hydrogeological maps for this study presented at a scale of 1:100,000. The original maps were upgraded and digitized using GIS. The maps referred to in this section are provided in Appendix A at a scale of 1:100,000.

136. Lithostratigraphy is discussed below as part of hydrostratigraphy given the latter's direct relevance to the objectives of the study. Structural geology is also discussed in the context of its influence on groundwater flow. Springs and public wells are described and listed in Table 2-17 and Table 2-18.

2.5.1 Hydrostratigraphy and Groundwater Flow Directions

<u>Jurassic Kesrouane Aquifer</u>

137. The oldest rocks' outcropping in the watershed area are the Jurassic rocks, starting with the Middle Jurassic rocks of the Kesrouane Formation, then Bhannes Formation, leading to the Bikfaya Formation and finally Salima Formation (Figure 2-25). The Kesrouane Formation (J4) has a thickness of 1,500 m and is considered an important karstic aquifer albeit with limited extent in the Study Area. Groundwater flows in preferential conduits and along fractures. This karstic aquifer occupies the southern portion of the Barouk-Niha range. It has high infiltration rates in recharge areas and steep recession graphs at the exit points or springs where present. This karstic aquifer has high transmissivity values approximately ranging between 10^{-3} and 0.45 m^2/s (UNDP, 1970). The main springs fed by this aquifer are Ain ed Daiaa (39 l/s[2]) and potentially Ain Abou Zeid (35 l/s[3]), which issues from the Cretaceous aquifer but suspected of also being fed from the Kesrouane aquifer across the Yammouneh Fault (Table 2-17).

[2] Average Minimum Discharge

[3] Average Minimum Discharge

Table 2-16. Hydrostratigraphic Units in the LLB Study Area

Period	**Age**	**Formation / Deposits / Age (Dubertret Alphanumeric Code)**	**Lithology**	**Thickness (m)**	**Hydrogeological Characterization**
Quaternary		Quaternary Deposits	Alluvial deposits (gravel, sand, silt and clay)	0-50	Semi-Aquifer Quaternary deposits and Miocene conglomerates are considered to act as one main porous aquiferous system; however patchy and of limited thickness to be of any significance in Lower Litani area.
Tertiary	Neogene	Upper Miocene (mcg)	Sand and conglomerates	Few meters	
		Middle Miocene (mL)	Limestone and marls	Few meters	Aquiclude
	Pliocene	Pliocene Basalts (βP)	Basalts and agglomerates	Few meters	
	Paleogene	Upper Eocene Formation (e2b)	Nummulitic Limestone – Cherty limestone	Up to 850	Aquifer with transmissivity ranging from 0.3×10^{-3} to 0.3 m^2/s
		Lower Eocene Formation (e2a)	Marl limestone and chalky marls	300	Aquiclude The e2a, Pa, and C6 formations act as an aquiclude in study area and a confining unit for the underlying Sannine-Maameltein aquifer
		Paleocene (Pa)	White chalks, marly chalks with phosphate and chert nodules and bands	Up to 350	
Cretaceous	Senonian	Chekka Formation (C6)			
	Turonian	Maameltain Formation (C5)	Massive to thin bedded white-gray limestone and marly limestone	Up to 300	Excellent karstic aquifer with transmissivity ranging from 2.3×10^{-3} to 0.8 m^2/s
	Cenomanian	Sannine Formation (C4)	Pale gray, fractures fine and thick bedded limestone and marly limestone with geodes and chert	600	
	Albian	Hammana Formation (C3)	Brown-green marl, marly limestone, and localized basalts	150	Aquiclude
	Aptian	Mdairej Formation (C2b)	Massive pale Limestone, highly jointed	60	Yields limited quantities for private use
	Barremian	Abeih (C2a)	Brown yellowish limestone, marl, and sandstone	100	May yield very limited quantities for private use
	Valanginian/ Hauterivian	Chouf Formation (C1-βC1)	Highly ferruginous red to white sandstone, with localized volcanics βC1, marls and lignites	150	Semi-aquifer with transmissivity ranging from 3×10^{-4} to 10^{-2} m^2/s

Period	Age	Formation / Deposits / Age (Dubertret Alphanumeric Code)	Lithology	Thickness (m)	Hydrogeological Characterization
Jurassic	Tithonian	Salima Formation (J7)	Oolitic limestone with marls and shales	35	Aquiclude
Jurassic	Kimmeridjian	Bikfaya Formation (J6)	Pale massive micritic limestone with basalt and tuff	50-90	Semi-Aquifer
Jurassic	Oxfordian	Bhannes Formation (J5)	Basalts and volcanic tuff, yellowish oolitic limestone, and dark brown marl.	20-50	Aquiclude
Jurassic	Pliensbachian to Callovian	Kesrouane Formation (J4)	Massive grey limestone and dolomite	1,500	Excellent karstic aquifer with transmissivity ranging from 10^{-3} to 0.45 m^2/s

Sannine-Maameltein Aquifer

138. Another major karstic aquifer is the Upper Cretaceous aquifer, the Cenomanian-Turonian aged (C4-C5) Sannine-Maameltein aquifer. It is around 900 m in thickness and it is observed in four (4) main areas in the LLB Study Area: Machghara, Nabi Sejod-Jarmaq, Deir Mimas - Markaba, and along the Litani River gorge between Marnaba-Kfar Sir and Jour En Nakhl along the shore.

139. Among the four areas where the aquifer is exposed at the surface, the Jarmaq area is where the two springs of El Maidane (58.5 l/s) and El Aabbara (10.9 l/s) emerge while being fed from the Cenomanian-Turonian rocks extending northeast (Table 2-17).

140. Similarly to the Jurassic aquifer, the Sannine-Maameltein aquifer has high infiltration rates in recharge areas and steep recession graphs at the exit points or springs when present. This is also noticed in the high transmissivity rates and ranging between 2.3×10^{-3} and 0.8 m^2/s (UNDP, 1970).

141. Groundwater flow in the Sannine-Maameltein aquifer is summarized as follows:

- Machghara: groundwater flow is toward southwest.
- Nabi Sejod-Jarmaq: groundwater flow is toward southwest where it drains from El Maidane and El Aabbara springs.
- Deir Mimas – Markaba: groundwater flow is toward northwest.
- Litani River gorge between Marnaba-Kfar Sir and Jour En Nakhl: groundwater flow is toward southwest.

Eocene Aquifer

142. The Tertiary period has one major karstic aquifer in the Study Area, the 850 m thick Eocene karstic aquifer (e2b). The Eocene, which includes two main units with the e2b aquifer being the top most one is found in three major zones in the Study Area: the first one starts north of Majdel Balhis in the northernmost portion of the Study Area and extends toward the southwest until Dibbine; the second one is found between Arnoun-Yohmor and Aaytaroun to the south; the third zone is closer to the sea between Kharayeb and Mazraat El Yahoudiyeh.

143. The first zone is predominantly composed of the e2b and is thus a very important aquifer which feeds the most important spring in the Study Area: Ain ez Zarqa with a minimum average discharge of 1,278 l/s. Two other main springs, Ain Nassif (5.9 l/s) and Nabaa Zilaya (3.5 l/s) also drain the Upper Eocene aquifer a bit further south from Ain ez Zarqa.

144. The second and third zones, mostly comprise lower permeability Eocene rocks, and are characterized by few springs and lower well discharges.

145. The e2b aquifer is characterized by high infiltration rates and flow in conduits and fractures, and also high rates of depletion at the resurgence points when present. It has high transmissivity values between 10^{-3} and 0.3 m^2/s (UNDP 1970).

146. Groundwater flow in the Eocene aquifer is summarized as follows:

- Majdel Balhis to Dibbine: groundwater flow is toward southwest.
- Arnoun-Yohmor to Aaytaroun: groundwater flow is toward southwest in the portion north of the Litani River and toward northwest in the portion south of the Litani River.
- Kharayeb to Mazraat El Yahoudiyeh: groundwater flow is toward southwest.

Semi-Aquifers

147. In addition to the main aquifers described above, several semi-aquifers exist in the Study Area and are able to yield water albeit with limited quantities because of either their limited permeability or limited extent and recharge. They are briefly described hereafter.

148. The Lower Cretaceous formation, mainly the Chouf Sandstone Formation (C1), forms a semi-aquifer. This aquifer is around 150 m in thickness and it is a porous medium aquifer, which is able of yielding limited quantities of water. It is mostly exposed between Daraiya-Rihane and Qlaiaa south of the Study Area, which is where it mostly yields water albeit with limited quantities. Flow in this aquifer is slow and transmissivity values range between 10^{-4} and 10^{-2} m^2/s (UNDP, 1970).

149. The Bikfaya Formation (J6) of Jurassic age is a karstic formation with the ability to form caves in the Study Area such as the Shataweh Cave in Mazraat Khallet Khazen despite the formation's limited thickness (50 m). The Shataweh Cave also yields water seasonally, which underscores the intermittent and limited water quantities such a semi-aquifer can yield.

150. The last of the semi-aquifers is the Quaternary aquifer (Q), which is only found along the coast around the mouth of the Litani River. This is because the Quaternary is very thin and patchy in the rest of the Study Area, and accordingly does not yield water. Along the coast, it is a porous medium aquifer with thickness not expected to exceed 50 m and is affected by seawater intrusion.

2.5.2 Structural Geology

151. The main structural features affecting the LLB Study Area are described as follows:

Faulting

- Yammouneh Fault: main Dead Sea Transform Fault (DSTF) also known as Levant Fault trace in Lebanon. It has a strike-slip movement and dip-slip component. It crosses the eastern portion of the Study Area from Aaytanit in the northeast to Houla in the southwest where it joins with another expression of the DSTF, which is the Roum Fault. This fault has resulted in vertical displacements exceeding 1,000 m (as shown in the Geology map and cross-section A-A' – refer to Appendix A) whereby it places the Jurassic Kesrouane Formation in contact with Cretaceous Cenomanian rocks of the Sannine Formation and even Tertiary Eocene rocks of the Upper Eocene Formation (e2b).

- Roum Fault: structural surface expression of the DSTF in Lebanon crossing the LLB Study Area from Jarmaq and joining the Yammouneh Fault in Houle. It has a strike-slip movement and dip slip component. This fault also has reported vertical displacement exceeding 600 m whereby Turonian rocks are placed against Eocene rocks in the area of Arnoun-Yohmor (as shown in the Geology Map – refer to Appendix A).

- NE-SW Faults: secondary faults to main DSTF with mainly right-lateral movements with dip-slip component rarely exceeding 100 m. These faults are expected to result in preferential groundwater drainage directions from the higher area toward the coast along the same directions.

Folding

152. Two main synclines distinctively characterize the two main outcrops of Eocene rocks east and west of the Yammouneh Fault (as shown in the Geology Map and Cross-Sections – refer to Appendix A). These synclines have a determining effect on groundwater flow whereby groundwater in the Upper Eocene aquifer (e2b) east of the Yammouneh Fault flows toward and then along the syncline axis toward the southwest until it mostly drains from Ain ez Zarka and further south but to a lesser extent from Ain Nassif and Ain Zilaya. The Eocene located south of Ain Nassif and Ain Zilaya but east of Yammouneh Fault is expected to drain into the Litani River.

153. The other Eocene rocks west of the Yammouneh Fault and affected by a synclinal structure also tend to drain north toward the Litani River similar to the surface water network.

154. Another small syncline affects the Cenomanian Sannine aquifer and focuses drainage of the aquifer from El Maidane and El Aabbara springs in Jarmaq area.

155. Smaller anticlinal structures can be found in the area and those can have localized groundwater influences.

2.5.3 *Springs*

156. The main springs with data identified in the LLB Study Area are shown in Table 2-17. Most springs were described as part of the relevant aquifers in section 2.5.1 above. There are about 154 springs within the Study Area, 150 of them are within the watershed. The Ain ez Zarqa spring is the largest known spring in the basin.

Table 2-17. Main Springs with Data in LLB Study Area

Name	Geographic Coordinates		Z (m)	Average Minimum Discharge (l/sec)	Aquifer Name / Basin Name
	Long	Lat			
Ain Abou Zeid	35.65402	33.52028	1,004	35.0	Cenomanian-Turonian Sannine-Maalmeltein Aquifer (C4-5) / Southern Bekaa Basin
Ain Ed Daiaa	35.65234	33.53062	1,048	39.0	Jurassic Kesrouane (J4) / Barouk Niha
Ain El Aabbara	35.53090	33.39285	399	10.9	Cenomanian-Turonian Sannine-Maalmeltein (C4-5) / Jezzine Basin
Ain Et Tannour	35.65313	33.52967	1,003	4.3	Chouf Sandstone Semi-Aquifer / Unproductive Basin
Ain ez Zarqa	35.65978	33.49457	686	1,278.4	Upper Eocene (e2b) / Southern Bekaa Basin
Ain Nassif	35.66995	33.47532	675	5.9	Upper Eocene (e2b) / Southern Bekaa Basin
Nabaa El Maidane	35.52489	33.40459	422	58.5	Cenomanian-Turonian Sannine-Maalmeltein (C4-5) / Jezzine Basin
Nabaa Zilaya	35.66446	33.46044	653	3.5	Upper Eocene (e2b) / Southern Bekaa Basin

2.5.4 *Public Wells*

157. The main public wells identified in the LLB Study Area total 62 wells as shown in Table 2-18. All public wells tap the three main aquifers of the Eocene, Cenomanian-Turonian Sannine-Maameltein, and Jurassic Kesrouane, in addition to one well tapping the Chouf Sandstone Semi-Aquifer.

Table 2-18. Public Wells in LLB Study Area

Well Code	Well Name	Geographic Coordinates		Geographic Coordinates	Usage	Depth (m)	Aquifer Tapped
		Long	Long				
SBJ007	Aynata Bent Jbayl	35.46020	33.12126	738	Domestic	570	Eocene e2
SBJ008	Aaytaroun	35.46277	33.12045	711	Domestic	455	Eocene e2

Well Code	Well Name	Geographic Coordinates		Geographic Coordinates	Usage	Depth (m)	Aquifer Tapped
		Long	Long				
SBJ009	Khirbet Selm	35.42432	33.22903	455	Domestic	460	Eocene e2
SBJ017	Ain Maalouli	35.43097	33.22903	454	Domestic	590	Eocene e2
SBJ020	Maroun El Rass	35.45221	33.09871	900	Domestic	400	Eocene e2
SBJ021	Wadi Slouqi 1	35.48584	33.18239	490	Domestic	NA	Eocene e2
SBJ022	Wadi Slouqi 2	35.48604	33.18260	490	Domestic	NA	Eocene e2
SBJ023	Wadi Slouqi 3	35.48610	33.18242	490	Domestic	NA	Eocene e2
SJE024	Srireh	35.61963	33.44267	939	Drinking-Domestic	400	Kesrouane J4
SJE026	Sejoud	35.54756	33.44309	894	Drinking-Domestic	480	Sannine-Maameltein C4-5
SJE027	Aychieh	35.55364	33.40777	661	Drinking-Domestic	520	Chouf SSt C1
SNA005	Kfar Sir1	35.39680	33.32078	376	Domestic	455	Sannine-Maameltein C4-5
SNA006	Syr Al Gharbiyeh 1	35.36435	33.32888	193	Domestic	NA	Sannine-Maameltein C4-5
SNA028	Yohmor 1	35.52003	33.32143	519	Domestic	520	Eocene e2
SNA031	Zaoutar Ech Charqiyeh 1	35.48214	33.32263	488	Domestic	580	Eocene e2
SNA032	Zaoutar Ech Charqiyeh 1	35.45840	33.32097	444	Domestic	560	Eocene e2
SNA040	Brayke 1	35.38150	33.33825	295	Domestic	350	Sannine-Maameltein C4-5
SNA041	Syr Al Gharbiyeh 2	35.38464	33.32798	359	Domestic	485	Sannine-Maameltein C4-5
SMA001	Souwanet Marje'oun1	35.43323	33.23347	535	Domestic	460	Eocene e2
SMA002	Wadi Al Hjah	35.44661	33.26917	244	Domestic	280	Eocene e2
SMA003	Mayss Al Jabal1	35.50420	33.16465	629	Domestic	550	Eocene e2
SMA004	Houla1	35.51340	33.20433	630	Domestic	650	Sannine-Maameltein C4-5
SMA005	Houla2	35.50868	33.20098	676	Domestic	630	Sannine-Maameltein C4-5
SMA006	Deir Mimas	35.54814	33.29690	517	Domestic	320	Sannine-Maameltein C4-5
SMA007	Deir Mimas1	35.54962	33.29365	494	Domestic	270	Kesrouane Formation J4

Well Code	Well Name	Geographic Coordinates		Geographic Coordinates	Usage	Depth (m)	Aquifer Tapped
		Long	Long				
SMA008	Kfar Kila	35.55824	33.27211	520	Domestic	370	Sannine-Maameltein C4-5
SMA013	Touline	35.43596	33.25259	465	Domestic	470	Sannine-Maameltein C4-5
SMA014	Tlousseh	35.48676	33.23526	525	Domestic	570	Eocene e2
SMA016	Qabrikha	35.45727	33.24826	459	Domestic	460	Sannine-Maameltein C4-5
SMA022	Blat	35.61341	33.38548	620	Domestic	NA	Eocene e2
SMA023	Bany Hayyan	35.49203	33.24930	517	Domestic	570	Eocene e2
SMA024	Majdel Selm	35.48247	33.20624	496	Domestic	600	Eocene e2
SMA025	Chaqra	35.48400	33.20312	435	Domestic	310	Eocene e2
BRA013	New well	35.75406	33.52669	977	Drinking-Domestic	380	Eocene e2b
BRA014	Old well	35.75250	33.52973	984	Drinking-Domestic	180	Eocene e2b
BRA015	NA	35.74502	33.52042	942	Drinking-Domestic	296	Eocene e2b
BRA039	Kawkaba New Well	35.76872	33.54217	1075	Drinking-Domestic	600	Eocene e2b
SSA058	Al Zrahrieh 1	35.33015	33.34547	304	Drinking-Domestic	350	Sannine-Maameltein C4-5
SSA059	Al Zrahrieh 4	35.32027	33.34162	294	Drinking-Domestic	350	Sannine-Maameltein C4-5
SSA060	Al Zrahrieh 3	35.33413	33.34115	272	Drinking - Domestic	350	Sannine-Maameltein C4-5
SSA074	Khrayeb 1	35.30307	33.34374	206	Drinking - Domestic	585	Eocene e2
SSO013	Berj Rahale3	35.27138	33.31312	125	Drinking - Domestic	182	Sannine-Maameltein C4-5
SSO016	Deir Qanoun En-Nahr 2	35.30571	33.30145	220	Drinking - Domestic	450	Sannine-Maameltein C4-5
SSO017	Deir Qanoun En-Nahr 1	35.32024	33.29568	268	Drinking - Domestic	460	Sannine-Maameltein C4-5
SSO018	Hallousiyeh Al fawka1	35.33057	33.30119	228	Drinking - Domestic	300	Sannine-Maameltein C4-5
SSO020	Berj Rahale 2	35.28887	33.31505	220	Drinking - Domestic	470	Sannine-Maameltein C4-5

Well Code	Well Name	Geographic Coordinates		Geographic Coordinates	Usage	Depth (m)	Aquifer Tapped
		Long	Long				
SSO021	Barghaliyeh 1	35.24811	33.31868	448	Drinking - Domestic	165	Eocene e2
SSO022	Barghaliyeh 2	35.24053	33.31112	20	Drinking - Domestic	60	Eocene e2
SSO046	Berj Rahale 1	35.28794	33.31256	170	Drinking - Domestic	525	Sannine-Maameltein C4-5
SSO047	Tayr Falsay 1	35.34948	33.30408	292	Drinking - Domestic	590	Sannine-Maameltein C4-5
SSO048	Hmairi 1	35.35263	33.30038	291	Drinking - Domestic	580	Sannine-Maameltein C4-5
SSO049	Ma'roub 1	35.35667	33.27918	361	Drinking - Domestic	490	Sannine-Maameltein C4-5
SSO071	Bedias 1	35.30115	33.31322	177	Drinking - Domestic	450	Sannine-Maameltein C4-5
BWB026	NA	35.65133	33.53022	1,078	Drinking-Domestic	90	Kesrouane J4
BWB027	Valley well	35.68703	33.51703	823	Drinking-Domestic	306	Eocene e2b
BWB028	School well	35.68864	33.51944	839	Drinking-Domestic	256	Eocene e2b
BWB029	Playground well	35.70060	33.52343	907	Drinking-Domestic	154	Eocene e2b
BWB032	NA	35.63555	33.47146	955	Drinking-Domestic	153	Kesrouane J4
BWB033	NA	35.68079	33.48593	939	Drinking-Domestic	336	Eocene e2b
BWB034	NA	35.63774	33.49447	1,029	Drinking-Domestic	250	Kesrouane J4
BWB035	NA	35.67246	33.48440	893	Drinking-Domestic	350	Eocene e2b
BWB036	Yohmor New Well	35.67943	33.48289	947	Drinking-Domestic	315	Eocene e2b

NA: Not Available

It is believed that there are many private wells, licensed and licensed, tapping the aquifers at different depths, and being pumped for various uses (agricultural, industrial, domestic, recreational (to fill swimming pools)), however, information on the number, legal status, location and discharge capacity could not be collected for the purpose of the study. Understanding the total discharges of groundwater within the basin is a necessary element in order to construct the water balance and study the water and river flow regime.

2.6 LLB STUDY ZONES

158. Given the large number of sub-watersheds and the differences in their sizes, some of the sub-watersheds were merged to create 'zones'. Zones are considered aggregate units of the Study Area governed by the sub-watershed areas drained by tributaries and the cadastral extents of localities within the Study Area. Study zones are developed to examine the existing pressures, to assess the current state of water and sediment quality, and to devise, at a later stage, a management scheme that considers the pre-existing cadastral and administrative characteristics of localities within the LLB. A single zone can consist of a single sub-watershed or more, as outlined in Table 2-19 below.

Table 2-19. Study Zones and their Respective Surface Area and Sub-watersheds

Zone	Surface area (km^2)	Sub-watershed
1	203.33	1, 2, 3
2	144.07	4, 5
3	85.52	6
4	231.27	7, 8, 9
5	127.38	10, 11

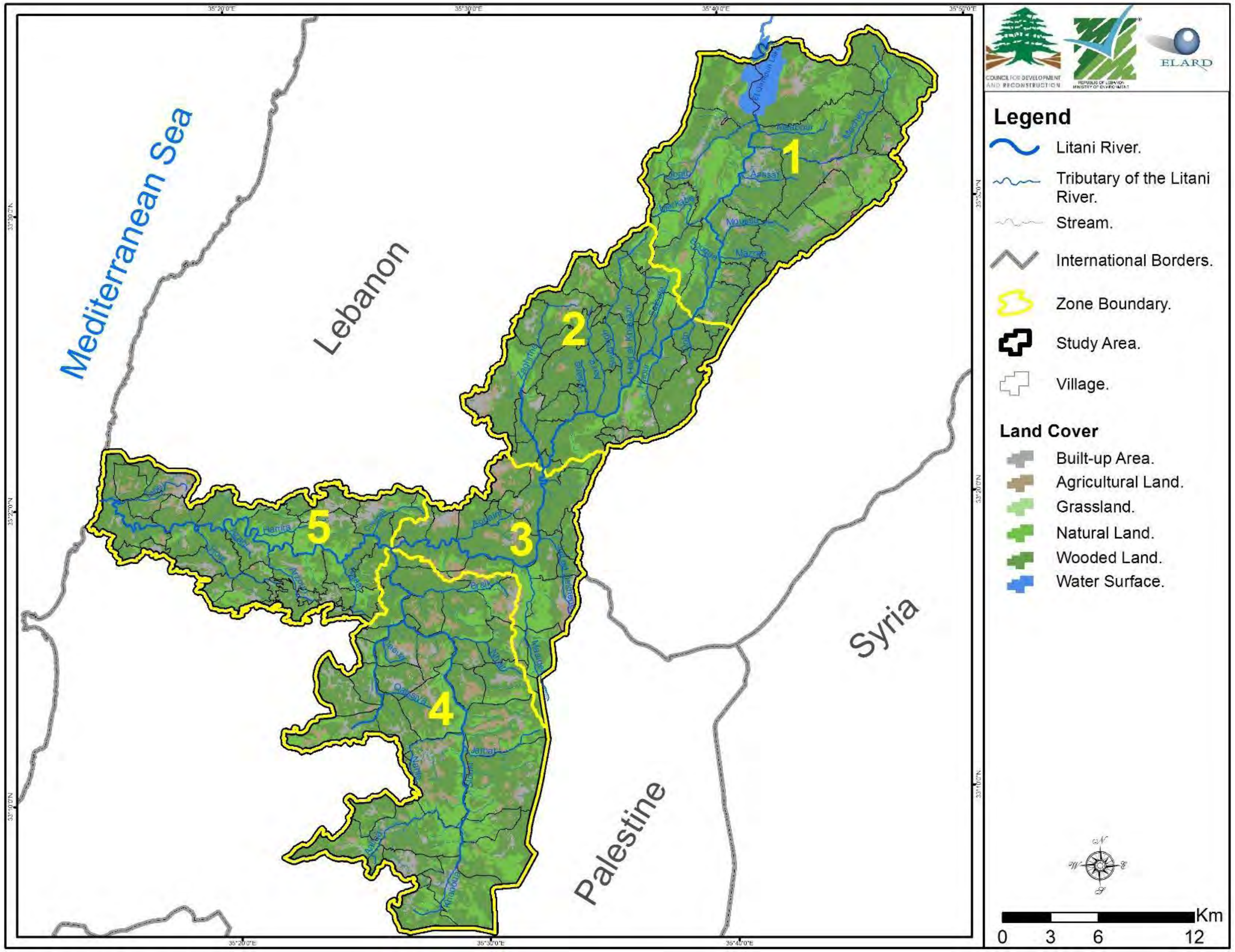


Figure 2-25. Study Zones of the LLB Study Area

2.7 DEMOGRAPHY

159. As shown in previous sections, the LLB Study Area comprises 132 localities in 10 districts. The upper reaches of the Lower Litani River from the Qaraaoun Dam until the Khardali bridge are predominantly rural or semi-rural areas. The urban populated areas are in Sour and Nabatiye districts, while Marjaayoun and Bent Jbayl districts are largely semi-urban. The most populous areas by governorate within the Study Area are Nabatiye governorate (districts of Marjaayoun, Nabatiye, Bent Jbayl and Hasbaiya), followed by South Lebanon (Sour, Saida, then Jezzine), and Bekaa (West Bekaa and Rachaiya).

160. Data on population count were collected from two main sources: the CAS population count by village for the year 2004, as cited in the NPMPLT, and the municipal survey conducted for this study in 2018. The population figures for the year 2018, based on the CAS 2004 data, were calculated as follows:

- The resident population annual growth rate for the years 2004-2015 was considered to be 1.684% as per the Word Population Prospects 2017[4], and applied to the CAS 2004 data
- The resident population annual growth rate for the years 2016-2018 was considered to be 0.567% as per the Word Population Prospects 2017, and applied to the estimated population of 2015
- The Syrian Displaced Persons data as of March 2018 was obtained from the UNHCR for each village within the Study Area
- The population of villages where less than 50% of the land was included within the Study Area boundaries was excluded from the total population

161. Municipalities were asked to report permanent resident Lebanese population, additional seasonal resident Lebanese population, Syrian DPs and foreign residents. The following table (Table 2-20) shows the estimated population data per village, and the population data reported by municipalities. Municipalities where less than 50% of land area falls within the Study Area were not interviewed and three municipalities did not cooperate to answer the questionnaire despite repeated requests – these are Rihane, Sejoud and Aaytanit.

162. The reported total population figures in the municipal survey were more than twice (2.33 times) the estimated/projected figures as per the CAS 2004 data. The permanent residents reported in the municipal survey, excluding Syrian DPs, were 23% more than the estimated

[4] United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The [June] 2017 Revision - "Average annual rate of population change by region, subregion and country, 1950-2100 (percentage) - Medium fertility variant, 2015 - 2100". Available online: https://esa.un.org/unpd/wpp/DVD/Files/1_Indicators%20(Standard)/EXCEL_FILES/1_Population/WPP2017_POP_F02_POPULATION_GROWTH_RATE.xlsx.
Although the 2010-2015 average annual rate of population change (percentage) for Lebanon is estimated at 5.99%, the authors considered it to be 1.684% (i.e., similar to the 2005-2010 rate), since the high rate of increase is attributed to the influx of Syrian DPs, whose numbers are accounted for separately for the year 2018

figures based on the CAS 2004 data. The figure for Syrian DPs reported in the municipal survey was 83% higher than the figure reported by the UNHCR.

163. As per the UN estimated population figures for 2018, the population of Lebanon is 6,093,509, including Syrian DPs[5]. Considering the total surface area of Lebanon to be 10,452 km^2, the population density is estimated at 583 persons/km^2.

164. The total area of the LLB Study Area is measured at 791.57 km^2, or 7.6% of the total surface area of Lebanon. A total resident population of 498,948 (including seasonal residents and Syrian DPs) as reported by municipalities, calculated at 8.2% of the total UN-estimated population, yields a population density of 630 persons/km^2, which is higher than the national population density. Nonetheless, if we are to use the resident Lebanese population, added to it the Syrian DPs and foreigners, then the population density figure would be 425 persons/km^2.

165. On the other hand, calculating the population density using the estimated population figure based on the CAS 2004 data, which is 213,129, calculated at 3.5% of the total UN-estimated population, yields 269 persons/km^2, which is much lower than the national population density.

166. Given the nature of land use, the pre-dominant semi-rural nature, level of urbanization, and the historically low population residency due to security issues in the South, the overall population density in the Lower Litani Basin study area is definitely not higher than the national population density. The municipalities-reported figure for total population is judged to be overestimated, while the municipality-reported figures for resident population (excluding Syrian DPs) and CAS-based estimates might seem more realistic given the nature of the area and population movement due to security issues over the years.

167. In the absence of official census data, the authors of this report have judged to use the estimated figures based on the CAS 2004 data and the UNHCR data for March 2018, and where these are missing the municipality-provided figures are used.

168. Hence, a medium-estimate of the resident (permanent and foreign) population of the Lower Litani Basin Study Area is calculated at 336,398 inhabitants (425 inhabitants/km^2).

[5] United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The [June] 2017 Revision - "Total population (both sexes combined) by region, subregion and country, annually for 1950-2100 (thousands) - Medium fertility variant, 2015 - 2100". Available online: https://esa.un.org/unpd/wpp/DVD/Files/1_Indicators%20(Standard)/EXCEL_FILES/1_Population/WPP2017_POP_F01_1_TOTAL_POPULATION_BOTH_SEXES.xlsx

Table 2-20. Population Counts in Lower Litani Study Area per Locality

Village (EN)	Village (AR)	% Land within Study Area	Population Count (CAS, 2004)	Projection of CAS Population Count to 2018 (without Syrian DPs)	Registered Syrian DPs (UNHCR Mar 2018)	Total Resident Population (2018)	Municipal Survey Population (2018)				Total Resident Population as per Municipal Survey (2018)
							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
Mount Lebanon – Chouf						**-**					**-**
NIHA (CHOUF)	*نيحا (الشوف)*	*14.95%*	*2,688*	*3,285*	*199*	*3,484*	-	-	-	-	-
Bekaa – West Bekaa			**21,833**	**26,684**	**6,402**	**33,086**	**31,600**	**13,300**	**9,530**	**280**	**54,710**
AAYTANIT	عيتنيت	100%	689	842	20	862	-	-	-	-	-
AIN ET TINEH (B-G)	عين التينة (ب-غ)	100%	1,249	1,527	75	1,602	1,500	1,500	150	-	3,150
LIBBAYA	لبايا	100%	2,301	2,812	46	2,858	3,000	3,000	150	-	6,150
LOUSSIA	لوسيا	100%	1	1	548	549	-	-	-	-	-
MAYDOUN	ميدون	100%	-	-	8	8	1,300	200	150	-	1,650
MACHGHARA	مشغرة	99.92%	6,793	8,302	505	8,807	8,000	6,000	3,000	150	17,150
QARAAOUN	قرعون	100%	4,208	5,143	3,958	9,101	5,200	300	4,800	30	10,330
QELAYA	قليا	100%	654	799	36	835	1,300	200	100	-	1,600
SOHMOR	سحمر	100%	3,994	4,882	956	5,838	8,500	1,000	900	100	10,500
YOHMOR (B-G)	يحمر (ب-غ)	100%	1,765	2,157	226	2,383	2,500	500	200	-	3,200
ZILAYA	زلايا	100%	179	219	24	243	300	600	80	-	980
BAALOUL (B-G)	*بعلول (ب-غ)*	*38.10%*	*1,219*	*1,490*	*784*	*2,274*	-	-	-	-	-
Bekaa – Rachaiya			**3,524**	**4,307**	**743**	**5,050**	**2,170**	**350**	**850**	**0**	**3,370**
KAOUKABA BOU AARAB	كوكبا بو عرب	99.97%	749	915	405	1,320	970	50	500	-	1,520
KFAR MICHKI	كفرمشكي	100%	671	820	99	919	600	100	200	-	900
NABI SAFA	نبي صفا	100%	36	44	-	44	-	-	-	-	-
MAJDEL BALHIS	مجدل بلهيص	100%	1,183	1,446	120	1,566	600	200	150	-	950
MHAIYDSEH (RACHAIYA)	مهيدثه (راشيا)	74.04%	885	1,082	119	1,201	-	-	-	-	-

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							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
RACHAIYA EL FOUKHAR	*راشيا الفخار*	*0.04%*	-	-	*70*	*70*	-	-	-	-	-
RAFID (RACHAIYA)	*رفيد (راشيا)*	*18.47%*	*2,193*	*2,680*	*1,261*	*3,941*	-	-	-	-	-
South Lebanon – Jezzine			**2,648**	**3,236**	**627**	**3,863**	**1,260**	**4,340**	**462**	**10**	**6,072**
AARAMTA	عرمتى	100%	980	1,198	89	1,287	500	3,000	180	-	3,680
AAYCHIYEH	عيشية	100%	364	445	152	597	150	550	120	10	830
MAHMOUDIYEH (JEZZINE)	محمودية (جزين)	100%	12	15	-	15	-	-	-	-	-
MAZRAAT OUAZAAIYEH	مزرعة اوزاعية	100%	1	1	-	1	-	-	-	-	-
MAZRAAT ZIGHRINE	مزرعة زغرين	100%	-	-	-	-	-	-	-	-	-
CHBAIL	شبيل	100%	-	-	-	-	-	-	-	-	-
JARMAQ	جرمق	100%	16	20	25	45	50	150	42	-	242
DEMACHQIYEH	دمشقية	100%	20	24	-	24	-	-	-	-	-
MAZRAAT EL AARQOUB	مزرعة العرقوب	100%	-	-	-	-	-	-	-	-	-
MAZRAAT TAMRA	مزرعة طمره	100%	-	-	-	-	-	-	-	-	-
MAZRAAT DARAYA	مزرعة داريا	100%	12	15	-	15	-	-	-	-	-
QATRANI	قطراني	100%	231	282	133	415	400	600	120	-	1,120
RIHANE (JEZZINE)	ريحان (جزين)	100%	793	969	182	1,151	-	-	-	-	-
MAZRAAT KHALLET KHAZEN	مزرعة خلة خازن	100%	-	-	12	12	-	-	-	-	-
MAZRAAT LOUZID (LOUAYZIYEH)	مزرعة لويزيد (اللويزية)	100%	-	-	-	-	-	-	-	-	-
MAZRAAT QROUH	مزرعة قروح	100%	-	-	-	-	-	-	-	-	-
OUARDIYEH	وردية	100%	1	1	-	1	-	-	-	-	-
SEJOUD	سجد	100%	218	266	34	300	-	-	-	-	-
SRAYRI	سريرة	100%	-	-	-	-	160	40	-	-	200

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							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
KFAR HOUNEH	*كفر حونة*	*22.80%*	*1,363*	*1,666*	*90*	*1,756*	-	-	-	-	-
South Lebanon – Saida			**12,526**	**15,310**	**2,933**	**18,243**	**24,500**	**7,300**	**5,000**	**3,190**	**39,990**
ARZAI	ارزي	86.81%	1,810	2,212	401	2,613	5,000	300	500	140	5,940
JAZIRA (SAIDA)	جزيرة (صيدا)	100%	74	90	6	96	-	-	-	-	-
MATARIYET ECH CHOUMAR	مطرية الشومر	100%	381	466	57	523	-	-	-	-	-
KHARAYEB (SAIDA)	خرايب (صيدا)	65.23%	3,478	4,251	1,362	5,613	12,000	3,000	3,500	2,900	21,400
MAZRAAT EL AAITANIYEH (YAHOUDIYEH)	مزرعة العيتانية (اليهودية)	73.05%	301	368	116	484	-	-	-	-	-
MAZRAAT EL OUASTA	مزرعة الوسطة	100%	1,195	1,461	17	1,478	-	-	-	-	-
MAZRAAT JAMJIM	مزرعة جمجيم	65.34%	301	368	-	368	-	-	-	-	-
ZRARIYEH	زرارية	33.40%	4,986	6,094	974	7,068	7,500	4,000	1,000	150	12,650
South Lebanon – Sour			**22,609**	**27,635**	**2,772**	**30,407**	**56,100**	**17,600**	**7,390**	**5,555**	**86,645**
ARZOUN	أرزون	100%	601	735	101	836	1,700	600	150	-	2,450
BEDIAS	بدياس	100%	1,166	1,425	50	1,475	1,700	400	100	5	2,205
BESTIYAT	بستيات	100%	134	164	23	187	350	150	50	-	550
BORJ RAHHAL	برج رحَال	100%	2,712	3,315	324	3,639	9,500	1,500	2,700	5,300	19,000
AIN ABOU ABDALLAH	عين ابو عبدالله	100%	2,630	3,214	405	3,619	-	-	-	-	-
CHEHOUR	شحور	100%	1,603	1,959	91	2,050	11,500	4,000	200	-	15,700
DEIR QANOUN EN-NAHR	دير قانون النهر	100%	3,243	3,964	226	4,190	8,000	1,000	1,000	-	10,000
DERDAGHAIYA	دردغيا	100%	577	705	47	752	1,500	500	280	150	2,430
HALLOUSSIYEH	حلوسية	100%	1,301	1,590	68	1,658	2,000	2,000	100	-	4,100
HMAIRI (SOUR)	حميري صور	100%	583	713	26	739	1,000	300	80	-	1,380
JENNATA	جناتا	100%	525	642	59	701	1,350	150	160	70	1,730

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							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
MAAROUB	معروب	100%	1,807	2,209	566	2,775	3,500	5,000	1,500	-	10,000
SRIFA	صريفا	100%	3,441	4,206	668	4,874	9,000	1,000	950	-	10,950
MARNABA	مرنبا	100%	6	7	4	11	-	-	-	-	-
MAZRAAT TAYR SEMHAT	مزرعة طير سمحات	100%	-	-	-	-	-	-	-	-	-
NIHA (SOUR)	نيحا (صور)	100%	327	400	-	400	-	-	-	-	-
TAYR FALSAY	طير فلسيه	100%	1,953	2,387	114	2,501	5,000	1,000	120	30	6,150
TOUAYRI	-	100%	-	-	-	-	-	-	-	-	-
AABBASSIYEH (SOUR)	*العباسية (صور)*	*8.19%*	*11,925*	*14,575*	*1,877*	*16,452*	-	-	-	-	-
Nabatiye – Hasbaiya			**844**	**1,031**	**142**	**1,173**	**600**	**650**	**80**	**0**	**1,330**
BOURGHOS	برغز	100%	55	67	79	146	50	250	-	-	300
DELLAFI	دلافة	100%	-	-	10	10	150	100	30	-	280
KAOUKABA (HASBAIYA)	كوكبا (حاصبيا)	100%	789	964	53	1,017	400	300	50	-	750
HASBAIYA	*حاصبيا*	*22.05%*	*7,744*	*9,465*	*643*	*10,108*	-	-	-	-	-
MIMESS	*ميمس*	*4.06%*	*1,319*	*1,612*	*86*	*1,698*	-	-	-	-	-
Nabatiye – Nabatiye			**25,731**	**31,450**	**6,077**	**37,527**	**68,300**	**16,475**	**8,855**	**50**	**93,680**
AALI ET TAHER	عالي الطاهر	38.35%	-	-	-	-	-	-	-	-	-
ARNOUN	أرنون	100%	511	625	111	736	600	-	300	-	900
BRAIQEAA	بريقع	35.99%	1,271	1,553	216	1,769	3,000	1,000	700	-	4,700
KFAR ROUMMANE	كفر رمان	100%	3,324	4,063	2,107	6,170	12,000	4,000	2,500	-	18,500
KFAR SIR	كفر صير	100%	4,330	5,292	597	5,889	10,000	5,000	1,280	-	16,280
KFAR TIBNIT	كفر تبنيت	100%	3,005	3,673	996	4,669	11,000	-	600	-	11,600
QAAQAAIYET EJ JISR	قعقعية الجسر	100%	3,594	4,393	439	4,832	6,000	4,000	600	50	10,650

Village (EN)	Village (AR)	% Land within Study Area	Population Count (CAS, 2004)	Projection of CAS Population Count to 2018 (without Syrian DPs)	Registered Syrian DPs (UNHCR Mar 2018)	Total Resident Population (2018)	Municipal Survey Population (2018)				Total Resident Population as per Municipal Survey (2018)
							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
QSAIBEH (NABATIYE)	قصيبة (النبطية)	100%	3,335	4,076	641	4,717	9,000	200	1,200	-	10,400
SIR EL GHARBIYEH	صير الغربية	98.58%	2,393	2,925	522	3,447	8,000	1,000	1,100	-	10,100
YOHMOR (NABATIYE)	يحمر (النبطية)	100%	1,475	1,803	121	1,924	2,700	300	250	-	3,250
ZAOUTAR ECH CHARQIYEH	زوطر الشرقية	100%	1,618	1,978	34	2,012	3,500	500	300	-	4,300
MAZRAAT EL HAMRA	مزرعة الحمرا	100%	-	-	8	8	-	-	-	-	-
ZAOUTAR EL GHARBIYEH	زوطر الغربية	100%	875	1,069	285	1,354	2,500	475	25	-	3,000
Nabatiye – Marjaayoun			**40,939**	**50,035**	**3,542**	**53,577**	**56,689**	**55,735**	**7,519**	**663**	**120,606**
AADAYSSEH (MARJAAYOUN)	عديسة (مرجعيون)	100%	1,910	2,334	201	2,535	3,000	2,000	355	73	5,428
AADCHIT (QOUSSAIR)	عدشيت (القصير)	100%	444	543	-	543	1,150	540	-	10	1,700
AALMANE (MARJAAYOUN)	علمان (مرجعيون)	100%	-	-	10	10	12	-	13	-	25
BANI HAIYANE	بني حيان	100%	217	265	26	291	300	2,200	63	20	2,583
BLAT (MARJAAYOUN)	بلاط (مرجعيون)	100%	746	912	154	1,066	500	1,400	100	-	2,000
BLIDA	بليدا	100%	1,540	1,882	150	2,032	1,200	3,000	350	30	4,580
BORJ EL MLOUK	برج الملوك	48.03%	735	898	158	1,056	300	300	150	-	750
BOUAYDA (MARJAAYOUN)	بويضة (مرجعيون)	99.79%	138	169	-	169	200	245	5	-	450
DEIR MIMAS	دير ميماس	100%	1,154	1,410	44	1,454	427	4,000	73	-	4,500
MAZRAAT DOUMIAT	مزرعة دمياط	100%	-	-	-	-	-	-	-	-	-
HOURA	هوره	100%	68	83	-	83	-	-	-	-	-
DEIR SIRIANE	دير سريان	100%	703	859	-	859	3,000	50	50	10	3,110
DIBBINE	دبين	100%	1,217	1,487	173	1,660	700	2,300	400	-	3,400

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							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
HOULA	حولا	99.98%	3,487	4,262	30	4,292	5,000	8,000	200	15	13,215
KFAR KILA	كفركلا	100%	4,566	5,581	484	6,065	6,000	1,500	2,000	-	9,500
MAJDEL SELM	مجدل سلم	100%	4,100	5,011	253	5,264	10,000	5,000	500	200	15,700
MARKABA	مركبا	100%	1,640	2,004	144	2,148	-	-	-	-	-
MEISS EJ JABAL	ميس الجبل	100%	3,100	3,789	383	4,172	8,000	10,000	1,000	30	19,030
MHAIBIB	محيبيب	100%	678	829	-	829	500	750	-	-	1,250
QABRIKHA	قبريخا	100%	1,683	2,057	113	2,170	1,200	500	300	30	2,030
QANTARA (MARJAAYOUN)	قنطرة (مرجعيون)	100%	26	32	13	45	1,000	1,600	50	10	2,660
QLAIAA	قليعة	70.64%	3,857	4,714	143	4,857	2,500	1,000	120	150	3,770
RABB ET TALATINE	رب ثلاثين	100%	482	589	109	698	500	3,250	300	5	4,055
SOUANEH (MARJAAYOUN)	صوانة (مرجعيون)	100%	1,746	2,134	106	2,240	3,500	400	200	20	4,120
TALLOUSSA	طلوسة	100%	518	633	30	663	1,000	3,000	40	30	4,070
TAYBEH (MARJAAYOUN)	طيبة (مرجعيون)	100%	3,915	4,785	226	5,011	4,500	3,500	450	10	8,460
TOULINE	تولين	100%	2,269	2,773	592	3,365	2,200	1,200	800	20	4,220
JDAIDEH (MARJAAYOUN)	*جديدة (مرجعيون)*	*10.42%*	*4,031*	*4,927*	*1,161*	6,088	*2,000*	*300*	*1,450*	*200*	*3,950*
Nabatiye – Bent Jbayl			**22,354**	**27,320**	**2,883**	**30,203**	**36,850**	**46,800**	**7,985**	**910**	**92,545**
AAYNATA (BENTJBAYL)	عيناثا	100%	3,542	4,329	283	4,612	4,000	4,000	1,500	200	9,700
AAYTAROUN	عيترون	100%	4,239	5,181	241	5,422	7,000	10,000	500	125	17,625
BEIT YAHOUN	بيت ياحون	100%	222	271	111	382	800	1,200	500	-	2,500
BORJ QALAOUIYEH	برج قلاويه	100%	851	1,040	63	1,103	600	700	100	30	1,430
CHAQRA	شقرا	100%	4,086	4,994	581	5,575	7,000	6,000	1,500	500	15,000

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							Permanent Resident Lebanese	Seasonal Resident Lebanese	Syrian DPs	Resident Non-Lebanese	
FROUN	فرون	100%	821	1,003	64	1,067	2,500	-	60	-	2,560
GHANDOURIYEH (BENTJBAYL)	غندورية (بنت بجبيل)	100%	595	727	55	782	450	350	50	-	850
JMAIJMEH	جميجمه	100%	1,434	1,753	390	2,143	2,900	100	780	-	3,780
KFAR DOUNINE	كفر دونين	100%	2,312	2,826	312	3,138	1,200	2,300	375	-	3,875
KHIRBET SELM	خربة سلم	100%	1,644	2,009	409	2,418	5,000	14,000	2,000	-	21,000
KOUNINE	كونين	100%	289	353	104	457	1,000	2,500	150	30	3,680
MAROUN ER RAS	مارون الراس	100%	341	417	39	456	1,000	1,000	50	-	2,050
QALAOUIYEH	قلاويه	100%	867	1,060	16	1,076	1,300	1,150	20	15	2,485
SOULTANIYEH (BENT JBAYL)	سلطانية	100%	754	921	131	1,052	1,500	2,000	300	10	3,810
TIRI	طيري	100%	357	436	84	520	600	1,500	100	-	2,200
BARAACHIT	*برعشيت*	*16.07%*	*1,496*	*1,828*	*149*	*1,977*	-	-	-	-	-
BENT JBAYL	*بنت جبيل*	*27.96%*	*9,238*	*11,291*	*1,077*	*12,368*	-	-	-	-	-
SAFAD EL BATTIKH	*صفد البطيخ*	*12.23%*	*555*	*678*	*345*	*1,023*	-	-	-	-	-
TOTAL POPULATION in STUDY AREA			**153,008**	**187,008**	**26,121**	**213,129**	**278,069**	**162,550**	**47,671**	**10,658**	**498,948**

The population count of villages in italics are not accounted for in the sub-total and total population counts.

3. POLLUTION PRESSURES, STATE OF RIVER WATER AND SEDIMENT QUALITY, AND SITUATION ANALYSIS

3.1 POLLUTION PRESSURES

3.1.1 General

169. The generation of a socio-economic and environmental profile for each of the zones was made possible through:

- A thorough desk review of previous studies and databases which hold socio-economic data on the villages and information on pollution pressures within the Study Area;
- Liaisons with stakeholders and coordinators of on-going projects who hold current data on the status of current and planned projects for pollution abatement with the Study Area;
- Extensive field data collection for desk data validation and confirmation of the geographical coordinates of pollution sources throughout the Spring of 2018.

170. A large part of the field data collected on economic activities in each zone was made possible through custom-made survey questionnaire tools, which were specifically prepared for this project.

Table 3-1. Sources of Information on Pollution Pressures in the Lower Litani River Basin

Information Fields	Sources of Information
Municipalities and Villages	MoIM Website
Population & Growth Rates Refugee Population and Distribution of Informal Tented Settlements	National Physical Master Plan of the Lebanese Territory (NPMPLT), 2004 UNHCR Refugee Population by Village, March 2018 UN World Population Prospects 2017
Industries	Ministry of Industry database by caza ELARD Municipal Survey & Field Survey 2018
Classified & Non-classified Non-industrial Establishments	ELARD Municipal Survey & Field Survey 2018
Hospitals & Dispensaries	Ministry of Public Health Database
Recreational Establishments	Ministry of Environment – South Regional Auhority ELARD Municipal Survey & Field Survey 2018 GIS & Remote Sensing Study at Islamic University of Lebanon and CNRS
Solid Waste Dumpsites and Solid Waste Management Facilities	ELARD Municipal Survey 2018 & UNDP/MoE/ELARD 2016 Updated Master Plan for the Closure and Rehabilitation of Dumpsites
Wastewater networks' status and coverage	ELARD Municipal Survey 2018
Wastewater Treatment Plants	ELARD Municipal Survey 2018, CDR and MoEW Meetings
Wastewater Discharge Points	ELARD Municipal Survey & Field Survey 2018

Information Fields	Sources of Information
Quarries	ABQUAR Project Field Survey 2005/2006 & ELARD Municipal Survey
Agriculture - Pesticides and Fertilizers	ELARD Farmers' Survey and Interviews with Agricultural Input Suppliers - 2018
Land Use / Land Cover	Land Use / Land Cover Map, 2017 (based on 2013 satellite images)

171. The data from the field surveys and desk data review are presented by zone in five tables that appear in Appendix C. The data are also put in a GIS platform which allowed for the generation of a map per zone that shows the pollution sources that may influence surface water quality in the Litani River.

3.1.1.1 Zone 1

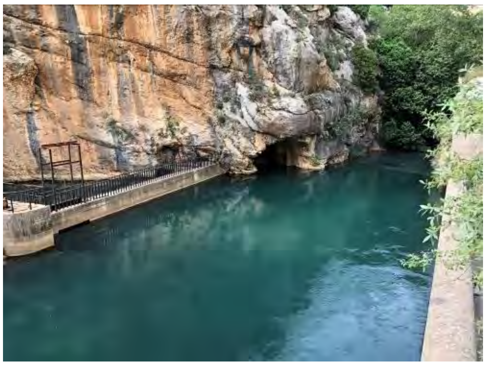
172. Zone 1 is in the upper northern part of the Study Area and is bounded by the Qaraaoun Lake dam wall in the north, along with the villages of Aaytanit, Qaraaoun, Baaloul, and Rafid (Rachaiya). It extends over a surface area of approximately 204.33 km^2 which makes up 25.7% of the total surface area of the LLB Study Area; the second largest Zone among all five. Zone 1 comprises 24 villages, all managed by municipal councils. The dominant land cover in Zone 1 is grassland (30%), followed by natural land (25%) and agricultural land (21%).

Table 3-2. Villages and Localities within Zone 1

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 1
Aaytanit	عيتنيت	West Beqaa	Yes	100.00
Ain Et Tineh	عين التينة	West Beqaa	Yes	100.00
Libbaya	لبايا	West Beqaa	Yes	100.00
Qaraaoun	قرعون	West Beqaa	Yes	100.00
Sohmor	سحمر	West Beqaa	Yes	100.00
Yohmor BG	يحمر (البقاع الغربي)	West Beqaa	Yes	100.00
Zilaya	زلايا	West Beqaa	Yes	100.00
Kfar Michki	كفرمشكي	Rachaiya	Yes	100.00
Nabi Safa	نبي صفا	Rachaiya	Yes – with Kfar Michki	100.00
Majdel Balhis	مجدل بلهيص	Rachaiya	Yes	100.00
Kaoukaba Bou Aarab	كوكبا بو عرب	Rachaiya	Yes	99.97
Machghara	مشغرة	West Beqaa	Yes	99.92
Qelaya	قليا	West Beqaa	Yes	86.32
Loussia	لوسيا	West Beqaa	Yes – with Maydoun	84.94
Mhaiydseh	محيثه	Rachaiya	Yes	74.04
Maydoun	ميدون	West Beqaa	Yes	57.51
Baaloul	بعلول	West Beqaa	Yes	38.10
Rafid	رفيد	Rachaiya	Yes	18.47

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 1
Niha	نيحا	Chouf	Yes	14.95
Hasbaiya	حاصبيا	Hasbaiya	Yes	14.92
Mimess	ميمس	Hasbaiya	Yes	4.06
Dellafi	دلافة	Hasbaiya	Yes	3.55
Kfar Houneh	كفرحونة	Jezzine	Yes	3.54
Rachaiya	راشيا	Rachaiya	Yes	0.04

Dam at Ain ez Zarqa Spring

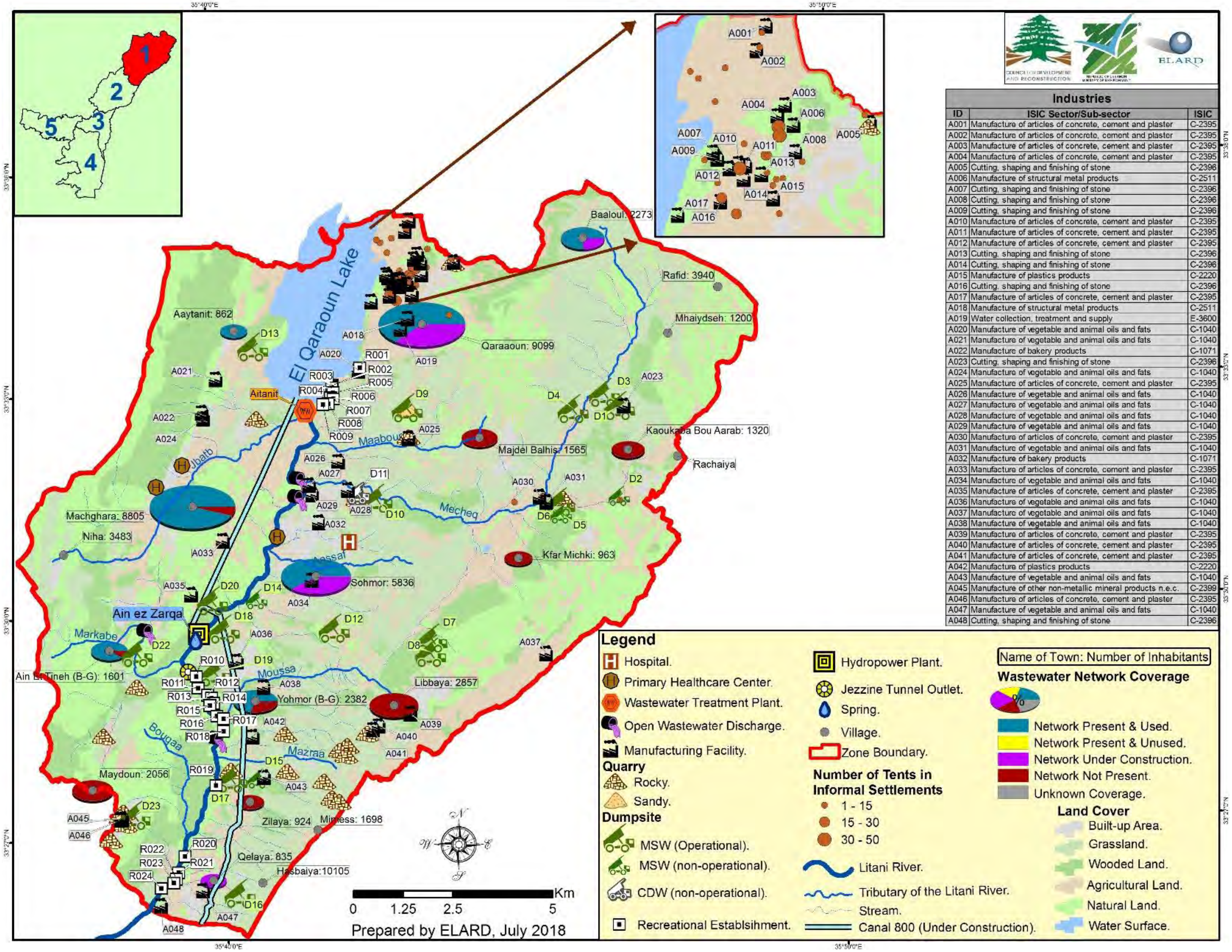


Litani River section south of the Qaraaoun Dam

Tributary from Machghara at low water flow in the dry season

Littering in the Litani River at Sohmor

Markaba Hydroelectric power generation plant



Industries

ID	ISIC Sector/Sub-sector	ISIC
A001	Manufacture of articles of concrete, cement and plaster	C-2395
A002	Manufacture of articles of concrete, cement and plaster	C-2395
A003	Manufacture of articles of concrete, cement and plaster	C-2395
A004	Manufacture of articles of concrete, cement and plaster	C-2395
A005	Cutting, shaping and finishing of stone	C-2396
A006	Manufacture of structural metal products	C-2511
A007	Cutting, shaping and finishing of stone	C-2396
A008	Cutting, shaping and finishing of stone	C-2396
A009	Cutting, shaping and finishing of stone	C-2396
A010	Manufacture of articles of concrete, cement and plaster	C-2395
A011	Manufacture of articles of concrete, cement and plaster	C-2395
A012	Manufacture of articles of concrete, cement and plaster	C-2395
A013	Cutting, shaping and finishing of stone	C-2396
A014	Cutting, shaping and finishing of stone	C-2396
A015	Manufacture of plastics products	C-2220
A016	Cutting, shaping and finishing of stone	C-2396
A017	Manufacture of articles of concrete, cement and plaster	C-2395
A018	Manufacture of structural metal products	C-2511
A019	Water collection, treatment and supply	E-3600
A020	Manufacture of vegetable and animal oils and fats	C-1040
A021	Manufacture of vegetable and animal oils and fats	C-1040
A022	Manufacture of bakery products	C-1071
A023	Cutting, shaping and finishing of stone	C-2396
A024	Manufacture of vegetable and animal oils and fats	C-1040
A025	Manufacture of articles of concrete, cement and plaster	C-2395
A026	Manufacture of vegetable and animal oils and fats	C-1040
A027	Manufacture of vegetable and animal oils and fats	C-1040
A028	Manufacture of vegetable and animal oils and fats	C-1040
A029	Manufacture of vegetable and animal oils and fats	C-1040
A030	Manufacture of articles of concrete, cement and plaster	C-2395
A031	Manufacture of vegetable and animal oils and fats	C-1040
A032	Manufacture of bakery products	C-1071
A033	Manufacture of articles of concrete, cement and plaster	C-2395
A034	Manufacture of vegetable and animal oils and fats	C-1040
A035	Manufacture of articles of concrete, cement and plaster	C-2395
A036	Manufacture of vegetable and animal oils and fats	C-1040
A037	Manufacture of vegetable and animal oils and fats	C-1040
A038	Manufacture of vegetable and animal oils and fats	C-1040
A039	Manufacture of articles of concrete, cement and plaster	C-2395
A040	Manufacture of articles of concrete, cement and plaster	C-2395
A041	Manufacture of articles of concrete, cement and plaster	C-2395
A042	Manufacture of plastics products	C-2220
A043	Manufacture of vegetable and animal oils and fats	C-1040
A045	Manufacture of other non-metallic mineral products n.e.c.	C-2399
A046	Manufacture of articles of concrete, cement and plaster	C-2395
A047	Manufacture of vegetable and animal oils and fats	C-1040
A048	Cutting, shaping and finishing of stone	C-2396

Figure 3-1. Sources of Pollution Pressure in Zone 1

3.1.1.2 Zone 2

173. Zone 2 spreads over a surface area of 144.07 km^2 that constitutes 18.2% of the LLB Study Area extent. A total of 35 localities villages make up Zone 2. However, it is noteworthy that 12 of these are farms with their own cadastral extents where the lands are owned/managed by nearby villages, as is the case for Jarmaq, Rihane and Aaychiyeh in Jezzine. Six of the localities are managed by a mokhtar, and the qae'maqam. The dominant land cover is wooded land (39%), followed by grassland (26%) and agricultural land (16%).

Table 3-3. Villages and Localities within Zone 2

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 2
Jarmaq	جرمق	Jezzine	Yes	100.00
Demachqiyeh	الدمشقية	Jezzine	Yes – with Jarmaq	100.00
Mazraat El Aarqoub	مزرعة العرقوب	Jezzine	Yes – with Jarmaq	100.00
Mazraat Ouazaaiyeh	مزرعة الوازعية	Jezzine	Yes – with Jarmaq	100.00
Mazraat Tamra	مزرعة طمرا	Jezzine	Yes – with Jarmaq	100.00
Rihane	الريحان	Jezzine	Yes	100.00
Mazraat Khallet Khazen	مزرعة خلة خازن	Jezzine	Yes – with Rihane	100.00
Mazraat Qrouh	مزرعة قروح	Jezzine	Yes – with Rihane	100.00
Mazraat Louzid (Louayziyeh)	مزرعة لوزيد (لويزية)	Jezzine	Yes – with Rihane	100.00
Ouardiyeh	وردية	Jezzine	Yes – with Rihane	100.00
Aaychiyeh	العيشية	Jezzine	Yes	100.00
Mahmoudiyeh	المحمودية	Jezzine	Yes – with Aaychiyeh	100.00
Mazraat Zighrine	مزرعة زغرين	Jezzine	Yes – with Aaychiyeh	100.00
Sejoud	سجد	Jezzine	Yes	100.00
Aaramta	عرمتى	Jezzine	Yes	100.00
Chbail	شبيل	Jezzine	No	100.00
Srayri	سريرة	Jezzine	No	100.00
Qatrani	القطراني	Jezzine	No	100.00
Mazraat Daraya	مزرعة داريا	Jezzine	No	100.00
Blat	بلاط	Marjaayoun	Yes	100.00
Dibbine	دبين	Marjaayoun	Yes	100.00

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 2
Kfar Roummane	كفررمان	Nabatiye	Yes	100.00
Bourghos	برغز	Hasbaiya	No	100.00
Kaoukaba	كوكبا	Hasbaiya	Yes	100.00
Dellafi	دلافة	Hasbaiya	Yes	96.45
Bouayda	بويضة	Marjaayoun	No	81.32
Mazraat Doumiat	مزرعة دمياط	Marjaayoun	Yes – with Deir Mimas	50.83
Maydoun	ميدون	West Beqaa	Yes	42.49
Loussia	لوسيا	West Beqaa	Yes – with Maydoun	15.06
Qelaya	قلايا	West Beqaa	Yes	13.68
Aali Et Taher	علي الطاهر	Nabatiye	Yes – with Nabatiye El Faouqa	38.35
Kfar Tibnit	كفرتبنيت	Nabatiye	Yes	28.55
Kfar Houneh	كفرحونة	Jezzine	Yes	19.26
Jdaideh (Marjaayoun)	جديدة (مرجعيون)	Marjaayoun	Yes	9.95
Hasbaiya	حاصبيا	Hasbaiya	Yes	7.13

Litani River at Dellafi Bridge. The western reach (left photo) is fed by springs

Stone cutting effluent at Kaoukaba Bou Arab

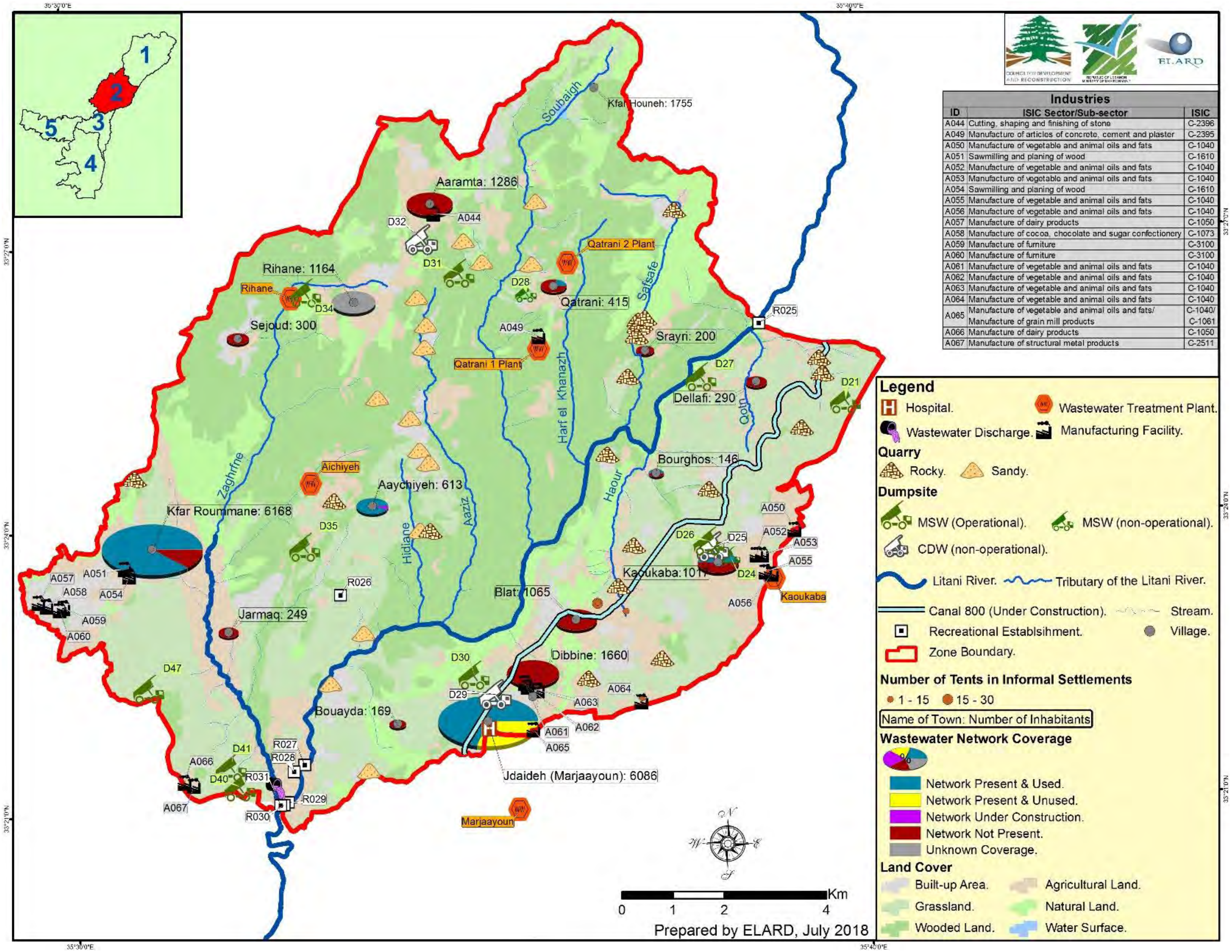
Resthouses near the riverbank in Mazraat Tamra

Solid waste pollution in Litani River in Marjayoun area

Litani River at Dellafi Bridge. The western reach (left photo) is fed by springs

Quarries at Aaychiyeh (left) and at Srayri (right)

EL Maidane Spring water pumped and used for irrigation



Industries		
ID	ISIC Sector/Sub-sector	ISIC
A044	Cutting, shaping and finishing of stone	C-2396
A049	Manufacture of articles of concrete, cement and plaster	C-2395
A050	Manufacture of vegetable and animal oils and fats	C-1040
A051	Sawmilling and planing of wood	C-1610
A052	Manufacture of vegetable and animal oils and fats	C-1040
A053	Manufacture of vegetable and animal oils and fats	C-1040
A054	Sawmilling and planing of wood	C-1610
A055	Manufacture of vegetable and animal oils and fats	C-1040
A056	Manufacture of vegetable and animal oils and fats	C-1040
A057	Manufacture of dairy products	C-1050
A058	Manufacture of cocoa, chocolate and sugar confectionery	C-1073
A059	Manufacture of furniture	C-3100
A060	Manufacture of furniture	C-3100
A061	Manufacture of vegetable and animal oils and fats	C-1040
A062	Manufacture of vegetable and animal oils and fats	C-1040
A063	Manufacture of vegetable and animal oils and fats	C-1040
A064	Manufacture of vegetable and animal oils and fats	C-1040
A065	Manufacture of vegetable and animal oils and fats/ Manufacture of grain mill products	C-1040/ C-1061
A066	Manufacture of dairy products	C-1050
A067	Manufacture of structural metal products	C-2511

Figure 3-2. Sources of Pollution Pressure in Zone 2

3.1.1.3 Zone 3

174. The surface area of Zone 3 is 85.52 km^2, which is 10.8% of the LLB Study Area in cadastral extent. A total of 23 localities are included in Zone 3, and are all managed by municipalities except for two. The dominant land cover is grassland, natural land and wooded land, combined totalling 62%, followed by agricultural land use (32%). The built-up area covers merely 6% of the entire surface area of Zone 3.

Table 3-4. Villages and Localities within Zone 3

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 3
Arnoun	أرنون	Nabatiye	Yes	100.00
Zaoutar Ech Charqiyeh	زوطر الشرقية	Nabatiye	Yes	100.00
Mazraat El Hamra	مزرعة الحمرا	Nabatiye	Yes – with Zaoutar Ech Charqiyeh	100.00
Yohmor	يحمر	Nabatiye	Yes	100.00
Aadaysseh	عديسة	Marjaayoun	Yes	100.00
Deir Mimas	ديرميماس	Marjaayoun	Yes	100.00
Mazraat Doumiat	مزرعة دمياط	Marjaayoun	Yes – with Deir Mimas	49.17
Houra	هوره	Marjaayoun	Yes – with Deir Mimas & Kfar Kila	100.00
Kfar Kila	كفر كلا	Marjaayoun	Yes	100.00
Aalmane	علمان	Marjaayoun	No	77.57
Kfar Tibnit	كفر تبنيت	Nabatiye	Yes	71.45
Qlaiaa	قليعة	Marjaayoun	Yes	70.64
Deir Siriane	دير سريان	Marjaayoun	Yes	61.04
Zaoutar El Gharbiyeh	زوطر الغربية	Nabatiye	Yes	54.12
Borj El Mlouk	برج الملوك	Marjaayoun	Yes	48.03
Taybeh	طيبة	Marjaayoun	Yes	44.10
Rabb Et Talatine	رب الثلاثين	Marjaayoun	Yes	32.13
Bouayda	بويضة	Marjaayoun	No	18.47
Markaba	مركبا	Marjaayoun	Yes	12.65
Houla	حولا	Marjaayoun	Yes	6.74
Qaaqaaiyet Ej Jisr	قعقعية الجسر	Nabatiye	Yes	4.74
Aadchit (Qoussair)	عدشيت (القصير)	Marjaayoun	Yes	2.40

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 3
Jdaideh (Marjaayoun)	جديدة (مرجعيون)	Marjaayoun	Yes	0.47

Informal Tented Settlements in Khiyam

Litani River near Khardali bridge

Resthouses at the riverbank at Qaaqaaiyet Ej Jisr

Taybeh Pumping Station

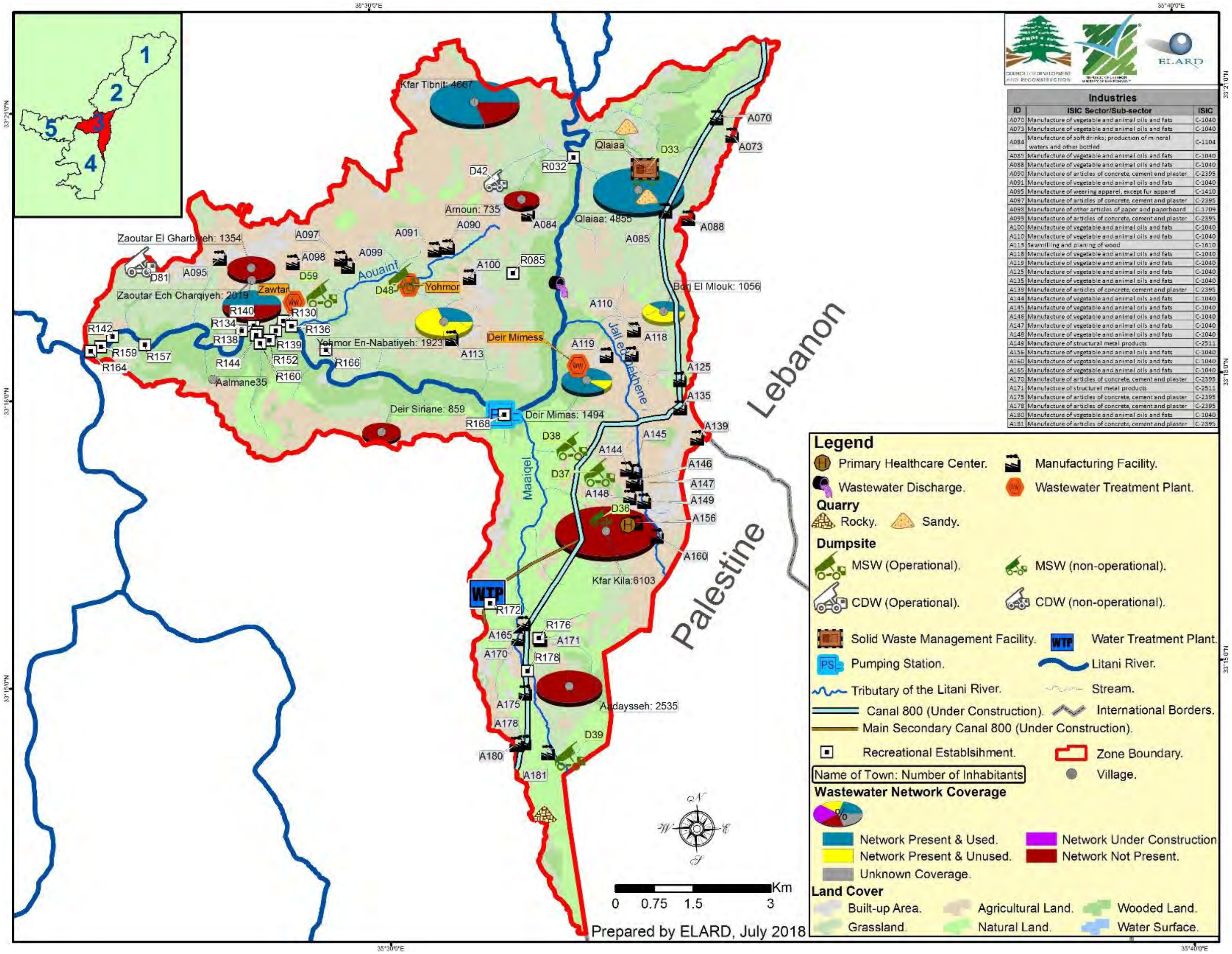


Figure 3-3. Sources of Pollution Pressure in Zone 3

3.1.1.4 Zone 4

175. Zone 4 spans a surface area of 231.27 km^2, the largest Zone within the study Area in terms of surface area (29.2%). Zone 4 comprises 35 villages, which have independent municipal councils except for the villages of Mhaibib and Aalmane. Zone 4 is administratively split between the Cazas of Bent Jbayl and Marjaayoun. The area is drained by a major tributary which feeds the Lower Litani River at Qaaqaaiyet Ej Jisr, which however is dry year-round and is home to the Wadi El Hujier Nature Reserve. The dominant land use is agricultural (40%), followed by grassland (21%), natural land (20%), wooded land (13%) and built-up areas constituting 7% of the surface area.

Table 3-5. Villages and Localities within Zone 4

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 4
Borj Qalaouiyeh	برج قلويه	Bent Jbayl	Yes	100.00
Blida	بليدا	Marjaayoun	Yes	100.00
Bani Haiyane	بني حيان	Marjaayoun	Yes	100.00
Beit Yahoun	بيت ياحون	Bent Jbayl	Yes	100.00
Touline	تولين	Marjaayoun	Yes	100.00
Jmaijmeh	جميجمه	Bent Jbayl	Yes	100.00
Khirbet Selm	خربة سلم	Bent Jbayl	Yes	100.00
Soultaniyeh	سلطانية	Bent Jbayl	Yes	100.00
Chaqra	شقرا	Bent Jbayl	Yes	100.00
Souaneh	صوانة	Marjaayoun	Yes	100.00
Talloussa	طلوسة	Marjaayoun	Yes	100.00
Tiri	طيري	Bent Jbayl	Yes	100.00
Aaytaroun	عيترون	Bent Jbayl	Yes	100.00
Aaynata	عيناتا	Bent Jbayl	Yes	100.00
Qabrikha	قبريخا	Marjaayoun	Yes	100.00
Qalaouiyeh	قلويه	Bent Jbayl	Yes	100.00
Qantara	قنطرة	Marjaayoun	Yes	100.00
Kfar Dounine	كفر دونين	Bent Jbayl	Yes	100.00
Kounine	كونين	Bent Jbayl	Yes	100.00
Maroun Er Ras	مارون الراس	Bent Jbayl	Yes	100.00
Majdel Selm	مجدل سلم	Marjaayoun	Yes	100.00

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 4
Mhaibib	محيبيب	Marjaayoun	No	100.00
Meiss Ej Jabal	ميس الجبل	Marjaayoun	Yes	100.00
Aadchit (Qoussair)	عدشيت (القصير)	Marjaayoun	Yes	97.60
Houla	حولا	Marjaayoun	Yes	93.24
Markaba	مركبا	Marjaayoun	Yes	87.35
Ghandouriyeh	غندورية	Bent Jbayl	No	84.73
Rabb Et Talatine	رب الثلاثين	Marjaayoun	Yes	67.87
Taybeh	طيبة	Marjaayoun	Yes	55.90
Deir Siriane	دير سريان	Marjaayoun	Yes	38.96
Bent Jbayl	بنت جبيل	Bent Jbayl	Yes	27.96
Froun	فرون	Bent Jbayl	Yes	27.65
Aalmane	علمان	Marjaayoun	No	22.43
Baraachit	برعشيت	Bent Jbayl	Yes	16.07
Safad El Battikh	صفد البطيخ	Bent Jbayl	Yes	12.23

Municipal solid waste dumping in Majdel Selm

Litani River passing through a canal in Qoussair

Dry Litani River Tributary in Qantara after Hujeir Spring outlet

Litani River Tributary section in Wadi El Hujeir Reserve

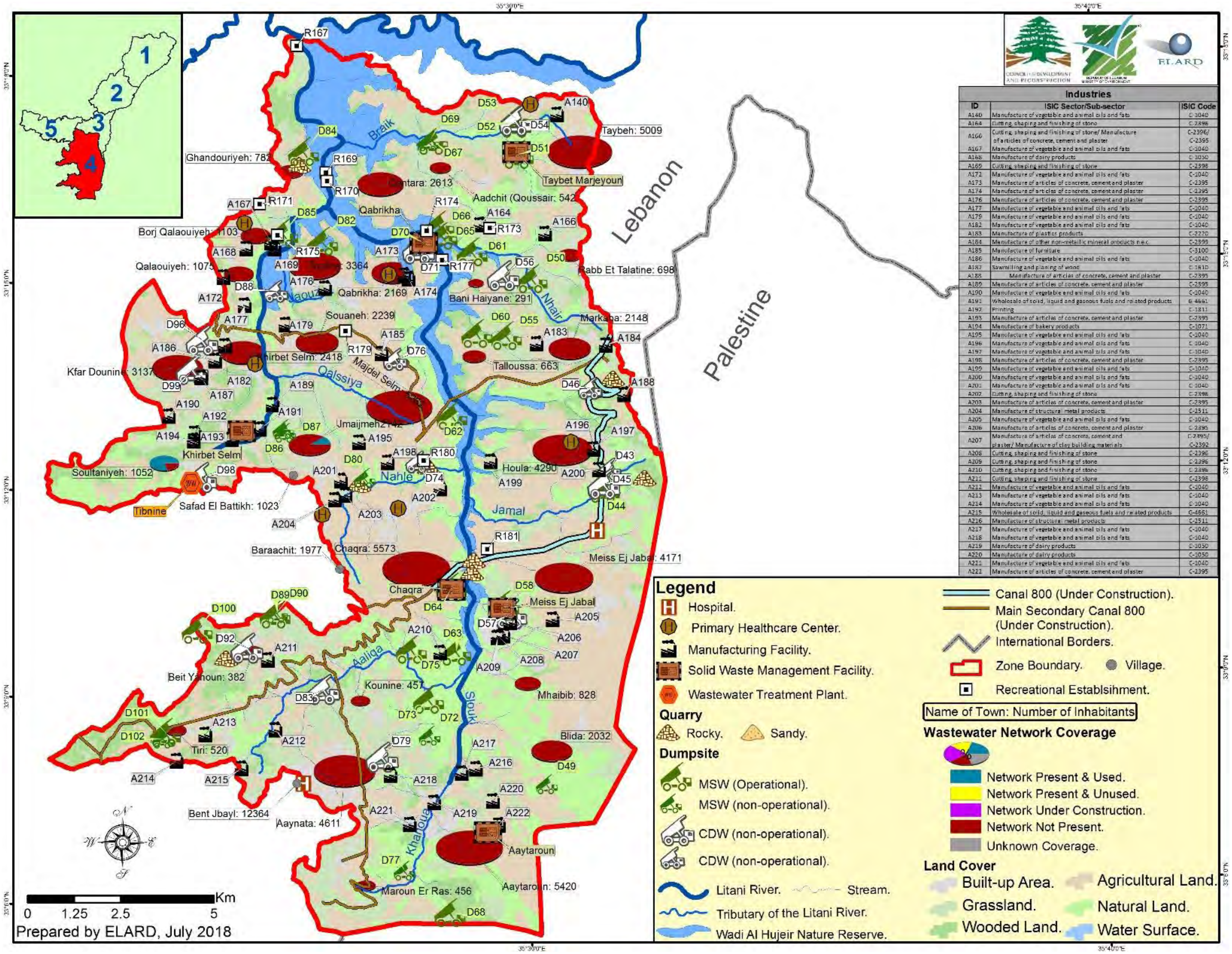


Figure 3-4. Sources of Pollution Pressure in Zone 4

3.1.1.5 Zone 5

176. Zone 5 extends over a surface area of 127.38 km^2, which makes up nearly 16.1% of the LLB Study Area, in surface area. Zone 5 comprises a total of 35 localities, 23 of which have independent municipal councils. Zone 5 is the largest zone by number of inhabitants, and 9% of its surface area is built-up. The dominant land use is agriculture at 38%, followed by grassland (19%), wooded land (17%) and natural land (17%).

Table 3-6. Villages and Localities within Zone 5

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 5
Qsaibeh	قصيبة	Nabatiye	Yes	100.00
Kfar Sir	كفر صير	Nabatiye	Yes	100.00
Arzoun	أرزون	Sour	Yes	100.00
Bestiyat	بثتيات	Sour	No	100.00
Bedias	بدياس	Sour	Yes	100.00
Borj Rahhal	برج رحّال	Sour	Yes	100.00
Ain Abou Abdallah	عين ابو عبدالله	Sour	Yes – with Borj Rahhal	100.00
Jazira (Saida)	جزيرة	Saida	Yes – with Arzai	100.00
Jennata	جناتا	Sour	Yes	100.00
Halloussiyeh	حلوسية	Sour	Yes	100.00
Hmairi	حميري	Sour	Yes	100.00
Derdaghaiya	دردغايا	Sour	Yes	100.00
Deir Qanoun En-Nahr	دير قانون النهر	Sour	Yes	100.00
Chehour	شحور	Sour	Yes	100.00
Tayr Falsay	طير فلسيه	Sour	Yes	100.00
Srifa	صريفا	Sour	Yes	100.00
Marnaba	مرنبا	Sour	Yes – with Srifa	100.00
Mazraat Tayr Semhat	مزرعة طير سمحات	Sour	Yes – with Srifa	100.00
Niha	نيحا	Sour	Yes – with Srifa	100.00
Touayri	طويري	Sour	No	100.00
Mazraat El Ouasta	مزرعة الواسطة	Saida	Yes – with Kharayeb	100.00
Matariyet Ech Choumar	مطرية الشومر	Saida	Yes – with Arzai	100.00
Maaroub	معروب	Sour	Yes	100.00

Village (EN)	Village (AR)	District	Municipality	% Village Area within Zone 5
Sir El Gharbiyeh	صير الغربية	Nabatiye	Yes	98.58
Qaaqaaiyet Ej Jisr	قعقعية الجسر	Nabatiye	Yes	95.26
Arzai	ارزي	Saida	Yes	86.81
Mazraat El Aaitaniyeh (Yahoudiyeh)	مزرعة العيتانية (اليهودية)	Saida	Yes – with Kharayeb	73.05
Froun	فرون	Bent Jbayl	Yes	72.35
Mazraat Jamjim	مزرعة جمجيم	Saida	Yes – with Kharayeb	65.34
Kharayeb (Saida)	الخرايب	Saida	Yes	65.23
Zaoutar El Gharbiyeh	زوطر الغربية	Nabatiye	Yes	45.88
Braiqeaa	بريقع	Nabatiye	Yes	35.99
Zrariyeh	زرارية	Saida	Yes	33.40
Ghandouriyeh	غندورية	Bent Jbayl	No	15.27
Aabbassiyeh	عباسية	Sour	Yes	8.19

Litani River at a resthouse (left) and municipal solid waste dumping in Bedias (right)

Litani River at Borj Rahhal

Al Sadd Al Raeesi in Zrariyeh (left) LRA Qassmieh Station (right)

Resthouse at the riverbank in Chehour, and (left) resthouse in Tayr Falsay (right)

Litani River at a resthouse (left) and municipal solid waste dumping in Bedias (right)		
Solid waste littering in Tabel tributary at Matariyet Ech Choumar		

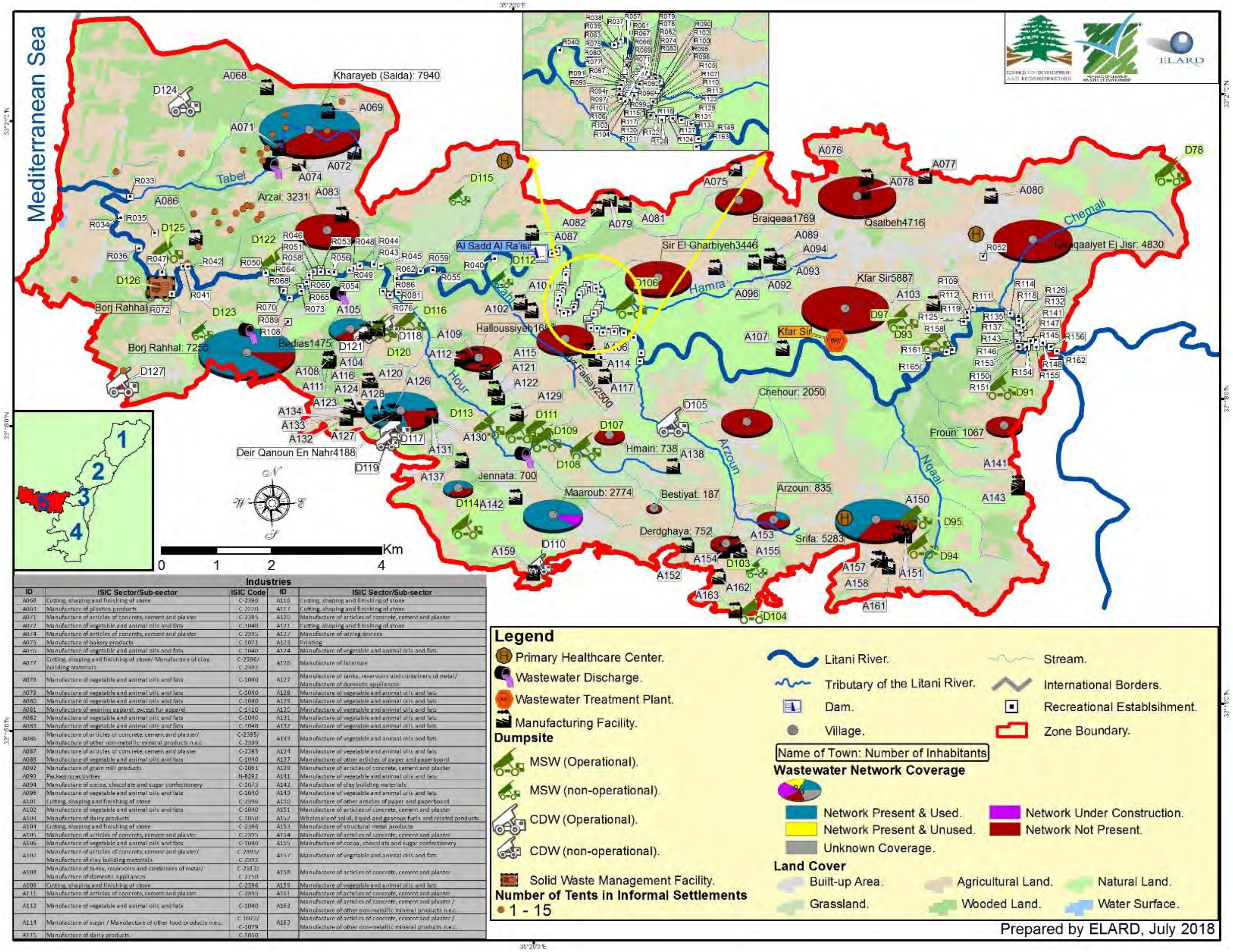


Figure 3-5. Sources of Pollution Pressure in Zone 5

3.1.2 Pollution Pressures from Solid Waste Disposal Practices

177. Municipal, industrial and healthcare waste disposal practices were analysed across the five zones to assess the threat posed by solid waste to the Lower Litani River and its tributaries' surface waters through littering and surface runoff. While it is acknowledged that leachate from solid waste dumpsites constitutes a threat to groundwater sources where aquifers are shallow and geologic formations allow infiltration of the leachate, the threat to groundwater from leaching and to surface water from the deposition of micropollutants generated from open burning practices in dumpsites outside of the watershed boundary were not considered in the analysis.

178. For each dumpsite and 'potentially' threatening solid waste disposal practice, the susceptibility of the surface water to be affected by the pressures was assessed based on the pressure's distance to the surface water stream or body (within 200 m from a surface water course), expert judgement from the field examination and likelihood of the dumpsite receiving solid wastes of hazardous nature from nearby pressure sources. The susceptibility indicator is represented by a low-medium-high rating. The overall pressure level rating for each zone was determined based on an average rating of solid waste pressures given across the zone in question.

179. Across the five zones, the surveyed dumps were reported to receive 219.2 tonnes per day, while the total generation rate was reported by municipalities to be 296.4 tonnes per day. The largest discrepancies between dumped and generated waste quantities are noted in Zones 1, 3 and 5. Sources of discrepancies could be due to mis-estimation of the quantities of waste in dumpsites, mis-reporting of quantities generated by municipalities, and/or presence of dumpsites outside of the LL river basin that could be receiving waste from villages within the basin. Although there are sorting and composting facilities with gross treatment capacity of 58 tonnes per day throughout the basin area (52 tonnes are in Zone 4), rejects from these facilities are received in dumpsites.

180. It is noteworthy that the types of wastes received by these dumspites are mixed wastes that could contain hazardous wastes such as household hazardous wastes, industrial waste, used oils, agricultural and household pesticides containers, that are mixed with municipal waste due to the absence of collection of sorted waste. It is reported by the hospitals that infectious healthcare waste is being collected by licensed private operators, nonetheless, it may be possible that such wastes from other healthcare facilities such as primary healthcare centers or clinics may be ending up in the mixed municipal waste stream that is disposed of in open dumps.

3.1.2.1 Zone 1

181. In this first zone of the Lower Litani River Basin, there are 21 dumpsites for MSW as shown in Table 3-7, and one dumpsite for construction and demolition wastes (currently non-operational). Four of the MSW dumpsites were abandoned within the past few years and are non-operational. The majority of the 17 MSW dumps are operating for more than 10 years and are currently receiving around 43.1 t/d of wastes of different kinds (municipal, industrial and slaughterhouse) that are disposed of in a haphazard manner.

182. In all of these dumps, open burning of wastes is practiced without any control to create space in the dump, often leading to complaints and air pollution (as per example shown in Figure 3-6). Except for Ain El Tineh, Sohmor and Majdel Balhis dumps (D22, D10 and D3), these dumps do not have a direct impact on the pollution of the River since they are relatively far from the main river or any of its tributaries.

Table 3-7. Characteristics of MSW Dumps in Zone 1

ID	Name	Latitude	Longitude	Current Status	Waste Dumped (t/d)	Distance (m) to Litani River or Tributary	
D22	F5-Ain el Tine-00	33.492213	35.644073	Operational	2	7	Markabe
D13	G5-Aitanit-00	33.560442	35.6773	Operational	0.3	1,893	Litani River
D16	F5-Qelia-00	33.43742	35.670111	Operational	1	1,649	Litani River
D1	G6-Kaoukaba-02	33.545019	35.77563	Operational	0.5	580	Mecheq
D2**	G6-Kaoukaba-01	33.524643	35.774865	Non-operational	0	1,809	Mecheq
D10	G5-Sohmor-01n	33.525579	35.70963	Operational	0.5	42	Mecheq
D6	G6-Kfarmeshki-01n	33.523682	35.75886	Operational	0.5	396	Mecheq
D5**	G6-Kfarmechki-00	33.521047	35.759136	Non-operational	0	584	Mecheq
D7	F5-Libbaya-00	33.49374	35.723437	Operational	2	1,711	Moussa
D8	LLB-Libbaya	33.490527	35.723093	Operational	1	1,441	Moussa
D20	G5-Machghara-00	33.503458	35.664665	Operational	9	278	Litani River
D3	LLB-Majdel Balhis	33.548083	35.771672	Operational	0.5	80	Mecheq
D4	G6-Majdel Balhis-00	33.544606	35.763112	Operational	1	248	Mecheq
D23	F5-Maidoun-00	33.45551	35.642338	Operational	0.8	1,162	Bouqaa
D9	G5-Qaraoun-00	33.545821	35.718462	Operational	10	918	Maabour
D14***	G5-Sohmor-00	33.503484	35.676555	Non-operational	0	253	Litani River
D12	F5-Sohmor-03n	33.496595	35.697218	Operational	9	1,030	Moussa
D18	F5-Yohmor-00	33.497049	35.667627	Operational	2	315	Litani River
D19	LLB-Yohmor BG	33.48737	35.66486	Operational	2	509	Litani River
D17	LLB-Zilaya	33.463285	35.668674	Operational	1	387	Litani River
D15	F5-Zellaya-00	33.463087	35.675674	Non-operational	0	414	Mazraa

** Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Covered
*** Reported in UNDP/MoE/ELARD (2017) study as Not Rehabilitated

Figure 3-6. Open Burning of Waste at Sohmor Dump (D10)

183. The three dumps of concern (Ain El Tineh, Sohmor and Majdel Balhis) are all located at close distance (less than 200 m) to one of the tributaries of the Litani River in this zone. They are relatively small in size and receive a small amount of waste from their respective villages.

184. Ain El Tineh dump (D22) is directly located on Markabe tributary and consequently poses a direct pressure to the pollution of the Litani River. The dump is located on a piece of land owned by the municipality. It occupies an area of 1,500 m^2 and receives around 2 t/d of mixed municipal wastes from the village of Ain El Tineh. Usually, wastes are piled up in the dump without any control to reach about 1m in height. Once the volume of waste in the dump increases, open burning is practiced to create new space for the disposal of fresh wastes.

185. Sohmor dump (D10) is located at 42 m from the Mecheq tributary and consequently poses a direct pressure to the pollution of the Litani River. The dump is located on a piece of land owned by the municipality. It occupies an area of 500 m^2 and receives a small portion (0.5 t/d) of the mixed municipal wastes generated in Sohmor. Usually, wastes are piled up in the dump without any control. Once the volume of waste in the dump increases, open burning is practiced to create new space for the disposal of future wastes.

186. Majdel Balhis dump (D3) is also located at 80m from the Mecheq tributary and is located on a piece of land owned by the municipality. It occupies an area of 500 m^2 and receives around 0.5 t/d of mixed municipal wastes from the village of Sohmor. Usually, wastes are piled up in the dump without any control and then burned to create new space for fresh waste.

187. Medical wastes generated from the only hospital in this zone (West Bekaa Hospital) are collected and treated by a local company (SAFE Contracting) at the sterilization center in Aabbassiyeh. According to SAFE Contracting, 200 kg/month of infectious medical waste from West Bekaa Governmental Hospital are collected and treated through autoclaving and shredding at their facility. Other primary health care centres present in the region are mainly located in Machghara and consequently do not pose a threat on the Litani River since they are located far from the River and wastes are expected to be either burned on site or dumped in Machghara dump (D20).

188. Other potential sources of pollution to the Litani River include industrial solid wastes that might be disposed of in any of the three dumps of concern or are directly disposed of in the River, especially during the dry season (at locations where industries are very close to the Litani River). Types of solid wastes include organic wastes, packaging wastes, oil cans, wood and plastics, construction debris; as well as some hazardous industrial wastes such as used oils, grease, used batteries, and wastes potentially contaminated with traces of heavy metals.

189. Pollution of the River's water might also be caused by littering and disposal of waste directly along the river banks, from recreational areas, surface water runoff and drainage of leachate to the River during summer and winter times.

190. The pressures to the Litani River from improper solid waste disposal practices in Zone 1 are summarised in Table 3-8. The overall pressure level exerted by the solid waste practices in Zone 1 is deemed to be low.

Table 3-8. Pressures Exerted in Zone 1 due to Solid Waste Disposal Practices

Pressure	Pathway	Susceptibility	Indicator	Impact
D22 – Ain El Tineh	Leachate and surface runoff into Markabe tributary Falling solid garbage in River	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D10 – Sohmor	Leachate and surface runoff into Mecheq tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D3 – Majdel Balhis	Leachate and surface runoff into Mecheq tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
Direct dumping of wastes in River	Dumping of solid garbage in Litani River	Low	Aesthetic deterioration through litter	Pollution of the river water: littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils

3.1.2.2 Zone 2

191. In Zone 2 of the Lower Litani Basin, there are 15 MSW dumps and three non-operational CDW dumps. Ten of the MSW dumps are operational while five were abandoned since almost six years (Table 3-9). The operational dumps receive around 20.3 t/d of mixed municipal wastes. Apart from Hasbaiya dump (D21) which receives around 6 t/d of waste, most of the dumps are very small and receive small quantities of wastes.

192. In all of these dumps, open burning of wastes is practiced without any control. Except for the Rihane-Jezzine dump (D34), these dumps do not have a direct impact on the pollution of the River since they are relatively far from the river or any of its tributaries and surface runoff is not expected to reach the River.

Table 3-9. Characteristics of MSW Dumps in Zone 2

ID	Name	Latitude	Longitude	Current Status	Waste Dumped (t/d)	Distance (m) to Litani or Tributary	
D35	F4-Aaychiye-00	33.396737	35.549203	Operational	0.2	1,705	Zaghrfne
D31	F4-Aaramta-00	33.444398	35.583075	Operational	1	562	Aaziz
*	E4-Blat Marjeyoun-00	33.395893	35.614185	Non-operational	0	31	Haour
D30	E4-Dibbine-01	33.373435	35.584135	Operational	1	680	Litani River
D27	F5-Dellafe-00	33.42504	35.633405	Operational	0.1	225	Litani River
*	E4-Dibbine-02	33.371698	35.585015	Non-operational	0	877	Litani River
*	E4-Dibbine-03	33.369766	35.588291	Non-operational	0	1,145	Litani River
D21	E5-Hasbaya-00	33.420469	35.663684	Operational	6	1,842	Qotn
D26	E5-Kaoukaba Hasbaya-01	33.396059	35.634233	Operational	2	1,872	Haour
D24**	E5-Kaoukaba Hasbaiya-02	33.393229	35.638478	Non-operational	0	2,087	Haour
D47	E4-Kfar Roummane-00	33.372351	35.515666	Operational	4	1,336	Litani River
D41	E4-Kfar Tibnit-00	33.358317	35.53265	Operational	3	674	Litani River
D40	LLB-Arnoun	33.354746	35.534374	Operational	1	653	Litani River
D28	LLB-Qatrani	33.440638	35.597034	Non-operational	0	470	Soubaigh
D34	F4-Rihane Jezzine-00	33.44156	35.550651	Operational	2	172	Zaghrfne

* Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Removed
** Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Covered

193. Rihane-Jezzine dump (D34) is located at 172 m from the Zaghrfne tributary and consequently poses pressure to the pollution of the Litani River. The dump is located on a piece of land owned by the municipality. It occupies an area of 700 m^2 and receives around 2 t/d of mixed municipal wastes generated from Rihane and the Syrian refugees present there. Usually, wastes are piled up in the dump without any control. Once the volume of waste in the dump increases, open burning is practiced to create new space for the disposal of future wastes.

194. Pollution of the Litani River in this zone is mainly from direct dumping of different types of waste in the water stream especially during the dry seasons. These might include some light industrial solid wastes such as organic waste, packaging waste, oil cans, wood and plastics; and some hazardous industrial wastes such as used oils, batteries and contaminated packaging.

195. In this zone, there is only one hospital - Marjaayoun Governmental Hospital (45 beds). This hospital has a contract with SAFE Contracting for the collection and treatment of its infectious waste at Aabbassiyeh treatment center. The average monthly quantity treated is 750 kg. Thus, no pollution of the Litani River from medical wastes is expected especially that the hospital is far away from any of its tributaries.

196. The potential pressures to the Litani River from improper solid waste disposal practices in Zone 2 are summarised in Table 3-10. The overall pressure level exerted by the solid waste practices in Zone 2 is deemed to be Low.

Table 3-10. Pressures Exerted in Zone 2 due to Solid Waste Disposal Practices

Pressure	Pathway	Susceptibility	Indicator	Impact
D34 – Rihane-Jezzine	Leachate and surface runoff into Zaghrfne tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
Direct dumping of wastes in River	Dumping of solid garbage in Litani River	Low	Aessthetic deterioration through litter	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils

3.1.2.3 <u>Zone 3</u>

197. In Zone 3 of the Lower Litani Basin, there are eight MSW dumps and three CDW dumps (two of which are non-operational). Six of the MSW dumps are operational while two were abandoned in 2004 and 2012, respectively. The operational dumps receive collectively a small amount of mixed municipal wastes (around 10.3 t/d). All of the dumps are relatively small and receive small quantities of wastes as described in Table 3-11.

198. In all of these dumps, open burning of wastes is practiced without any control. Except for Yohmor En Nabatiye dump (D48), these dumps do not have a direct impact on the pollution of the River since they are relatively far from the river or any of its tributaries and surface runoff is not expected to reach the River.

Table 3-11. Characteristics of MSW Dumps in Zone 3

ID	Name	Latitude	Longitude	Current Status	Waste Dumped (t/d)	Distance (m) to Litani or Tributary	
D39	C4-Aadaysse Marjeyoun-00	33.236066	35.538066	Operational	2	220	Maaiqel
D38	D4-Deir Mimas-00	33.289929	35.540052	Operational	0.8	743	Maaiqel
D37	LLB-Deir Mimas	33.28525	35.545639	Operational	0.5	764	Jall ed Dekhene
D36**	D4-Kfar Kila-00	33.277362	35.54571	Non-operational	0	839	Jall ed Dekhene
D59	LLB-Zaoutar Ech-Charqiye	33.317578	35.488889	Operational	1	443	Aouainal
D33	E4-Qlaiaa-00	33.337499	35.556797	Operational	5	1,288	Litani River
D48	LLB-Yohmor en-Nabatieh	33.320003	35.506032	Operational	1	24	Aouainal
*	D3-Zaoutar El-Gharbiye-00	33.318647	35.444334	Non-operational	0	795	Litani River

* Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Removed
** Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Covered

199. Yohmor En Nabatiye dump (D48) is located at 24 m from the Aouainal tributary and consequently poses pressure to the pollution of the Litani River. The dump is relatively new (less than 2 years old) and is located on a private land. The dump receives around 1 t/d of mixed municipal wastes generated in parts of Yohmor where wastes are burnt on a regular basis.

200. There are no hospitals in this zone. Only one health care center is present in Kfar kila. This center generates small amounts of medical wastes (around 35 kg/month) and is expected to dispose of it in Deir Mimas dump (D37) which is far away from the Litani River and does not pose any threat to the River.

201. Pollution of the Litani River in this zone is mainly from direct dumping of waste of different types in the water stream especially during the dry seasons. These might include some light industrial solid wastes such as organic waste, packaging waste, oil cans, wood and plastics; and some hazardous industrial wastes such as used oils, batteries and contaminated packaging.

202. The potential pressures to the Litani River from improper solid waste disposal practices in Zone 3 are summarised in Table 3-12. The overall pressure level exerted by the solid waste practices in Zone 3 is deemed to be low.

Table 3-12. Pressures Exerted in Zone 3 due to Solid Waste Disposal Practices

Pressure	Pathway	Susceptibility	Indicator	Impact
D48 – Yohmor (Nabatiye)	Leachate and surface runoff into Aouainal tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils

Pressure	Pathway	Susceptibility	Indicator	Impact
Direct dumping of wastes in River	Dumping of solid garbage in Litani River	Low	Aesthetic deterioration through litter	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils

3.1.2.4 Zone 4

203. Despite the presence of the largest number of solid waste treatment facilities, this zone of the Lower Litani Basin is characterized by the highest number of dumps. In this zone, there are 40 MSW dumps and 19 CDW dumps (eight of the CDW dumps are non-operational), as shown in Table 3-13. From the 40 MSW dumps, 15 are non-operational while 25 receive around 85.3 t/d of mixed municipal solid wastes. The reason for having this high number of operational and non-operational dumps is since Kfour Nabatiye sorting and composting facility that serves the Nabatiye district was operated and shut down at several occasions, thus municipalities had to resort to new dumps for the disposal of their waste in the absence of any alternatives.

204. The existing SWM facilities in this area are mainly small-scale sorting and composting facilities that were built more than 15 years ago by USAID and have been refurbished and upgraded in the last five years through European funding through OMSAR or ESFD. These facilities are the following: Aaytaroun, Meiss Ej Jabal, Khirbet Selm, Qabrikha and Taybeh. The capacity varies between 5 t/d to 20 t/d. They are mostly of the drum composting type except for Aaytaroun and Qabrikha that are based on windrow composting.

Table 3-13. Characteristics of MSW Dumps in Zone 4

ID	Name	Latitude	Longitude	Current Status	Waste Dumped (t/d)	Distance (m) to Litani or Tributary	
D67	D3-Aadchit El-Qouassair-01	33.282028	35.476978	Operational	1.5	174	Braik
D69	LLB-Aadchit Qoussair	33.281857	35.475839	Non-operational	0	160	Braik
D66	LLB-Qantara	33.261521	35.478137	Operational	1	416	Litani River
D65	D3-Qantara-00	33.258992	35.478906	Operational	1	241	Nhair
D68	B3-Maroun Er Ras-03n	33.095285	35.476632	Operational	2	1,320	Khanoua
D61	C3-Bany Haiyane-00	33.25482	35.487522	Operational	0.3	145	Nhair
D89	B3-Beit Yahoun-01	33.168725	35.428962	Non-operational	0	1,999	Aaliqa
D90	LLB-Beit Yahoun	33.168447	35.428388	Operational	0.5	1,994	Aaliqa
D100	C3-Aaita Ej-Jabal-00	33.165209	35.405846	Operational	5	2,930	Aaliqa
D49* **	B3-Aitaroun-00	33.1258	35.505371	Non-operational	0	2,436	Litani River
D85	D3-Borj Qalaouiye-00	33.260443	35.433186	Operational	1	264	Litani River
D64	C3-Chaqra-00	33.173933	35.479309	Operational	10	380	Litani River
D75	B3-Kounine-01	33.159164	35.46727	Operational	3	129	Aaliqa

ID	Name	Latitude	Longitude	Current Status	Waste Dumped (t/d)	Distance (m) to Litani or Tributary	
D63	C3-Baraachit-00	33.15848	35.480133	Operational	1	494	Litani River
D53	LLB-Deir Siriane	33.286947	35.501022	Operational	0.4	331	Braik
D52	D3-Deir Siriane-00	33.285673	35.501032	Operational	0.2	193	Braik
D84	D3-Ghandouriyet Bent Jbayl-00	33.280045	35.439674	Operational	0.7	543	Litani River
*	C4-Houla-01	33.19807	35.523885	Non-operational	0	74	Jamal
D44	LLB-Houla	33.196965	35.523956	Operational	3.5	102	Jamal
D80**	C3-Safad LBattikh-01	33.200827	35.455053	Non-operational	0	189	Nahle
D87***	C3-Jmaijme-01	33.213134	35.431978	Non-operational	0	500	Litani River
D86***	C3-Jmaijme-02	33.212207	35.432495	Non-operational	0	583	Litani River
*	C3-Kfar Dounine-00	33.240916	35.412905	Non-operational	0	1,233	Litani River
D73	B3-Aaynata Bent Jbayl-02n	33.147006	35.471967	Operational	5	274	Aaliqa
D72**	B3-Aaynata Bent Jbayl-00	33.138209	35.471976	Non-operational	0	775	Litani River
D62	C3-Majdel Selm-03	33.215489	35.48059	Operational	12	377	Litani River
D77**	B3-Maroun Er-Ras-01	33.105749	35.463855	Non-operational	0	227	Khanoua
D58	C4-Meiss Ej-Jabal-00	33.169417	35.494187	Operational	10	814	Litani River
D70	C3-Qabrikha-01	33.257455	35.473293	Operational	4	221	Litani River
*	D3-Qalaouiye-01	33.251773	35.424435	Non-operational	0	146	Litani River
D50	D3-Rabb Et-Tlatine-00	33.248004	35.504616	Operational	0.5	178	Nhair
*	C3-Khirbet Selm-00	33.212918	35.420913	Non-operational	0	281	Litani River
*	C3-Soultaniyet Bent Jbayl-01	33.199355	35.39675	Non-operational	0	1,476	Litani River
D60	C3-Talloussa-00	33.235107	35.488297	Operational	0.3	1,161	Litani River
D55	C4-Markaba-00	33.234398	35.49682	Operational	3	1,241	Nhair
D51	D3-Taybet Marjeyoun-00	33.278157	35.501451	Operational	15	623	Braik
D101	LLB-Tiri	33.140429	35.396021	Operational	0.4	2,353	Aaliqa
D102	B3-Tiri-00	33.139024	35.395335	Non-operational	0	2,384	Aaliqa
D82	C4-Touline-00	33.258268	35.444518	Operational	4	729	Litani River
*	C3-Saouanet Marjeyoun-01	33.244017	35.430759	Non-operational	0	329	Litani River

* Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Removed
** Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Covered
*** Reported in UNDP/MoE/ELARD (2017) study as Not Rehabilitated

205. Out of the 25 operational dumps, six are expected to have a direct impact on the pollution of the Litani River since they are at close distances from the River and its tributaries (less than 200 m). These are:

- Aadchit El Quassair dump (D67) is located at 174 m from Braik tributary and receives around 1.5 t/d of mixed MSW. The dump is located on a piece of land that is 500 m^2 in size. The waste are piled up and burned when their volume increases.

- Bani Haiyane dump (D61) is located at 145 m from Nhair tributary and receives 0.3 t/d of mixed MSW from the village. The area of the dump is very small in size (100 m^2).
- Kounine dump (D75) is located at 129 m from Aaliqa tributary and receives around 3 t/d of mixed MSW. The area of the dump is around 1,000 m^2. Waste is often burned to reduce volumes.
- Deir Siriane dump (D52) is located at 193 m from Braik tributary and receives 0.2 t/d of mixed MSW.
- Houla dump (D44) is located at 102 m from Jamal tributary and receives 3.5 t/d of mixed waste from Houla village. The dump is located along the valley and has a size of 1,000 m^2.
- Rabb Et Talatine dump (D50) is located at 178 m from Nhair tributary and receives 0.5 t/d of mixed MSW. The dump has an area of 1,500 m^2 and is located in the valley.

206. In all of the six dumps, open burning is often practiced to reduce the volume of waste in the dumps.

207. Two governmental hospitals are present in this zone, these are Mays El Jabal (45 beds) and Bent Jbayl (100 beds). These hospitals generate around 85 kg of infectious waste per day that should be properly disposed of. According to SAFE Contracting, both hospitals have a contract with arc-en-ciel for the collection and treatment of their infectious waste and consequently they are not expected to cause any harm to the Litani River. Small health care centers in this zone exist but have contracts with SAFE to collect and treat their waste in the Aabbassiyeh treatment center (Imam El Sader Center in Chaqra and Deir Siriane, and Borj Qalaouiyeh Center in Ghandouriyeh).

208. The potential pressures to the Litani River from improper solid waste disposal practices in Zone 4 are summarised in Table 3-14. The overall pressure level exerted by the solid waste practices in Zone 4 is deemed to be low.

Table 3-14. Pressures Exerted in Zone 4 due to Solid Waste Disposal Practices

Pressure	Pathway	Susceptibility	Indicator	Impact
D67 – Aadchit el Qoussair	Leachate and surface runoff into Braik tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D61 – Bany Haiyane	Leachate and surface runoff into Nhair tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D75 – Kounine	Leachate and surface runoff into Aaliqa tributary	Low	Aesthetic deterioration through litter	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and

Pressure	Pathway	Susceptibility	Indicator	Impact
			High BOD, COD, nitrites and heavy metals in river water	potential contamination with heavy metals and oils
D52 – Deir Siriane	Leachate and surface runoff into Braik tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D44 – Houla	Leachate and surface runoff into Jamal tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D50 – Rabb Et Talatine	Leachate and surface runoff into Nhair tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
Direct dumping of wastes in River	Dumping of solid garbage in Litani River or any of its tributaries	Low	Aesthetic deterioration through litter River water quality	Pollution of the river water; littering on the river banks, increase in the organic content of the river water and potential contamination with heavy metals and oils

3.1.2.5 *Zone 5*

209. Similar to Zone 4, this zone of the LLB has a large number of dumps. In this zone, there are 27 MSW dumps and nine CDW dumps (five of which are non-operational). From the 27 MSW dumps, eight are non-operational while 19 receive around 60.2 t/d of mixed municipal solid wastes (Table 3-15). The reason for having this high number of operational and non-operational dumps is also due to the fact that Ain Baal sorting and composting facility and Ras el Ain dump were operated and shut down at several occasions, thus municipalities had to resort to new dumps for the disposal of their waste in the absence of any alternatives.

210. SWM facilities serving parts of this zone exist but are located outside the Study Area. These are Ain Baal sorting and composting facility and Zrariyeh thermal treatment center. Ain Baal facility was built by OMSAR in 2009 and operated in 2011. The facility has a capacity of 150 t/d and serves around 27 municipalities from the Union of Tyre Municipalities. This facility faced several operational difficulties since the start. The other facility is the Green

Ecotech facility in Zrariyeh. The facility has a capacity of 10 t/d and is mainly a sorting and thermal treatment through pyrolysis. Waste are transformed to coal while syngas is generated and used inside the facility. The facility serves four villages including Zrariyeh, Aadchit, Kfar Roummane and Qsaibeh, but its operation has been officially stopped by MoE.

Table 3-15. Characteristics of MSW Dumps in Zone 5

ID	Name	Latitude	Longitude	Current Status	Waste Dumped (t/d)	Distance (m) to Litani or Tributary	
D126	D2-Borj Rahhal-02	33.322319	35.263269	Operational	7	157	Litani River
D123**	D2-Borj Rahhal-01	33.315074	35.271201	Non-operational	0	764	Litani River
D122	D2-Arzai-00	33.326218	35.285754	Operational	6	288	Litani River
D116	D2-Bedias-01	33.315967	35.311967	Operational	2	139	Hour
D120	D2-Bedias-02	33.314912	35.306184	Operational	0.5	585	Hour
D113	D2-Deir Qanoun En Nahr-00	33.298586	35.326845	Operational	6	15	Hour
D103**	D2-Derdaghaiya-02	33.274083	35.37846	Non-operational	0	787	Arzoun
D104	D2-Derdaghaiya-03n	33.267335	35.377619	Operational	0.2	1,499	Arzoun
D91	D3-Froun-00	33.303112	35.427084	Operational	3	709	Litani River
D111	D2-Hallousiyeh-00	33.297771	35.333064	Operational	3	375	Hour
D108	D2-Maaroub-05n	33.296235	35.337918	Operational	8	1	Hour
D107	D2-Hmairi Sour-00	33.294706	35.345586	Operational	2	148	Hour
*	D2-Maaroub-01	33.294657	35.345527	Non-operational	0	140	Hour
D125	D2-Quasmiye-02n	33.328604	35.26486	Operational	1	413	Litani River
D114	D2-Jannata-00	33.28231	35.322148	Operational	0.2	1,420	Hour
D97	LLB-Kfar Sir	33.314576	35.408143	Operational	1.8	882	Litani River
D93	LLB-Kfar Sir	33.310872	35.414612	Operational	2	265	Litani River
*	D2-Maaroub-03	33.28371	35.331612	Non-operational	0	1,069	Hour
*	D3-Qaaqaaiyet Ej-Jisr-00	33.331636	35.450942	Non-operational	0	44	Chemali
*	D2-Sir El Gharbiye-00	33.321401	35.351813	Non-operational	0	264	Litani River
D106	LLB-Sir El Gharbiyeh	33.317825	35.355159	Operational	3	4	Hamra
D95	D3-Srifa-03	33.282273	35.409941	Operational	8	396	Nqaai
D94	LLB-Srifa	33.27739	35.41102	Operational	3	198	Nqaai
D112***	D2-Tayr Falsay-00	33.322544	35.33003	Non-operational	0	225	Azahi
D109	LLB-Tayr Falsay	33.298298	35.33707	Operational	2.5	232	Hour
D78	LLB-Zaoutar El Gharbiyeh	33.337572	35.461098	Operational	1	831	Chemali
D115**	E2-Zrariye-00	33.336205	35.322062	Non-operational	0	1,229	Litani River

* Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Removed
** Reported in UNDP/MoE/ELARD (2017) study as Rehabilitated and Covered
*** Reported in UNDP/MoE/ELARD (2017) study as Not Rehabilitated

211. Out of the 19 operational dumps, seven are expected to have a direct impact on the pollution of the Litani River since they are at close distances from the River and its tributaries. These are:

- Borj Rahhal dump (D126) is located at 157 m from Litani River and receives around 7 t/d of mixed MSW. The dump is located on a piece of land that is 600 m^2 in size. The wastes are piled up to 3 meters in height and then burned.
- Bedias dump (D116) is located at 139 m from Hour tributary and receives 2 t/d of mixed MSW. The size of this dump is very small (100 m^2).
- Deir Qanoun En-Nahr dump (D113) is located at 1 m from Hour tributary and receives 6 t/d of mixed MSW from the village. The area of the dump is around 600 m^2 and is expected to have a negative impact on the surface water pollution of the tributary.
- Maaroub dump (D108) is located at 1 m from Hour tributary and receives around 8 t/d of mixed MSW. The area of the dump is around 1,000 m^2. Waste is often burned to reduce volumes.
- Hmairi Sour dump (D017) is located at 148 m from Hour tributary and receives 2 t/d of mixed MSW. The area of the dump is 600 m^2.
- Sir El Gharbiyeh dump (D106) is located at 4 m from Hara tributary and receives 3 t/d of mixed MSW from the village. The area of the dump is around 500 m^2 and is expected to have a negative impact on the surface water pollution of the tributary.
- Srifa dump (D94) is located at 198 m from Nqaai tributary and receives 3 t/d of mixed MSW. The area of the dump is 600 m^2.

212. No hospitals are present in this zone, consequently pollution from medical waste is not of concern. There exists one primary health care center in Srifa that generates small amounts of infectious waste. These should be sent for treatment at Aabbassiyeh treatment center, as currently there is no such arrangement in place.

213. Industries dispose of their solid industrial wastes either at the operational dumps or directly into the river. Wastes of concern include waste from food processing industries (organic wastes), used oils, packaging waste containing contaminated materials, and waste from rock cutting.

214. The potential pressures to Litani River from improper solid waste disposal practices in Zone 5 are summarised in Table 3-16. The overall pressure level exerted by the solid waste practices in Zone 5 is deemed to be medium.

Table 3-16. Pressures Exerted in Zone 5 due to Solid Waste Disposal Practices

Pressure	Pathway	Susceptibility	Indicator	Impact
D126 – Borj Rahhal	Leachate and surface runoff into Litani River	Medium	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D116 – Bedias	Leachate and surface runoff into Hour tributary	Low	Aesthetic deterioration through litter	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and

Pressure	Pathway	Susceptibility	Indicator	Impact
			High BOD, COD, nitrites and heavy metals in river water	potential contamination with heavy metals and oils
D113 – Deir Qanoun En-Nahr	Leachate and surface runoff into Hour tributary	Medium	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D108 – Maaroub	Leachate and surface runoff into Hour tributary	Medium	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D107 – Hmairi Sour	Leachate and surface runoff into Hour tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D106 – Sir El Gharbiyeh	Leachate and surface runoff into Hamra tributary	Medium	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
D94 – Srifa	Leachate and surface runoff into Nqaai tributary	Low	Aesthetic deterioration through litter High BOD, COD, nitrites and heavy metals in river water	Pollution of the river water: Littering on the river banks, Increase in the organic content of the river water and potential contamination with heavy metals and oils
Direct dumping of wastes in River	Dumping of solid garbage in Litani river and its tributaries	Low	Aesthetic deterioration through litter River water quality	Pollution of the river water: littering on the river banks, increase in the organic content of the river water and potential contamination with heavy metals and oils

3.1.3 Pollution Pressures from Liquid Waste Disposal Practices

3.1.3.1 <u>Domestic Wastewater Discharges</u>

215. Domestic wastewater discharges were calculated for each zone. Population, wastewater collection and final disposal methods formed the basis for examining the nature and degree of the wastewater threats to the Litani River and its tributaries. The wastewater volume generated per capita are calculated at 150 l/capita/day, and the population is that of residents in 2018.

216. The assessment of the severity of the threat from each urban settlement is based on the discharge location of the wastewater outflow (surface water or cesspools), the estimated wastewater outflow, the presence/absence of a wastewater network and the plans to connect the settlement in question to a wastewater treatment plant in the future. The threat to surface water was primarily considered, while the threat to groundwater contamination was considered as a secondary threat to the quality of the River water, which is the main target of this study. Susceptibility of pollution of the surface water from the pressures is thus the measure chosen to define the severity of the threat. Susceptibility of threat to surface water from each settlement was determined using the criteria illustrated in Figure 3-7.

217. The analysis of pollution pressures from wastewater discharges across the LLB is carried across the five zones of the study area. Current and approved Wastewater Masterplans for the Bekaa and South Lebanon were reviewed, and the towns and villages located within the five zones with a minimum population of 10 houses and above were identified. The Master Plans' provisions, Law No. 63/2016 programming for establishing wastewater treatment plants and networks within the study area, as well as feedback from the CDR and MoEW were the key information used in assessing whether there are gaps in wastewater services that this Business Plan should address. Through the 2018 municipal survey carried out for the purpose of this study, municipalities provided information on wastewater network coverage, discharge points, as well as information on the existence of small wastewater treatment plants within their jurisdiction.

218. The assessment assigned priority levels to the planned measures. The prioritization is based on the resident population of 2018, estimated wastewater outflow, the presence/absence of a wastewater network (Point pollution sources) and whether the settlement in question is connected to a wastewater treatment plant.

219. Gaps in network coverage and plans to service the areas with wastewater treatment were examined based on the association of the zones' maps which portray population figures and network coverage.

220. It is noted that many settlements continue to rely on the privy vault-cesspool system operated in a decentralised manner. Whenever it is indicated that a town lacks a sewer network; it implies that cesspools are used. Privy vaults and cesspools are basically holing in the ground, constructed in cellars, beneath or within proximity to residences. They are designed to drain much of the wastewater into the surrounding soil, but they still require periodic cleaning. The unplanned and uncontrolled drainage of wastewater from privy

vaults and cesspools contaminates soils, ground and surface water. In most cases, privy vaults and cesspools prove unable to manage urban wastewater effectively. This implemented decentralised management technology does not prevent contamination of nearby surface water or groundwater.

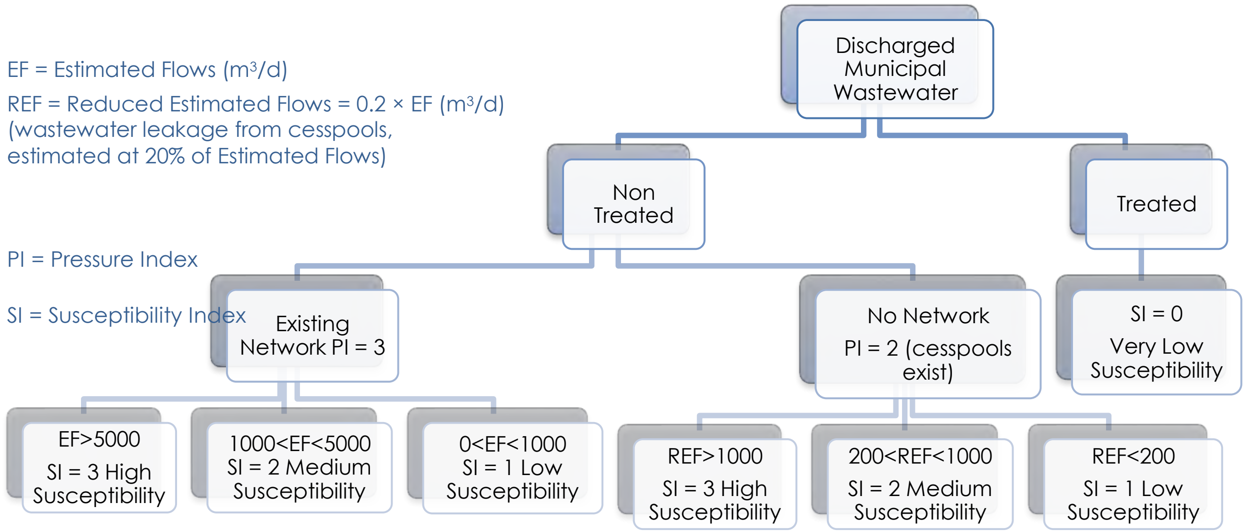


Figure 3-7. Determination of the Susceptibility Index for Wastewater Pressure in a Settlement

221. The determination of the overall level of susceptibility in each zone considers the total daily estimated wastewater generated from all the settlements in the zone, in order to provide the collective picture of the threat of municipal wastewater in each of the five zones. The single criterion used is thus the total daily estimated flow, and threat level is determined based on the flow ranges shown in Table 3-17.

Table 3-17. Pressure Threat Criterion from Domestic Wastewater in a Zone

Total Estimated Daily Flow of MWW (m^3/d)	Pressure Level
≤ 1,000	Low (1)
1,001 – 5,000	Medium (2)
5,001 – 10,000	High (3)
≥ 10,001	Very high (4)

222. Gaps in network coverage and plans to service the areas with wastewater treatment were examined based on the association of the zones' maps which portray population figures and network coverage (Figure 3-1, Figure 3-2, Figure 3-3, Figure 3-4**.** and Figure 3-5). While in the absence of WWTPs, the threat of pollution from wastewater discharges remains, the analysis assumes that plans to construct these WWTPs and their associated collectors and networks constitute a programmed solution which is expected to alleviate the pollution threat in the medium to long term.

223. Indicators of pollution with domestic wastewater are common across all zones. Surface waters that are polluted with domestic wastewater are characterised by high levels of soluble organics (BOD_5 and COD), Total Suspended Solids (TSS), elevated nutrient levels,

phosphorus, ammonia nitrogen (NH_3-N, NH_4-N), faecal coliforms and E. *coli*. The main impacts from such pollution in rivers are manifested through an increase in the organic load of the river water, oxygen deficiency in the river water, growth of algal blooms in waterways, obstruction of sunlight penetration into deep water for photosynthesis, eutrophication, aesthetic impacts, human and animal health risk (during bathing), pathogens and acute toxicity to fauna and flora.

3.1.3.1.1 Zone 1

224. In this first zone, seven villages have sewer networks, four of which are currently connected to Aaytanit Plant (Aaytanit, Baaloul, Qaraaoun and Machghara), and three are discharging directly into the River (Yohmor, Sohmor and Ain ET Tineh). Five of the localities (Yohmor, Sohmor, Zilaya, Ain Et Tineh, Maydoun & Loussia) and Machghara Plain are planned to be connected to the planned Zilaya WWTP (as per Law No. 63/2016 – US$ 15.4 M), three to the Majdel Balhiss WWTP (Majdel Balhis, Kaoukaba Bou Arab (25%) and Kfar Michki (25%)), two (Kaoukaba Bou Arab (75%) and Kfar Michki (75%)) to the Haouche El Qennabeh WWTP (outside the LLB Study Area), one (Libbaya) to Hasbaiya WWTP (outside the LLB Study Area) and one (Qelaya) to the Srayri WWTP.

225. The total daily generation of MWW from Zone 1 is estimated at about 6,207 m^3/d for the population of 2018, from which less than 3,156 m^3/d are currently reaching the Aaytanit WWTP for treatment before discharge. The daily untreated direct discharge volume into the river is estimated at 1,472 m^3, where the largest contributors are Sohmor and Yohmor (B-G). The MWW volume discharged into cesspools is estimated at 1,579 m^3/d. Table 3-18. Domestic Wastewater Infrastructure and Discharges in Zone 1 summarises the status of wastewater connections in villages of Zone 1.

226. The current collective discharges of raw MWW into the Litani River from villages of Zone 1 that have wastewater networks would rate the pressure level to be Medium (≤5,000 m^3/d). Notwithstanding, the river flow in the upper reaches of the Lower Litani River from Qaraaoun Dam until Ain ez Zarqa is weak as water only flows in the rainy season, fed by tributaries and springs in Machghara and Sohmor, and thus it is not acceptable that the river receives raw wastewater discharge in that stretch. In addition, Zone 1 relies in its water supply on Ain ez Zarqa and therefore, wastewater discharges into cesspools within the recharge zone of Ain ez Zarqa should be stopped, and all villages should have networks that connect to the planned Zilaya, Majdel Balhiss, Haouch El Qennabeh, Hasbaiya and Srayri WWTPs. Wastewater from households, hospitals, industrial facilities and schools located within the villages which are not yet connected, discharge into residential cesspools or septic tanks which are in most cases technically unsuitable.

227. Given the low flows in this section of the Litani River, and the presence of the downstream Ain ez Zarqa spring which supplies surrounding villages with potable water and feeds water into the Jezzine or Awali Tunnel, the wastewater pressure in Zone 1 is judged to be High.

228. The most recent feasibility study (October 2017) which assessed the wastewater schemes that the Bekaa Wastewater Master Plan had set concludes the requirement for five WWTPs

to serve the West Bekaa and Rachaiya villages south of the Qaraaoun dam. The proposed WWTPs are Zilaya, Majdel Balhiss, Srayri, Haouch El Qennabeh and Hasbaiya. Law No. 63/2016 allocates funding for the Zilaya WWTP and its networks serving the villages of Zilaya, Libbaya, Maydoun & Loussia, Ain Et Tineh, Qelaya, Sohmor, Yohmor (B-G) and Dellafi as specified in the Law. The plant in Majdel Balhiss is planned to serve Majdel Balhiss, Kfar Michki & Nabi Safa, and Kaoukaba Bou Arab, is mentioned in the Master plan but not programmed for in Law No. 63/2016. The sewerage networks of these villages must be designed and constructed in parallel to the wastewater treatment plant construction.

229. Hence, funding for the networks in the target villages of West Bekaa (Libbaya, Zilaya, Maydoun & Loussia, Yohmor, Sohmor, Ain Et Tineh, Qelaya) as well as Dellafi, and the Zilaya WWTP is allocated as part of Law No. 63/2016. The gap in funding for Zone 1 is the Majdel Balhiss WWTP and networks in Majdel Balhiss, Kaoukaba Bou Arab, Kfar Michki and Nabi Safa. The planned plants of Hasbaiya and Haouch El Qennabeh are parts of the Hasbani Spring and River basin, and their funding is not secured yet.

230. The villages of Niha (Chouf), Mhaiydseh, Rafid, Rachaiya, Hasbaiya and Mimess are partially included within Zone 1 of the Study Area, since some of the cadastral outskirts of these villages intersect with the Lower Litani watershed. However, the inhabited areas of these villages are outside of the Study Area, and hence the wastewater pressure from these villages is not considered in the scope of this assessment, and neither are the planned WWTPs for these areas accounted for in this business plan.

Table 3-18. Domestic Wastewater Infrastructure and Discharges in Zone 1

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Pressure Level
Direct discharges into surface water	Aaytanit	Yes	100%	Aaytanit Plant (existing)	Aaytanit Plant	862	129	None
	Baaloul	Yes	76%	Aaytanit Plant (existing)	Aaytanit Plant	2,273	341	Low
	Machghara	Yes	95%	Aaytanit Plant (existing), Zilaya Plant (Machghara Plain)	Aaytanit Plant	8,805	1,321	None
	Qaraaoun	Yes	62%	Aaytanit Plant (existing)	Aaytanit Plant	9,099	1,365	Low
	Sohmor	Yes	60%	Zilaya Plant (Law No. 63/2016)	RIVER	5,836	875	Medium
	Yohmor	Yes	70%	Zilaya Plant (Law No. 63/2016)	RIVER	2,382	357	Low
	Ain Et Tineh	Yes	90%	Zilaya Plant (Law No. 63/2016)	RIVER	1,601	240	None
Indirect overflow from cesspools of houses	Zilaya	No	-	Zilaya Plant (Law No. 63/2016)	Underground tanks	924	139	Low
	Libbaya	No	-	Hasbaiya Plant	Underground tanks	2,857	429	Low
	Maydoun	No	-	Zilaya Plant (Law No. 63/2016)	Underground tanks	2,056	308	Low
	Loussia	Annex to Maydoun	-					
	Qelaya	No	-	Srayri Plant	Underground tanks	835	125	Low
	Majdel Balhis	No	-	Majdel Balhis Plant (25%)	Underground tanks	1,565	235	Low
	Kaoukaba Bou Aarab	No	-	Majdel Balhis Plant (25%) & Haouche El Qennabeh Plant (75%)	Underground tanks	1,320	198	Low
	Kfar Michki	No	-	Majdel Balhis Plant (25%) & Haouche El Qennabeh Plant (75%)	Underground tanks	963	145	Low
	Nabi Safa	Annex to Kfar Michki	-					

3.1.3.1.2 Zone 2

231. Zone 2 is sparsely inhabited. There are currently four small WWTPs serving individual villages. These are Aaychiyeh, Rihane, Marjaayoun- Khiyam and Kaoukaba (Hasbaiya) WWTPs. These plants' capacities and treatment level effectiveness and their operational status were not assessed.

232. In Zone 2, only five villages have sewer networks; four of them are connected to the existing WWTPs in Aaychiyeh, Kaoukaba, Marjaayoun, and Rihane. Kfar Roummane, the largest urban agglomeration in Zone 2, discharges the collected wastewater into Wadi El Kfour (Nabatiye Plant). The rest of the localities are planned to be connected to the planned Hasbaiya (only for Kaoukaba), Srayri, Wadi Jarmaq and Nabatiye-2 (Wadi El Kfour) plants, and to the existing Marjaayoun-Khiyam and Rihane WWTPs. The Wadi Jarmaq WWTP was included in the Master Plan but not programmed for construction in Law No. 63/2016. The Wadi Jarmaq WWTP would service the locality of Jarmaq, surrounding farmlands and parts of Kfar Roummane.

233. The most recent feasibility study (October 2017) which assessed the wastewater schemes that the South and Bekaa Wastewater Master Plans had set concludes the requirement for a wastewater treatment plant in Srayri to serve the villages of Bourghos, Dellafi and Srayri, as well as Qelaya from Zone 1.

234. Discussions with the CDR and MoEW representatives concluded that a plant for Wadi Jarmaq is needed as well as channeling the wastewater from Kfar Houneh and Aramta to the planned Sarafand Plant instead of Nabeh El Tasseh Plant.

235. Table 3-19 summarises the status of the wastewater connections. Wastewater from the households, hospitals, industrial facilities and schools located within these not yet connected villages are discharged into residential cesspools or septic tanks which are in most cases technically unsuitable.

236. The total estimated daily generation of MWW from Zone 2 is about 2,475 m^3/d for the population of 2018, from which less than 420 m^3/d are diverted to treatment plants before discharge. Nonetheless, the treatment effectiveness at the Rihane, Aaychiyeh, Marjaayoun and Kaoukaba WWTPs should be evaluated. The Marjaayoun and Kaoukaba WWTPs lie outside of the study area, however they receive wastewater from localities located within the LLB Study Area.

237. It was reported during the field survey that there are two small WWTPs in Qatrani which were privately developed in 2011-2012 to serve a residential complex with maximum occupancy of 1,800 persons. Given the current low occupancy, these two plants are running at below 10% of their capacity, and operate for 7-8 hours per day. They are equipped with blowers, oil-water separators, tanks for sedimentation and chlorination units.

238. Hence, funding for the networks in the villages of Marjaayoun (Dibbine, Blat and Bouyada), Jezzine (Srayri and Jarmaq), Hasbaiya (Bourghos and Dellafi) is not allocated

since Law No. 63/2016 did not identify the needed investments for these villages' wastewater collection systems. The gap in funding for Zone 2 is also the Srayri and Wadi Jarmaq plants, as well as any upgrades to the Marjaayoun Plant.

239. Given the relatively low population pressure in Zone 2, the wastewater pressure is deemed Low.

Table 3-19. Domestic Wastewater Infrastructure and Discharges in Zone 2

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Pressure Level
Direct discharges into surface water	Aaychiyeh	Yes	95%	Aaychiyeh Plant (exisiting & Law No. 63/2016)	Aaychiyeh Plant	613	92	Very Low
	Mazraat Zighrine	Annex to Aaychiyeh						
	Mahmoudiyeh	Annex to Aaychiyeh						
	Jdaideh (Marjaayoun)*	Yes	70%	Marjaayoun Plant (existing)	Marjaayoun Plant	6,086	913	Low
	Kaoukaba	Yes	50%	Kaoukaba Plant (existing) & Hasbaiya Plant	Kaoukaba Plant	1,017	153	Medium
	Kfar Roummane	Yes	90%	Nabatiye-2 Plant (Law No. 63/2016) & Wadi Jarmaq Plant	OPEN LAND	6,168	925	Medium
	Rihane	Yes	Not known	Rihane Plant (exisiting & Law No. 63/2016)	Rihane Plant	1,164	175	Medium
	Mazraat Khallet Khazen	Annex to Rihane						
	Mazraat Louzid (Louayziyeh)	Annex to Rihane						
	Mazraat Qrouh	Annex to Rihane						
	Ouardiyeh	Annex to Rihane						
Indirect overflow from cesspools of houses	Chbail	No	-	Rihane Plant (existing & Law No. 63/2016) (?)	Underground Tanks	-	-	-
	Mazraat Daraya	No	-	Rihane Plant (existing & Law No. 63/2016) (?)	Underground Tanks	-	-	-
	Sejoud	No	-	Rihane Plant (exisiting & Law No. 63/2016)	Underground Tanks	300	45	Low

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Pressure Level
	Kfar Houneh	No	-	Sarafand Plant (Law No. 63/2016)	Underground Tanks	1,755	263	Low
	Aaramta	No	-	Sarafand Plant (Law No. 63/2016)	Underground Tanks	1,286	193	Low
	Blat	No	-	Marjaayoun Plant (existing)	Underground Tanks	1,065	160	Low
	Dibbine	No	-	Marjaayoun Plant (existing)	Underground Tanks	1,660	249	Low
	Bouayda	No	-	Marjaayoun Plant (existing)	Underground Tanks	169	25	Low
	Bourghos	No	-	Srayri Plant	Underground Tanks	146	22	Low
	Dellafi	No	-	Srayri Plant	Underground Tanks	290	44	Low
	Jarmaq	No	-	Wadi Jarmaq Plant	Underground Tanks	249	37	Low
	Demachqiyeh	Annex to Jarmaq		Wadi Jarmaq Plant				
	Mazraat El Aarqoub	Annex to Jarmaq		Wadi Jarmaq Plant				
	Mazraat Ouazaaiyeh	Annex to Jarmaq		Wadi Jarmaq Plant				
	Mazraat Tamra	Annex to Jarmaq		Wadi Jarmaq Plant				
	Qatrani	No	-	-	Two private WWTPs	415	62	Low
	Srayri	No	-	Srayri Plant	Underground Tanks	200	30	Low

* Not more than 10% of Jdaideh Marjaayoun is located within the Study Area, and hence the wastewater pressure is deemed low

3.1.3.1.3 Zone 3

240. In Zone 3, six villages have sewer networks, one of which is connected to the existing Deir Mimas Plant, a second is connected to Yohmor Plant, a third connected to Zaoutar Plant, while two of the largest localities of Kfar Tibnit and Qlaiaa discharge directly onto land leading to the river. The largest agglomeration of Kfar Kila does not have a sewer network and discharges its wastewater into cesspools.

241. It is important to discern the wastewater pressures in Zone 3, given the planned Khardali Dam and the downstream extraction of the river water at Taybeh, where the river water is treated and supplied to users in the Bent Jbayl and Marjaayoun Water Service Areas.

242. Table 3-20 summarises the status of the wastewater connections. Wastewater from the households, hospitals, industrial facilities and schools located within these not yet connected villages are discharged into residential cesspools or septic tanks which are in most cases technically unsuitable.

243. The total estimated daily generation of MWW from Zone 3 is about 4,145 m^3/d for the population of 2018, from which less than 816 m^3/d are sent to treatment plants before discharge.

244. It can be considered that the two established lagoon WWTPs of Yohmor and Zaoutar are operational, however, they are not receiving the entire flow from the towns they serve. Zaoutar El Gharbiyeh will be connected to the Zaoutar Plant in the future or to the planned Sarafand Plant. As per Law No. 63/2016, the Wadi El Kfour at Nabatiye-2 Plant will serve Kfar Tibnit. Based on discussions with CDR and MoEW, Arnoun will also be served by the Wadi El Kfour Plant.

245. The two villages in Marjaayoun of Borj El Mlouk and Qlaiaa discharge their collected wastewater in the River and on open land. Borj El Mlouk wastewater collection network is incomplete. Both villages should be connected to the Marjaayoun plant upon assessing the latter's treatment capacity.

246. The two villages in Marjaayoun of Adaysseh and Deir Siriane were programmed within Law No. 63/2016 to be piping their wastewater to Wadi El Slouki WWTP. Discussions with CDR and MoEW led to the understanding the the two plants of Breiqaa and Wadi El Slouki will be merged into one plant at Qaaqaaiyet Ej Jisr, which will serve the two villages of Adaysseh and Deir Siriane. The networks are programmed for in Law No. 63/2016.

247. Deir Mimas has a treatment plant which was built by the UNIFIL and rehabilitated in 2016. The treatment effectiveness at this plant is not known. It is noteworthy that Law No. 63/2016 programmed for a WWTP to received discharges from Deir Mimas, Kfar kila and Houra (a locality that is under the joint administrative jurisdiction of Deir Mimas and Kfar Kila). The plans should be aligned with the current conditions and the feasibility of expanding the current plant at Deir Mimas should be studied.

248. Hence, the funding gaps for Zone 3 are the networks for Borj El Mlouk and its connection along with Qlaiaa to Marjaayoun Plant, and the completion of networks in Yohmor, Zaoutar Ech Charqiyeh and Zaoutar El Gharbiyeh.

249. Given the location and nearby downstream uses of the river water at Taybeh, it is deemed that the wastewater pressure in Zone 3 is Medium.

Table 3-20. Domestic Wastewater Infrastructure and Discharges in Zone 3

<table>
<tr><th>Type of Pressure</th><th>Village</th><th>Sewer Network</th><th>Network Coverage</th><th>Planned Discharge</th><th>Actual Discharge</th><th>Population</th><th>Est. WW Flow rate (m^3/d)</th><th>Pressure Level</th></tr>
<tr><td rowspan="9">Direct discharges into surface water</td><td>Kfar Tibnit</td><td>Yes</td><td>80%</td><td>Nabatiye-2 Plant (Law No. 63/2016)</td><td>RIVER</td><td>4,667</td><td>700</td><td>Medium</td></tr>
<tr><td>Qlaiaa</td><td>Yes</td><td>100%</td><td>Marjaayoun Plant (existing)</td><td>OPEN LAND</td><td>4,855</td><td>728</td><td>Medium</td></tr>
<tr><td>Borj El Mlouk</td><td>Yes</td><td>40%</td><td>Marjaayoun Plant (existing)</td><td>RIVER</td><td>1,056</td><td>158</td><td>Medium</td></tr>
<tr><td>Deir Mimas</td><td>Yes</td><td rowspan="3">90%</td><td rowspan="3">Deir Mimas Plant (existing & Law No. 63/2016)</td><td rowspan="3">Deir Mimas Plant</td><td rowspan="3">1,494</td><td rowspan="3">224</td><td rowspan="3">Low</td></tr>
<tr><td>Houra</td><td>Annex to Deir Mimas</td></tr>
<tr><td>Mazraat Doumiat</td><td>Annex to Deir Mimas</td></tr>
<tr><td>Yohmor</td><td>Yes</td><td>30%</td><td>Yohmor Plant (existing)</td><td>Yohmor Plant</td><td>1,923</td><td>289</td><td>Medium</td></tr>
<tr><td>Zaoutar Ech-Charqiyeh</td><td>Yes</td><td rowspan="2">50%</td><td>Zaoutar Plant (existing)</td><td rowspan="2">Zaoutar Plant</td><td rowspan="2">2,019</td><td rowspan="2">303</td><td rowspan="2">Medium</td></tr>
<tr><td>Mazraat El Hamra</td><td>Annex to Zaoutar Ech-Charqiyeh</td><td>Zaoutar Plant (existing)</td></tr>
<tr><td rowspan="6">Indirect overflow from cesspools of houses</td><td>Kfar Kila</td><td>No</td><td>-</td><td>Deir Mimas Plant (existing & Law No. 63/2016)</td><td>Underground Tanks</td><td>6,103</td><td>916</td><td>Low</td></tr>
<tr><td>Aadaysseh</td><td>No</td><td>-</td><td>Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)</td><td>Underground Tanks</td><td>2,535</td><td>380</td><td>Low</td></tr>
<tr><td>Deir Siriane</td><td>No</td><td>-</td><td>Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)</td><td>Underground Tanks</td><td>859</td><td>129</td><td>Low</td></tr>
<tr><td>Zaoutar El Gharbiyeh</td><td>No</td><td>-</td><td>Zaoutar Plant (existing) & Sarafand Plant (Law No. 63/2016)</td><td>Underground Tanks</td><td>1,354</td><td>203</td><td>Low</td></tr>
<tr><td>Aalmane*</td><td>No</td><td>-</td><td>-</td><td>Underground Tanks</td><td>35</td><td>5</td><td>Low</td></tr>
<tr><td>Arnoun</td><td>No</td><td>-</td><td>Nabatiye-2 Plant (Law No. 63/2016)</td><td>Underground Tanks</td><td>735</td><td>110</td><td>Low</td></tr>
</table>

* Vacant Land or Locality that has a very small Number of Houses (<10)

3.1.3.1.4 Zone 4

250. In Zone 4, only two villages have partial or incomplete sewer networks, and both are connected to Tibnine Plant. The rest of the localities discharge of their wastewaters in underground tanks. As per the South Lebanon Wastewater Master plan, these localities are planned to be served by the Wadi Slouki WWTP, Qaaqaaiyet Ej Jisr WWTP, Bent Jbayl WWTP, and Sour WWTP. On the other hand, the Law No. 63/2016 has programmed for the Wadi Slouki and Braiqeaa wastewater treatment systems to serve villages of Zone 4. Discussions with the CDR and MoEW to align the plans, resulted in an understanding that the Wadi Slouki and Braiqeaa wastewater treatment systems will be combined into one treatment system at Qaaqaaiyet Ej Jisr.

251. Three localities are on the outskirts of Zone 4, and which are Bent Jbayl, Safad El Battikh and Baraachit. Bent Jbayl is served by its own existing WWTP to which Tiri and Aaynata are planned to be connected. Safad El Battikh and Baraachit are planned to be connected to the exisiting Tibnine Plant. Table 3-21 summarises the status of the wastewater connections. Wastewater from households, hospitals, industrial facilities and schools located within these not yet connected villages are discharged into residential cesspools or septic tanks which are in most cases technically unsuitable.

252. The total estimated daily generation of MWW from Zone 4 is about 9,891 m^3/d for the population of 2018, from which less than 479 m^3/d are diverted to a treatment plant before discharge. Despite the relatively low volumes of wastewater generated from single localities, the collective wastewater volume can generate a high contamination pressure to water supplies in the region. The Bent Jbayl area relies mostly on surface water from the Litani River through the Taybeh water treatment plant and on groundwater sources to augment this supply. Hence, it is important to ensure that the same localities being supplied with freshwater from the underground wells are not polluting their own sources with wastewater.

253. It is understood that the feasibility study for the wastewater treatment plants and network systems in the Bent Jbayl area is currently being updated.

254. Hence the funding gap for the Zone 4 are networks in Maroun Er Ras, Aaytaroun, Blida, Kounine, Beit Yahoun, Mhaibib, Chaqra, Meiss Ej Jabal, Houla, Souaneh, and Qalaouiyeh, and connection of these villages to the planned Qaaqaaiyet Ej Jisr Plant, in addition to Aaynata and Tiri which do not have wastewater collection networks and would need to be connected to the existing Bent Jbayl WWTP.

255. Based on the estimated wastewater volumes generated in Zone 4, and given that the treatment plans await clarification, the wastewater pressure level in Zone 4 is rated High.

Table 3-21. Domestic Wastewater Infrastructure and Discharges in Zone 4

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Susceptibility
Direct discharges into surface water	Jmaijmeh	Yes	10%	Tibnine Plant (existing) & Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Tibnine Plant	2,142	321	Medium
	Soultaniyeh	Yes	80%	Tibnine Plant (existing)	Tibnine Plant	1,052	158	None
Indirect overflow from cesspools of houses	Maroun Er Ras	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	456	68	Low
	Aaytaroun	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	5,420	813	Low
	Aaynata	No	-	Bent Jbayl Plant (existing)	Underground Tanks	4,611	692	Low
	Blida	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	2,032	305	Low
	Kounine	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	457	69	Low
	Beit Yahoun	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	382	57	Low
	Mhaibib	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	828	124	Low
	Chaqra	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	5,573	836	Low
	Meiss Ej Jabal	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	4,171	626	Low
	Houla	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	4,290	644	Low

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Susceptibility
	Majdel Selm	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	5,262	789	Low
	Khirbet Selm	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	2,418	363	Low
	Souaneh	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	2,239	336	Low
	Talloussa	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	663	100	Low
	Markaba	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	2,148	322	Low
	Qalaouiyeh	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	1,075	161	Low
	Touline	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	3,364	505	Low
	Qabrikha	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	2,169	325	Low
	Bani Haiyane	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	291	44	Low
	Rabb Et Talatine	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	698	105	Low
	Borj Qalaouiyeh	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	1,103	166	Low
	Ghandouriyeh	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	782	117	Low
	Qantara	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	2,613	392	Low
	Aadchit (Qoussair)	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	542	81	Low

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Susceptibility
	Taybeh	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	5,009	751	Low
	Kfar Dounine	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	3,137	471	Low
	Tiri	No	-	Bent Jbayl Plant (existing)	Underground Tanks	520	78	Low

3.1.3.1.5 Zone 5

256. In Zone 5, nine villages have sewer networks, but none are connected to a treatment plant. They are programmed under Law No. 63/2016 to be connected to Srifa WWTP, the second phase of Sour WWTP, and to the Sarafand WWTP.

257. There are two wastewater plants currently serving this Zone, which are the Kfar Sir WWTP and the Sour WWTP. The connection of the served villages to these two plants is yet to be finalized, and it was understood that the two plants are currently not operational.

258. The rest of the localities are planned to be connected to Sour-2 WWTP, Braiqeaa WWTP, Halloussiyeh WWTP, and Wadi Slouki as per Law No. 63/2016. Based on discussions with CDR and MoEW, it is understood that the Halloussiyeh and Srifa wastewater treatment systems will be merged with Sour treatment system. The Sarafand planned system will receive wastewater from additional villages as summarized in Table 3-22. Wastewater from the households, hospitals, industrial facilities and schools located within these not yet connected villages are discharged into residential cesspools or septic tanks which are in most cases technically unsuitable.

259. No funding gaps are identified in Zone 5.

260. The total estimated daily generation of MWW from Zone 5 is about 10,553 m^3/d for the population of 2018. Given the high population density in Zone 5, and the presence of recreational facilities and irrigated agriculture land in Zone 5, it is imperative that wastewater is properly collected and treated prior to discharge into surface water. In addition, the treated wastewater may be considered for use in irrigated agriculture if the quality meets the irrigation water quality standards. The wastewater pressure level in Zone 5 is rated High.

Table 3-22. Domestic Wastewater Infrastructure and Discharges in Zone 5

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Pressure Level
Direct discharges into surface water	Srifa	Yes	65%	Sour-2 Plant (Law No. 63/2016)	OPEN LAND	5,283	793	Medium
	Marnaba	Annex to Srifa		Sour-2 Plant (Law No. 63/2016)				
	Mazraat Tayr Semhat	Annex to Srifa		Sour-2 Plant (Law No. 63/2016)				
	Niha	Annex to Srifa		Sour-2 Plant (Law No. 63/2016)				
	Arzoun	Yes	20%	Sour-2 Plant (Law No. 63/2016)	RIVER	835	125	Medium
	Maaroub	Yes	90%	Sour-2 Plant (Law No. 63/2016)	OPEN LAND	2,774	416	Medium
	Jennata	Yes	60%	Sour-2 Plant (Law No. 63/2016)	SEA	700	105	Low
	Deir Qanoun En-Nahr	Yes	80%	Sour-2 Plant (Law No. 63/2016)	SEA	4,188	628	Low
	Bedias	Yes	60%	Sour-2 Plant (Law No. 63/2016)	OPEN LAND	1,475	221	Medium
	Borj Rahhal	Yes	90%	Sour-2 Plant (Law No. 63/2016)	RIVER	7,255	1,088	Medium
	Ain Abou Abdallah	Annex to Borj Rahhal						
	Kharayeb (Saida)	Yes	60%	Sarafand Plant (Law No. 63/2016)	OPEN LAND	7,940	1,191	Very High
	Mazraat El Aaitaniyeh (Yahoudiyeh)	Annex to Kharayeb						
	Mazraat El Ouasta	Annex to Kharayeb						
	Mazraat Jamjim	Annex to Kharayeb						
	Zrariyeh	Yes	80%	Sarafand Plant (Law No. 63/2016)	RIVER	7,066	1,060	Medium
Indirect overflow from	Arzai	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	3,231	485	Low
	Jazira (Saida)	Annex to Arzai						

Type of Pressure	Village	Sewer Network	Network Coverage	Planned Discharge	Actual Discharge	Population	Est. WW Flow rate (m^3/d)	Pressure Level
	Matariyet Ech Choumar	Annex to Arzai						
	Halloussiyeh	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	1,658	249	Low
	Tayr Falsay	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	2,500	375	Low
	Hmairi	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	738	111	Low
	Bestiyat	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	187	28	Low
	Derdaghaiya	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	752	113	Low
	Chehour	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	2,050	308	Low
	Sir El Gharbiyeh	No	-	Sour-2 Plant (Law No. 63/2016)	Underground Tanks	3,446	517	Low
	Braiqeaa	No	-	Braiqeaa Plant (Law No. 63/2016)	Underground Tanks	1,769	265	Low
	Kfar Sir	No	-	Kfar Sir Plant (existing)	Underground Tanks	5,887	883	Low
	Qsaibeh	No	-	Sarafand Plant (Law No. 63/2016)	Underground Tanks	4,716	707	Low
	Qaaqaaiyet Ej Jisr	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	4,830	725	Low
	Froun	No	-	Qaaqaaiyet Ej Jisr Plant (Law No. 63/2016)	Underground Tanks	1,067	160	Low
	Touyari*	No	-	Sour-2 Plant (Law No. 63/2016)	-	-	-	Low

* Vacant Land or Locality that has a very small Number of Houses (<10)

3.1.3.2 Industrial Wastewater Discharges

261. While domestic wastewater contains contaminants, industrial wastewater may contain both contaminants and pollutants. Industrial wastes contain a large variety of pollutants which are categorised as follows:

262. ***Inorganic pollutants***. These include alkalis, mineral acids, inorganic salts, free chlorine, ammonia, hydrogen sulphide, salts of chromium, nickel, zinc, cadmium, copper, silver, etc., anions such as phosphates, sulphates, chlorides, nitrites and nitrates, cyanides; cations such as calcium, magnesium, sodium, potassium, iron, manganese, mercury, arsenic, etc.

263. ***Organic pollutants***. These include high molecular weight compounds such as sugars, oils and fats, proteins, hydrocarbons, phenols, detergents, and organic acids.

264. In all zones of the Study Area there are factories producing effluents loaded with organic pollutants. These effluents are conveyed to surface water through either the nearby tributary or the existing sewer networks. Most of the generated wastes, whether liquid or solid, are of biodegradable organic nature. Despite their characteristics, these wastes, when found in high concentration, can still contribute to the natural imbalance of ecosystems. Other industries within the same zones produce a mixture of organic and inorganic effluents and which may contain hazardous compounds (herbicides, pesticides and metal granulate). Effluents containing hazardous compounds should not be discharged into the environment without proper treatment.

265. Unlike the Upper Litani Basin, the manufacturing industries in the LLB area are mainly small scale and are concentrated in Zones 1, 4 and 5 as presented in Table 3-23. The majority of the industries present in the LLB are olive mills, rock cutting and shaping, and concrete blocks manufacturing (168 out of 223 industrial establishments).

Table 3-23. Distribution of Industrial Establishments across Zones

	Number of establishments	Percent Distribution (%)
Zone 1	47	21.1
Zone 2	20	9.0
Zone 3	34	15.2
Zone 4	57	25.6
Zone 5	65	29.1
TOTAL	**223**	**100.0**

266. Each establishment was assigned one or more ISIC codes (UN, 2008) depending on the products manufactured at the premises. The manufacturing processes identified to be present in the Study Area, and the distribution of these processes across the five zones are shown in Table 3-24.

Table 3-24. Distribution of Manufacturing Processes across Zones

ISIC Code	ISIC Sector/Sub-sector	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	TOTAL
C-1040	Manufacture of vegetable and animal oils and fats	14	10	20	22	23	**89**
C-1050	Manufacture of dairy products	-	2	-	3	2	**7**
C-1061	Manufacture of grain mill products	-	-	-	-	1	**1**
C-1071	Manufacture of bakery products	2	-	-	1	1	**4**
C-1072	Manufacture of sugar / Manufacture of other food products n.e.c.	-	-	-	-	1	**1**
C-1073	Manufacture of cocoa, chocolate and sugar confectionery	-	1	-	-	2	**3**
C-1104	Manufacture of soft drinks; production of mineral waters and other bottled	-	-	1	-	-	**1**
C-1410	Manufacture of wearing apparel, except fur apparel	-	-	1	-	1	**2**
C-1610	Sawmilling and planing of wood	-	2	1	1	-	**4**
C-1709	Manufacture of other articles of paper and paperboard	-	-	1	1	1	**3**
C-1811	Printing	-	-	-	1	1	**2**
C-2220	Manufacture of plastics products	2	-	-	1	1	**4**
C-2392	Manufacture of clay building materials	-	-	-	-	1	**1**
C-2395	Manufacture of articles of concrete, cement and plaster	16	1	8	12	14	**51**
C-2396	Cutting, shaping and finishing of stone	9	1	-	9	9	**28**
C-2399	Manufacture of other non-metallic mineral products n.e.c.	1	-	-	1	-	**2**
C-2511	Manufacture of structural metal products	2	1	2	2	1	**8**
C-2512	Manufacture of tanks, reservoirs and containers of metal	-	-	-	-	2	**2**
C-2733	Manufacture of wiring devices	-	-	-	-	1	**1**
C-3100	Manufacture of furniture	-	2	-	1	1	**4**
E-3600	Water collection, treatment and supply	1	-	-	-	-	**1**
G-4661	Wholesale of solid, liquid and gaseous fuels and related products	-	-	-	2	1	**3**
N-8292	Packaging activities	-	-	-	-	1	**1**
	Total number of industries in each zone	**47**	**20**	**34**	**57**	**65**	**223**

267. Pollution pressures from the industries located in the different zones were identified based on a desk review of international and national studies on the characteristic pollutants expected to be found in the discharges from such types of manufacturing processes. The identification was also based on expert knowledge about the scale of manufacturing processes carried out in the Lebanese context.

268. In the absence of production data and data on the quantity and quality of effluents generated in most industries present in the area of study, a diagnostic analysis was conducted to prioritise polluting industries and to determine the pre-treatment processes required and their associated costs. This section presents the methodology used to select the priority industrial pressures and the results of the prioritisation, while section 5.2.2.3 presents the proposed mitigation measures and their estimated costs.

Categorisation of industries

269. The type and quantities of effluents generated from the different industries in the Lower Litani River catchment area vary from one establishment to the other based on the type of manufacturing process and the size of the industry. Some industries use dry process manufacturing such as, plastic transformation, grain milling, concrete blocks making, bakeries, and metal working and shaping among others, thus producing no wastewater. Others use wet processes, which result in the discharge of variable amounts of wastewater effluents that are loaded with organic and non-organic pollutants. Wet process manufacturing is used in industries such as dairy production, olive mills, paint production, rock and stone cutting, etc. Since the field industrial survey conducted by ELARD in spring of 2018 consisted of collecting physical data about industries including their geographic coordinates and the types of products produced along with photographic documentation, it was possible to define the processes in each industry as one of two types: wet and dry, as shown in Table 3-25.

Table 3-25. Nature of Manufacturing Processes

ISIC Code	Manufacturing process	Category of manufacturing process
C-1040	Manufacture of vegetable and animal oils and fats	Wet process
C-1050	Manufacture of dairy products	Wet process
C-1061	Manufacture of grain mill products	Dry process
C-1071	Manufacture of bakery products	Dry/wet process
C-1072	Manufacture of sugar / Manufacture of other food products	Dry process
C-1073	Manufacture of cocoa, chocolate and sugar confectionery	Dry/wet process
C-1104	Manufacture of soft drinks; production of mineral waters and other bottled	Wet process
C-1410	Manufacture of wearing apparel, except fur apparel	Dry process
C-1610	Sawmilling and planing of wood	Dry process
C-1709	Manufacture of other articles of paper and paperboard	Dry process
C-1811	Printing	Dry process
C-2220	Manufacture of plastics products	Dry process
C-2392	Manufacture of clay building materials	Dry process
C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
C-2396	Cutting, shaping and finishing of stone	Wet process
C-2399	Manufacture of other non-metallic mineral products	Dry process
C-2511	Manufacture of structural metal products	Dry process

ISIC Code	Manufacturing process	Category of manufacturing process
C-2512	Manufacture of tanks, reservoirs and containers of metal	Dry process
C-2733	Manufacture of wiring devices	Dry process
C-3100	Manufacture of furniture	Dry process
E-3600	Water collection, treatment and supply	Wet process
G-4661	Wholesale of solid, liquid and gaseous fuels and related products	Dry process
N-8292	Packaging activities	Dry process

Prioritisation of industries

270. Due to the large number of industries present in the area of study, it was necessary to prioritise industries according to their potential direct impact on the water quality of the Litani River. Two priority groups were identified in each zone:

a- Priority Group 1: This group includes all wet process industries falling within the watershed area discharging into the Lower Litani Basin and are located in villages having an existing wastewater network in good condition (refer to Table 3-26). These were considered as the most potentially threatening to surface water quality since these industries produce industrial effluents and probably discharge them either directly to the sewers which end up discharging in open channels or through pipes laid for short distances to reach the nearest flowing water stream or body.

Table 3-26. Condition of Existing Wastewater Networks as reported by Municipalities

Name of Village[1]	Existing Network Condition
Qlaiaa	Average Condition
Yohmor (B-G)	Good Condition
Yohmor (Nabatiye)	Good Condition
Machghara	Good Condition
Sohmor	Good Condition
Soultaniyeh	Good Condition
Kfar Tibnit	Good Condition
Zaoutar Ech-Charqiyeh	Average Condition
Kfar Roummane	Good Condition
Deir Qanoun En-Nahr	Good Condition
Jmaijmeh	Good Condition
Srifa	Average Condition
Maaroub	Good Condition
Jennata	Good Condition
Kaoukaba (Hasbaiya)	Good Condition
Qatrani	Good Condition
Borj El Mlouk	Bad Condition

Name of Village[1]	Existing Network Condition
Deir Mimas	Good Condition
Jdaideh (Marjaayoun)	Average Condition
Bedias	Good Condition
Kharayeb (Saida)	Good Condition
Zrariyeh	Good Condition
Qaraaoun	Good Condition

[1] Only villages with an existing wastewater network as reported by the municipalities are included

b- Priority Group 2: All wet process industries located within less than 400 m from Litani River or any of its tributaries and that were not covered under Priority Group 1 above. It was judged that small industries that are located farther than 400m from a surface water body pose insignificant pollution threat to the surface water even if their effluents are discharged into the sewer network due to the dilution factor that increases with distance and mixing.

271. The results of the prioritisation of industries are presented in Table 3-27, and are further broken down by the nature of the process whether it is a wet, wastewater-generating process or a dry process where no liquid effluents from the manufacturing processes are known to be generated.

Table 3-27. Prioritisation of Industries within the Area of Study

Group	Total number of industries	Wet processes	Dry processes
Priority Group 1	50	21	29
Priority Group 2	46	25	21
Total	**96**	**46**	**50**

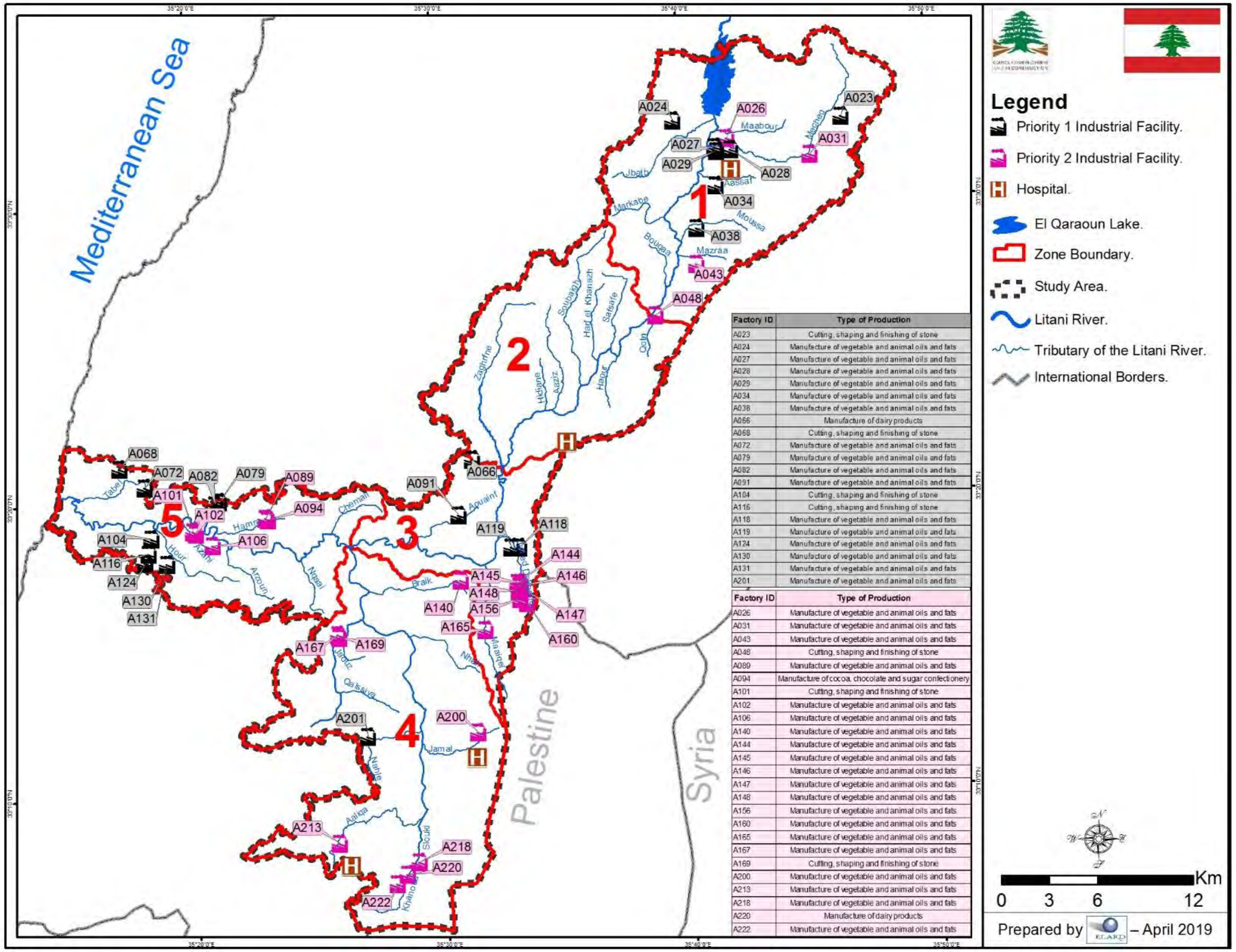
272. Table 3-27 shows that there are 96 priority industries, 46 of them generate varying amounts of wastewater while the remaining 50 industries produce no or little quantity of effluents (dry process type). Only wet process industries will be considered later for their pollution potential of the Litani River.

273. The priority industries in each zone, along with their categorisation, estimated daily wastewater quantities generated and the effluents' characteristics are listed in the tables hereafter.

274. The overall pressure from industrial wastewater discharges is determined based on the number of priority industries in each zone and estimated daily wastewater discharge from all priority industries in the relevant zone. The different industrial pressure levels for each zone were assigned based on the industrial effluents discharge brackets shown in Table 3-28.

Table 3-28. Pressure Threat Criterion from Industrial Wastewater in a Zone

Total Estimated Daily Flow of IWW (m^3/d) from Priority Industries in a Zone	Pressure Level
≤ 500	Low
501 – 1,500	Medium
1,501 – 2,500	High
≥ 2,501	Very high



Factory ID	Type of Production
A023	Cutting, shaping and finishing of stone
A024	Manufacture of vegetable and animal oils and fats
A027	Manufacture of vegetable and animal oils and fats
A028	Manufacture of vegetable and animal oils and fats
A029	Manufacture of vegetable and animal oils and fats
A034	Manufacture of vegetable and animal oils and fats
A038	Manufacture of vegetable and animal oils and fats
A066	Manufacture of dairy products
A068	Cutting, shaping and finishing of stone
A072	Manufacture of vegetable and animal oils and fats
A079	Manufacture of vegetable and animal oils and fats
A082	Manufacture of vegetable and animal oils and fats
A091	Manufacture of vegetable and animal oils and fats
A104	Cutting, shaping and finishing of stone
A116	Cutting, shaping and finishing of stone
A118	Manufacture of vegetable and animal oils and fats
A119	Manufacture of vegetable and animal oils and fats
A124	Manufacture of vegetable and animal oils and fats
A130	Manufacture of vegetable and animal oils and fats
A131	Manufacture of vegetable and animal oils and fats
A201	Manufacture of vegetable and animal oils and fats

Factory ID	Type of Production
A026	Manufacture of vegetable and animal oils and fats
A031	Manufacture of vegetable and animal oils and fats
A043	Manufacture of vegetable and animal oils and fats
A048	Cutting, shaping and finishing of stone
A089	Manufacture of vegetable and animal oils and fats
A094	Manufacture of cocoa, chocolate and sugar confectionery
A101	Cutting, shaping and finishing of stone
A102	Manufacture of vegetable and animal oils and fats
A106	Manufacture of vegetable and animal oils and fats
A140	Manufacture of vegetable and animal oils and fats
A144	Manufacture of vegetable and animal oils and fats
A145	Manufacture of vegetable and animal oils and fats
A146	Manufacture of vegetable and animal oils and fats
A147	Manufacture of vegetable and animal oils and fats
A148	Manufacture of vegetable and animal oils and fats
A156	Manufacture of vegetable and animal oils and fats
A160	Manufacture of vegetable and animal oils and fats
A165	Manufacture of vegetable and animal oils and fats
A167	Manufacture of vegetable and animal oils and fats
A169	Cutting, shaping and finishing of stone
A200	Manufacture of vegetable and animal oils and fats
A213	Manufacture of vegetable and animal oils and fats
A218	Manufacture of vegetable and animal oils and fats
A220	Manufacture of dairy products
A222	Manufacture of vegetable and animal oils and fats

Figure 3-8. Priority Sources of Indusrial Pollution Pressure

3.1.3.2.1 Zone 1

275. The total estimated daily flow from priority industries in Zone 1 is calculated at 132 m^3/day of effluents that are mainly of the organic, biodegradable nature. The flow from olive mills, estimated at 72 m^3/day is seasonal and is limited to no more than 60 days per year, however the nature of the OMWW (high organic load and presence of non-biodegradable organic compounds such as long-chain fatty acids and phenols) can result in acute river pollution, accumulation of phenols in sediments and high organic loads that could overload the wastewater treatment functions if the OMWW is discharged with municipal wastewater streams.

276. The pressure from Industrial Wastewater in Zone 1 is accordingly deemed to be Medium.

Table 3-29. Priority Industries in Zone 1

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics
Priority 1	A023	Kaoukaba	Rock cutting	30	TSS, Turbidity
	A027	Sohmor	Olive Mill	6	BOD, COD, oil and grease, TSS
	A029	Sohmor	Olive Mill	6	BOD, COD, oil and grease, TSS
	A034	Sohmor	Olive Mill	6	BOD, COD, oil and grease, TSS
	A038	Yohmor	Olive Mill	9	BOD, COD, oil and grease, TSS
	A024	Machghara	Olive Mill	9	BOD, COD, oil and grease, TSS
	A028	Sohmor	Olive Mill	9	BOD, COD, oil and grease, TSS
Priority 2	A026	Majdel Balhis	Olive Mill	9	BOD, COD, oil and grease, TSS
	A031	Majdel Balhis	Olive Mill	6	BOD, COD, oil and grease, TSS
	A043	Zillaya	Olive Mill	12	BOD, COD, oil and grease, TSS
	A048	Qelaya	Rock Cutting	30	TSS, Turbidity

3.1.3.2.2 Zone 2

277. The total estimated daily flow from priority industries in Zone 2 is calculated at 20 m^3/day of effluents that are mostly of the organic, biodegradable nature, and hence the overall threat is deemed to be low.

Table 3-30. Priority Industries in Zone 2

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics
Priority 1	A066	Kfar Tibnit	Dairy Products	20	BOD, COD, oil and grease, TSS

3.1.3.2.3 Zone 3

278. The total estimated daily flow from priority industries in Zone 3 is calculated at 73 m^3/day of seasonal effluents from the olive mills limited to no more than 60 days per year, however the nature of the OMWW (high organic load and presence of non-biodegradable organic

compounds such as long-chain fatty acids and phenols) can result in acute river pollution, accumulation of phenols in sediments and high organic loads that could overload the wastewater treatment functions if the OMWW is discharged with municipal wastewater streams.

279. The pressure from Industrial Wastewater in Zone 3 is accordingly deemed to be Medium.

Table 3-31. Priority Industries in Zone 3

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics
Priority 1	A118	Deir Mimas	Olive Mill	6	BOD, COD, oil and grease, TSS
	A119	Deir Mimas	Olive Mill	6	BOD, COD, oil and grease, TSS
	A091	Yohmor (Nabatiye)	Olive Mill	6	BOD, COD, oil and grease, TSS
Priority 2	A145	Kfar Kila	Olive Mill	9	BOD, COD, oil and grease, TSS
	A147	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS
	A148	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS
	A156	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS
	A160	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS
	A144	Kfar Kila	Olive Mill	9	BOD, COD, oil and grease, TSS
	A146	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS
	A165	Aadaysseh	Olive Mill	6	BOD, COD, oil and grease, TSS

3.1.3.2.4 Zone 4

280. The total estimated daily flow from priority industries in Zone 4 is calculated at 96 m^3/day of effluents, partly seasonal from the olive mills. Although the discharge is estimated to be limited to 51 m^3/day and for no more than 60 days per year, however the nature of the OMWW (high organic load and presence of non-biodegradable organic compounds such as long-chain fatty acids and phenols) can result in acute river pollution, accumulation of phenols in sediments and high organic loads that could overload the wastewater treatment functions if the OMWW is discharged with municipal wastewater streams.

281. The pressure from Industrial Wastewater in Zone 4 is accordingly deemed to be Medium.

Table 3-32. Priority Industries in Zone 4

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics
Priority 1	A201	Jmaijmeh	Olive Mill	6	BOD, COD, oil and grease, TSS
Priority 2	A140	Taybeh	Olive Mill	6	BOD, COD, oil and grease, TSS
	A167	Borj Qalaouiyeh	Olive Mill	6	BOD, COD, oil and grease, TSS
	A169	Borj Qalaouiyeh	Rock Cutting	30	TSS, Turbidity

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics
	A200	Houla	Olive Mill	6	BOD, COD, oil and grease, TSS
	A213	Kounine	Olive Mill	6	BOD, COD, oil and grease, TSS
	A218	Aaytaroun	Olive Mill	6	BOD, COD, oil and grease, TSS
	A222	Aaytaroun	Olive Mill	15	BOD, COD, oil and grease, TSS
	A220	Aaytaroun	Dairy Products	15	BOD, COD, oil and grease, TSS

3.1.3.2.5 Zone 5

282. The total estimated daily flow from priority industries in Zone 5 is calculated at 202 m^3/day of effluents. The majority of effluents are from the rock cutting industries that generate highly turbid and solids-laden effluents. Then there are seasonal effluents from the olive mills limited to no more than 60 days per year, however the nature of the OMWW (high organic load and presence of non-biodegradable organic compounds such as long-chain fatty acids and phenols) can result in acute river pollution, accumulation of phenols in sediments and high organic loads that could overload the wastewater treatment functions if the OMWW is discharged with municipal wastewater streams.

283. The pressure from Industrial Wastewater in Zone 5 is accordingly deemed to be High, due to the presence of rock cutting and olive mill wastewater discharges.

Table 3-33. Priority Industries in Zone 5

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics
Priority 1	A068	Kharayeb (Saida)	Rock Cutting	30	TSS, Turbidity
	A072	Kharayeb (Saida)	Olive Mill	6	BOD, COD, oil and grease, TSS
	A079	Zrariyeh	Olive Mill	6	BOD, COD, oil and grease, TSS
	A082	Zrariyeh	Olive Mill	6	BOD, COD, oil and grease, TSS
	A104	Bedias	Rock Cutting	30	TSS, Turbidity
	A116	Deir Qanoun-En Nahr	Rock Cutting	30	TSS, Turbidity
	A124	Deir Qanoun-En Nahr	Olive Mill	12	BOD, COD, oil and grease, TSS
	A130	Deir Qanoun-En Nahr	Olive Mill	12	BOD, COD, oil and grease, TSS
	A131	Deir Qanoun-En Nahr	Olive Mill	9	BOD, COD, oil and grease, TSS
Priority 2	A094	Kfar Sir	Chocolate	10	BOD, COD, oil and grease, TSS
	A089	Qsaibeh	Olive Mill	9	BOD, COD, oil and grease, TSS
	A101	Tayr Falsay	Rock Cutting	30	TSS, Turbidity
	A102	Tayr Falsay	Olive Mill	6	BOD, COD, oil and grease, TSS
	A106	Tayr Falsay	Olive Mill	6	BOD, COD, oil and grease, TSS

3.1.3.3 Healthcare Wastewater Discharges

284. Water consumption in healthcare facilities depends heavily on factors such as the kind of healthcare services provided, number of beds, accessibility to water, climate, level of care and local water-use practices (WHO, 2014). According to the United Kingdom's Department of Health, the average water consumption in hospitals is between 0.531 m^3 and 0.710 m^3 per bed per day (Department of Health, 2013).

285. Considering a conservative water consumption rate of 0.71 m^3 per bed per day, the hospitals in the LLB Study Area could be consuming around 258 m^3 of water per day or around 94,331 m^3 per year. Wastewater generation usually constitutes between 70% and 90% of water use. Assuming an 80% return rate, it is estimated that the hospitals generate an average of around 207 m^3 of wastewater per day or around 75,464 m^3 per year, as shown in Table 3-34.

286. Wastewater from healthcare establishments is of similar quality to urban wastewater, but may also contain various potentially hazardous components (WHO, 1999):

- Microbiological pathogens – enteric pathogens, including bacteria, viruses and helminths
- Hazardous chemicals – from cleaning and disinfection operations.
- Pharmaceuticals – including antibiotics and genotoxic drugs from hospital pharmacies and various wards.
- Radioactive isotopes – from oncology departments.
- Related hazards, e.g. from epidemics such as cholera

287. Common pollutants from hospitals are (Dodd, 2008):

- Silver from x-rays and mammograms
- Oil and grease and BOD from kitchen and cafeterias
- On-site laundry facility
- Unused pharmaceuticals and personal care products flushed to drain and may be potential endocrine disruptors

288. Important chemicals in hospital wastewater include anaesthetics, disinfectants (formaldehyde, glutaraldehyde), chemicals from laboratory activities, photochemical solutions (hydroquinone), and X-ray contrast media containing absorbable organohalogen compounds (AOX); mercury from dental amalgams or lab chemicals; excessive nutrients and nitrates; pharmaceuticals including antibiotics; radioactive wastes; infectious agents, including bacteria, viruses and parasites (UNDP/GEF).

Table 3-34. Hospitals' Wastewater Generation in LLB Study Area

Zone	Number of Hospitals, Primary Healthcare Centers, Medical Clinics and Labs	Number of beds at hospitals	Estimated Average Water Consumption (m^3) per Zone per day by Hospitals only	Estimated Average Wastewater Generation (m^3) per Zone per day from Hospitals only
Zone 1	1 Hospital 3 Dispensaries 30 Medical Clinics 7 Medical Labs	151 beds	107.2	85.8

Zone	Number of Hospitals, Primary Healthcare Centers, Medical Clinics and Labs	Number of beds at hospitals	Estimated Average Water Consumption (m^3) per Zone per day by Hospitals only	Estimated Average Wastewater Generation (m^3) per Zone per day from Hospitals only
Zone 2	1 Hospital 10 Dispensaries 22 Medical Clinics 3 Medical Labs	49 beds	34.8	27.8
Zone 3	13 dispensaries 28 Medical Clinics 2 Medical Labs	-	-	-
Zone 4	2 Hospitals 60 Medical Clinics 4 Medical Labs	64 beds & 100 beds	116.4	93.2
Zone 5	16 dispensaries 91 Medical Clinics 7 Medical Labs	-	-	-

289. The hospitals are located far from Litani River or its tributaries, and in localities where sewer networks are established, except for Meiss Ej Jabal in Zone 4. The estimated quantities of wastewater generated by hospitals are considered low, and therefore the pressure threat from hospital wastewater is low. It is imperative however that hospitals separate the hazardous liquid waste from the domestic-like wastewater, similar to the practice in solid waste management. It was not established if the hospitals separate their hazardous liquid waste, or if they are connected to the sewer or to underground tanks. The presence of sewer networks does not reduce the threat from hazardous healthcare wastewater discharges to surface water since there are no operational wastewater treatment plants that treat the collected wastewater.

290. Establishing the quality of healthcare wastewater from each hospital will aid in the decision whether pre-treatment of wastewater is required prior to draining the wastewater to the municipal sewer.

3.1.4 Pollution Pressures from Classified and Non-Classified Non-Industrial Establishments

291. The largest pollution sources are from the domestic and industrial sectors in the LLB Study Area, whether for waste or wastewater. The count of facilities reported in this sub-section as summarized in Table 3-35 is collected from the municipal survey where municipality officials and mokhtars were interviewed, and hence, the correct numbers could not be verified due to the absence of readily available and consolidated databases at the ministry, governorate or Qaim'maqam levels.

292. For petrol stations, vehicle repair shops and vehicle wash facilities, the Consultants collected information that was reported municipalities during the survey on the number of facilities operating in their jurisdiction, however no specific activity data on number of vehicles serviced, water consumption, waste and wastewater generations, method of

disposal and the presence of settling or decantation tanks and oil-water separators were collected, and which would permit the quantification of the pollution load from those facilities. However, it is noted that given the poor infrastructure of wastewater and stormwater collection in the LLB Study Area, it can be assumed that the polluted wastewater from these facilities is more likely than not making its way to the watercourses or seeping underground. It is noted that there is informal collection of used waste oils and lubricants, however the size and comprehensiveness of this activity were not established.

293. The permitting of these facilities is managed by governorates and municipalities, where environmental conditions for the operations are set forth by the Initial Environmental Examination (if requested) and its Environmental Management Plan, and the general and sector-specific environmental guidelines set forth in the Lebanese legislation. The observation and compliance with permit rules and general environmental conditions are seldom and inconsistently enforced by the regulators and officers as it is common practice that due to resource constraints, public officials respond to complaints instead of regular checks.

Table 3-35. Petrol Stations, Vehicle Repair Shops, Vehicle Wash Facilities, Farms, Slaughterhouses and Butchery Shops Reported by Municipalities in LLB Study Area

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	TOTAL
Petrol Stations	22	16	22	45	41	**146**
Vehicle Repair Garages	72	45	20	53	127	**317**
Vehicle Wash Facilities	22	14	10	61	65	**172**
Poultry Farms (nb. of birds)	22 (186,200)	10 (212,800)	15 (180,000)	59 (122,900)	83 (213,000)	**189**
Cattle Farms (nb. of heads)	60 (527)	10 (257)	12 (1,925)	63 (775)	23 (330)	**168**
Sheep & Goat Farms (nb. of heads)	54 (37,400)	22 (6,330)	14 (9,575)	36 (3,150)	21 (3,270)	**147**
Slaughterhouses	3	0	1	5	8	**17**
Meat Butcheries:						
- Beef & Lamb	25	16	25	61	103	**230**
- Chicken	13	0	8	42	25	**88**

294. The number of farms (poultry, cattle and sheep & goats) was also collected through the municipal survey with the municipality officials who were interviewed. The numbers could have been under or overestimated, however they provide an insight on the size of these sectors and an indication for future detailed surveying. Geographical coordinates of some farms and slaughterhouses are included in Appendix D, Table D-3. Information on the number of birds and heads is also incomplete, and should not be taken at face value prior to more detailed surveying. The main environmental pressures from these farms and pens, include wastewater with organic load (BOD, Nitrogen) and ammonia from the excreta of animals and birds, and the manure waste itself which can however be treated and re-purposed to serve as fertilizer in agricultural uses or in biogas production depending on collected quantities. A more detailed field survey of the current practices in these farms,

the practices in the use of rangeland and farmland and the waste outputs should be investigated in more detail to determine the magnitude of the pressure and develop targeted responses.

295. Information on slaughterhouses and butcheries in the LLB study area were also collected from the municipal survey. The permitting conditions for these activities are set forth by the general and specific environmental legislation, and within the Environmental Management Plans of Environmental Impact Assessments or Initial Environmental Examinations, if these were requested in the permitting for construction of such facilities.

296. Solid and liquid discharges from these facilities are organic in nature, however include animal pathogens, and therefore open disposal of animal remains may constitute a biological hazard. Liquid discharges of wastewater, mainly blood and animal excreta, could be discharged with wastewater if the quantities are not large, provided that wastewater is being treated and not discharged untreated in watercourses. For solid discharges, consisting of bones, guts and unrecyclable parts, their separate collection can allow for small incinerators operated within centralized and properly solid waste management facilities.

297. The level of pressure from the slaughterhouses and butcheries could not be ascertained as more information is needed on the size of operations and the measures taken to separate, recycle, reuse and dispose of the wastes at each of the facilities, and which could not be realized as part of this study. A more detailed survey should be undertaken to document the level of pressure and determine the compliance of facilities with their permit and general environmental conditions.

3.1.5 Pollution Pressures from Quarries

298. Quarrying activities in the Lower Litani River basin are mostly prevalent in Zones 1 and 2. Information on the license presence and validity was not available at the time of the field survey. However, it was observed that there are sand quarries within close distances (< 500 m) from the Litani and tributaries' courses, mostly within Zone 2, and fewer in Zone 4. Active quarrying was more observed in villages where no municipalities exist. A total of 63 quarrying sites were recorded; some active and some inactive. At the time of surveying, the environmental prosecution had started investigation in the status of quarries, and therefore surveying this matter proved to be difficult, and most information was collected from the municipalities.

3.1.6 Pollution Pressures from Recreational Establishments

299. As shown in the maps of Section 3.1.1, several structures, mostly recreational establishments, can be found along the river embankments. For the purposes of this business plan, secondary and primary data were collected on the presence of these encroachments within a 10 m buffer zone of the Lower Litani River course.

300. A Master's thesis project carried out in 2017 by Survey Engineering students at the Islamic University of Lebanon and with guidance from researchers at the National Center for Remote Sensing, examined the existing structures along the Lower Litani River using

available cadastral maps, remote sensing techniques, GIS tools, satellite images and field verification. The encroachments were defined as built infrastructure within a 10 m buffer zone of the river polygon, which was defined as the public domain. A total of 145 infringements were recorded in 28 localities in seven districts, covering 11% of the river length or 9.5 km in total length. The largest number of encroachments were recorded in Tayr Falsay, followed by Kfar Sir, Ain Abou Abdallah, Qaaqaaiyet Ej Jisr and Jazira (Saida). The types of encroachments recorded were: restaurants, fisheries, farms, campsites, hotels, farm houses, mineral extraction sites, plastic houses, military site, and parking. The majority of the recorded types were restaurants stretching over a total of 5.7 km along the river, followed by farms.

301. The South Regional Department within the Ministry of Environment conducted a detailed field survey of recreational establishments along the Litani River in the Governorates of South Lebanon and Nabatiye in August 2017, and identified 35 establishments along the river embankment in the districts of Tyre and Nabatiye, their operational status, built structure, water supply and wastewater treatment and disposal practices.

302. The municipal and field survey carried out for the purposes of this study in 2018, identified a total of 181 recreational establishments in the Study Area within the vicinity of the River and its tributaries. The majority of these establishments, numbering 153, were adjacent to the water course. Evaluating whether the establishment is encroaching the river domain was not possible within the scope of this study, as this exercise requires a detailed examination of the zoning and cadastral maps, topographic surveying to identify the boundaries of existing structures and verification with the planning and administrative authorities whether the occupants or land users are legally or illegally using the domain (by legal agreement / concession on land and water use). Nonetheless, based on article 12 of Law 646/2004, the establishments within 10 m from the river course were identified as completely encroaching on the legal boundary of the river, followed by those that were partially located within the 10 m boundary, and those outside the 10 m boundary. A complete list of the recreational establishments is included in Appendix D; Table D-5.

303. The recreational establishments are active during the months from April/May through September/October, and are mostly shut for the rest of the year. The main pollutant streams from recreational establishments are litter and wastewater discharges of the municipal/domestic nature.

304. Considering the number and concentration of recreational establishments which are within 10 m from the river course, the pressure from the presence of recreational establishment is rated high in Zone 5, Medium in Zone 1, and Low in Zones 2, 3 and 4. The distribution of recreational establishments across zones and relative to the river boundary is shown in Table 3-36.

Table 3-36. Recreational Facilities in the Vicinity of the Lower Litani River

	Camp Site			Hotel/Restaurant			Restaurant			Restaurant/Fishery			Public Garden			Recreational			Resort			Unspecified			Total
Zone 1	-	-	-	-	-	-	13	-	8	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	**25**
Zone 2	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	**6**
Zone 3	1	1	1	-	-	-	3	1	-	-	-	-	1	-	-	2	-	-	2	-	-	5	-	-	**17**
Zone 4	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	**11**
Zone 5	2	1	1	-	2	-	31	24	18	-	-	-	-	-	-	3	5	2	9	3	3	13	4	1	**122**
Total	**3**	**2**	**2**	-	**2**	-	**55**	**28**	**26**	**2**	-	**2**	**1**	-	-	**5**	**5**	**2**	**16**	**3**	**3**	**19**	**4**	**1**	**181**

Within 10 m boundary
Partially
Out of 10 m boundary

3.1.7 Pollution Pressures from Informal Tented Settlements

305. As per the UNHCR, the number of tents recorded in March 2018 within the LLB Study Area was 384 tents sheltering 2,005 refugees or Syrian displaced persons (DPs). The largest number (294 tents, 1,552 DPs) was recorded in the Qaraaoun Village (Zone 1), followed by Kharayeb, Jazira, Matariyet Ech Choumar and Mazraat El Ouasta in the district of Saida, and Aabbassiyeh and Aain Abou Abdallah in the district of Sour (Zone 5 – 55 tents and 302 DPs). The lowest number (35 tents, 151 DPs) was recorded in Zone 2, in the villages of Blat Marjaayoun and Kaoukaba Hasbaiya. A list of the numbers of ITS recorded across the LLB in provided in Table D-6. The pollution pressure from ITS is hence considered Low in all zones.

3.1.8 Pollution Pressures from Agricultural Sources

306. Agriculture is one of the main economic activities in the Lower Litani Basin (LLB), it constitutes about 33.1% of the land use as per the 2013 Land Use/Land Cover Map. The most common agricultural crops cultivated in the study area are field crops (49%) and olives (32.8%) as shown in Table 3-37 below.

Table 3-37. Type of Crops/Crop Categories and Total Areas in the LLB

	Open Horticulture	Citrus	Grapes	Fruit Trees	Olives	Field Crops	Banana	Total
Areas (ha)	216	1,441	1,536	819	9,092	13,595	1,044	**27,743**
%	0.8%	5.2%	5.5%	3.0%	32.8%	49.0%	3.8%	**100.0%**

Source: Land Use/Land Cover Map (2013)

307. Agriculture is generally one of the main sources of non-point source pollution affecting surface or groundwater flows. Pollutants of that source are transported to surface or groundwater flows. The most important constituents of agricultural runoff and water seepage are agricultural chemicals (fertilizers) and non-degradable pesticides which end up in waterways with irrigation overflows or deep percolation.

308. For the purpose of this Business Plan, two surveys were prepared as tools to collect information about pesticides and fertilizers used per crop:

a) Farmers' surveys (Appendix B): the farmers' surveys included farm information (farmer name, location, areas, etc.), crop information (type, area, planting date, irrigation technique, expected yields, etc.) and pesticides & fertilizers information (name, type, quantity, price, date of application, etc.). The survey also included information about farmers' attitude regarding pollution.

b) Agricultural input suppliers' surveys (Appendix B): that was conducted through interviews with major agricultural input suppliers and included the types and quantities of pesticides and fertilizers sold per crop in the study area, the trade and common names of pesticides and fertilizers, their concentration and/or formulation, the target crop or pest to which they are applied, and the application rates as per the labels and as used by the farmers according to the providers' field knowledge.

309. For the farmers/crops' surveys, Atlas Agricole du Liban and the Agricultural Census 2010 were used to determine the main agricultural crops at districts and villages level. Seven main crops or crop categories were identified in the Study Area: olives, bananas, citrus, fruit trees, vineyards, field crops and horticultural crops including 19 different crops.

310. The Land Use/Land Cover (LUC) Map was used to determine the main agricultural areas in the LLB, and to select the villages from which the farmers will be selected for each crop. For each crop or crop category, 8 to 10 farmers were interviewed to collect information about their use of pesticides and fertilizers as well as their understanding and attitude towards water pollution.

311. A total of 49 farmers were interviewed in the different districts of the Study Area: West Bekaa, Rachaiya, Hasbaiya, Jezzine, Marjaayoun, Nabatiye, Bent Jbayl, Saida and Sour.

312. For the agricultural input suppliers' surveys, six main suppliers in the Study Area were contacted and interviewed in order to explore the types and quantities of fertilizers and pesticides sold in the study area per crop. This survey was used also to cross-check the authenticities of the data supplied by surveyed famers and fill the gaps including the trade and common names of the fertilizers and pesticides, their concentration and/or formulation, the target crop or pest to which they are applied, and the application rates as per the labels and as used by the farmers according to the providers' field knowledge.

3.1.8.1 Pesticides

313. During the field survey and data collection, it was noticed that many pesticides are being applied in more than recommended rates, applying more than three times in a season which somehow leads to pesticide resistance. Some farmers sometimes double the dose per application when the pesticide is close to expiry date or have expired. Most of the farmers did not know the name or type of the pesticides, and insecticides are called "poisons" without differentiating what insects they are meant to target.

314. It was clear from the survey that the Lebanese famer lacks knowledge about pests, pesticides and alternative pest management techniques which are the main factors contributing to pesticide misuse. A wide list of pesticides is being used in the Study Area including some of the banned fertilizers by the MoA. The fate in water of these pesticides are shown in Table 3-38 and Table 3-39 where pesticides' degradation differs in the environment. Some may last from 10 weeks to two months, while others may resist for years such as Propargite and 2,4-D.

Table 3-38. Fate in Water of the Used Insecticides and Acaricides

Insecticides/Acaricides	
Active ingredient	**Fate in water**
Abamectin	No bio-accumulation
Acetamiprid	Relatively non persistent and though it is mobile rapid degradation will reduce its potential to leach to groundwater

Insecticides/Acaricides	
Active ingredient	**Fate in water**
Alpha-cypermethrin	Moderately to fast degradation
Chlorpyriphos	DT50: 35 - 78 days at pH = 7 and 25°C
Cypermethrin	DT50: 50 days at pH = 7
Deltamethrin	No residues detected
Dimethoate	Dimethoate is not expected to adsorb to sediments or suspended particles, hydrolysis half-lives of 3.7 and 118 days at pH 9 and pH 7
Endosulfon	DT50: 20 days at pH = 7 and 20°C
Flufenoxuron	DT50 (25°C): 112 days at pH 5, 104 days at pH 7, 36.7 days at pH 9
Imidacloprid	DT50: 30 days at pH 7 and 25°C in surface water, in ground water it may range from 45 - 190 days
Indoxacarb	Minimal environmental residues of this chemical in water resources are expected
Lufenuron	Lufenuron is not persistent in water
Methamidiphos	DT50: 5 days at pH = 7 and 20°C
Methiocarb	Moderately persistent and relatively immobile in soil, and is not likely to contaminate groundwater. DT50: 24 days at pH = 7 and 20°C, 321 days at pH 5, 0.21 days at pH 9 and 25°C
Methomyl	DT50 at pH's 6.0, 7.0, 8.0 and 9.0 have been experimentally determined to be 54, 38, 20 weeks and 5 weeks, respectively, at 25°C
Mevinphos	DT50: 1.4 hr at pH 11, 3 days at pH 9, 35 days at pH 7, and 120 days at pH 6
Propargite	The aqueous hydrolysis half-lives in aqueous buffer were 120 -702, 48 - 78 and 2 - 3 days at pH 5, 7 and 9 respectively
Thiamethoxam	DT50: stable pH 1 to pH 7, 11.5 days at pH 9, all at 20°C

Table 3-39. Fate in Water of the Used Herbicides and Fungicides

Herbicides/Fungicides	
Active ingredient	**Fate in water**
2,4-D	Hydrolysis (pH 7): 1 to 2 years in buffer solutions (sterile water); The half-life of 2,4-D in water ranges from 10 to 50 days. One study detected significant residues of 2,4-D in ponds and reservoirs as long as 6 months after treatment.
Glyphosate	Stable in water at pH 3, 5, 6, and 9 at 35°C, and pH 5 to 8 at 25°C; in pond water DT50 ranges from 12 days to 10 weeks
Oxyfluorfen	Rapidly decomposed by light, DT50: 5.6 days at pH = 7 and 20°C
Paraquat	Stable pH 5 to pH 9, 30 days at 25 and 40°C
Benomyl	DT50: 0.8 day at pH = 7 and 20°C, 2 months in water surface
Carbendazim	Stable at pH 5 to pH 7, DT50: 22-124 days at pH 9 and 20°C
Copper hydroxide	Stable at 20°C and pH 7

Herbicides/Fungicides	
Active ingredient	**Fate in water**
Copper oxychloride	Stable at 20°C and pH 7
Cyproconazole	DT50: 40 days at pH = 7 and 20°C
Hexaconazol	Stable, not sensitive to pH
Mancozeb	DT50: 2-36 hours at pH 5, 5.5-55 hours at pH 7, 15 hours at pH 9 at 20°C
Myclobutanil	Stable
Sulfur	Stable, not a main degradation route
Triadimenol	Stable pH 4 to pH 9 at 20 and 40°C
Zineb	Stable, usually does not move below the upper layer of soil. For this reason, zineb is unlikely to contaminate groundwater

315. The following remarks were noted during the field surveys:

- In general, there is a weak knowledge about pesticides and alternative pest management techniques that could contribute to pesticide misuse and/or overuse.
- Most of the farmers do not know the names of the used pesticides; they use what the providers recommend.
- Regardless of occurrence of diseases, most of the pesticides are used as preventive measures leading to high usage.
- Majority of farmers rely on their experience in pesticides application: regardless of occurrence of pests, if they are used to spray certain pesticides, they will continue to do it.
- Many generic names are found in the market corresponding to one active ingredient and different concentrations which may be misleading to farmers sometimes.
- Many farmers were unable to differentiate between the different types of pesticides and their appropriate uses.
- Absence of proper handling and use of the pesticides according to labels' instructions.
- There is a lack of appropriate use of adequate protective gear: no precaution is taken on health and safety and farmers tend to be careless in dealing with the pesticides.
- After application, no proper cleaning of application equipment and proper disposal of empty containers take place. Some even use the empty bottles for drinking water.
- No respect of pre- and post-harvest intervals, where some farmers tend to spray then cultivate immediately afterwards thus increasing the risk of having residues of pesticides exceeding the maximum recommended residue levels.
- The prices of pesticides are a concern. Older generic products are flooding the Lebanese market because they are cheaper than their more modern replacements, but at the same time these older products pose a risk because of their higher intrinsic hazard and the manner in which they are applied. Sometimes, farmers look for cheaper pesticides regardless of their effectiveness or adequacy.

- A tendency to apply more pesticides and buy expensive pesticides was noticed in the case of some cash crops such as vegetables and fruit trees.
- Many farmers lack crop information and proper production practices, they rely mostly on the recommendations from providers.

316. Overuse and inappropriate pesticide handling can lead to the weakening of effective natural control and development of pesticide resistance cases. The main environmental concerns about pesticides, especially herbicides, relate to water and soil contamination which lead to bioaccumulation in the food chain hence indirectly affecting human health.

317. Sediment and water sampling were carried out in June 2018 and samples were analyzed for traces of Organic Chlorinated Pesticides, Phosphor Pesticides, Nitrogen Pesticides and other miscellaneous pesticides. Although overuse of pesticides was noted during the surveys, all these pesticides were found to be below detection limits and no traces in the ecosystem. Since water and sediments samples were taken before and after major agricultural areas, this reveals low impact of pesticides on river pollution. It is important to note that the agricultural area in Zone 5 is concentrated around the river, but is more or less a flat area and extending along the coast. Therefore, the agricultural returns are possibly going directly to the sea and not into the river hence no pesticide residues were found in the samples.

318. However, it is also important to note that sampling at critical times of the year that are linked to periods of pesticide use could potentially reveal different results. Concentrations usually decrease to a minimum during rainfalls and low agricultural activity periods. Sampling was done in June, which is considered a low activity period for olives and some field crops which are dominant is the Study Area. Significant amounts of pesticides can only be detected shortly after application. Therefore, for better tracing of the effect of pesticides, monitoring has to be done on a weekly and monthly basis coinciding with agricultural activities to give better information about the fate and concentrations of specific pesticides of concern.

3.1.8.2 Fertilizers

319. In Lebanon, the soil profiles are classified as calcareous and gypsiferous which generally are very low in phosphorus (P) due to the immobilization of added phosphorus. Applied P reverts quickly to insoluble forms, and phosphate retention is more severe in gypsiferous soils because of their higher calcium (Ca) activity. It is often reported in the literature that because P is immobile in the soil, surface applications after the crop is planted will not lead to movement of P near the zone of root activity and will be of little value to annual crops in the year of application. Therefore, placement of P nearer to the roots is recommended.

320. The addition of N fertilizers is essential in calcareous soils as their organic matter content is relatively low - around 0.4 to 1.5% for surface layers and negligible in subsurface layers.

321. The problems associated with application of N fertilizers are losses through leaching of nitrates and ammonia volatilization and/or fixation by soil clay minerals. To prevent the loss

of ammonia, N fertilizers should be incorporated well into soils, especially in soil conditions where the pH is higher than 7.

322. Three main factors should be considered in the management of fertilizer applications:

1) applied forms of the fertilizers,
2) nutrient content and clay mineralogy of the soil, and
3) the amount and type of $CaCO_3$ present in the soil.

323. During the field survey, investigations were done to assess the amount of fertilizers applied by crop. The applied amounts were compared to the practical recommendations and guidelines on nutrient management for specific crops from the Food and Agriculture Organization (FAO). These guidelines are based on balanced crop nutrition for sustaining medium to high yields of crops under similar conditions to the environment of the Study Area.

324. The data on fertilizer use was analyzed per crop, where the N-P-K values were derived from the application rates and frequencies, and then compared to the recommended rates (as shown in Table 3-40). Analysis of the data revealed the following:

- Farmers apply the same amount of fertilizers regardless of their expected yields, and the recommendations they are given by the providers do not take into consideration crop nutrient uptake. Therefore, most of the times, the applied fertilizers exceed the recommended dose.
- Very few farmers have done soil analysis, and there is no reliance on available soil nutrients when applying fertilizers.
- There is a common understanding among farmers, that the more fertilizers are applied, the higher the yields. Also, more fertilizers are applied for what is considered cash crops (vegetables, grapes, and some fruit trees).
- Nitrogen fertilization ranged from 1.86 (for citrus crops) to 5.55 (fruits trees) times the recommended dose, except for banana and olives where the N application rates were close to the recommended dose as per crop uptake and utilization that would generate the expected yield.
- Phosphorus fertilization ranged from 1.43 (olives) to 5.18 (vegetables) times the recommended doses.
- Potassium (K) fertilization was mostly high in case of fruits trees where it reaches 4 times the recommended dose.

325. It could be concluded that farmers are over-fertilizing their crops and doses are being applied without proper soil and water analysis and interpretation. Nutrient demands are being exceeded and crop yields are comparably low with respect to the input of fertilizers.

Table 3-40. Average Rates of Fertilizers used by Farmers compared to Recommended Doses

	Applied by Farmers			Recommended by FAO		
Crop	**N**	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
Orange	50.7	29.6	45.2	10-20	3.5-4.5	5-16
Lemon	23.9	14.9	22.4	10-20	3.5-4.5	5-16
Banana	27.8	10.9	29.1	20-40	4.5-6	24-48
Olive	25.3	10.0	17.2	20-25	5.5-7	16-21
Watermelon	42.3	51.7	49.8	8-10	2.5-6	3.5-8
Melon	58.1	81.8	45.3	8-10	2.5-6	3.5-8
Tomato	40.1	34.2	22.1	10-15	6.5-11	16-24
Pepper	15.0	15.0	15.0	10-17	2.5-5	5.5-10
Beans	40.0	32.0	15.6	2-4	4-6	5-12
Cucumber	27.1	22.5	15.0	15-20	16-18	25-40
Eggplant	14.3	12.9	14.5	10-15	6-10	20-30
Grape	34.5	13.0	27.7	10-16	4-6	16-23
Onion	12.4	-	3.2	6-10	2.5-4.5	4.5-8
Tobacco	45.0	22.0	29.5	4-8	3-9	5-11
Sesame	7.5	7.5	7.5	3.5-5	2-3	2-3
Wheat	19.8	3.1	5.8	15	3.5-4.5	2.5-5
Almond	67.5	12.5	30.3	8-10	3-5	8-15
Peach	66.4	26.3	98.1	10-15	6-10	10-20
Apple	82.3	43.0	102.7	10-15	3-6	10-20

* Highlighted cells represent values that exceed recommended doses

326. Water samples showed low levels of nitrates, phosphate and potassium and the salinity levels are low for agriculture purposes (less than 400 ppm in all samples) which is not reflecting the amounts of applied fertilizers in the Study Area.

327. However, it is noticed that the salinity is increasing as we go downstream especially in SP14 and SP15 that are located in Zone 5 close to the river end and where the agricultural area is concentrated. When examining the cations and anions, it is noticed that the major increase in total dissolved solids is coming from the increase of sodium (Na) and chloride (Cl). This is an indication that the reason of this increase is due to sea water intrusion rather than agricultural return flows especially that potassium, phosphate and nitrate levels are not increasing a lot.

328. It is important to note that the agricultural area in Zone 5 is more or less a flat area and extending along the coast. Therefore, the agricultural returns are possibly going directly to the sea and not into the river hence the low salinity and nutrients levels in the samples.

329. However, sampling at critical times of the year that are linked to periods of fertilizers use would reveal different results. Sampling was done in June, which is considered low activity period for olives and some field crops which are dominant is the Study Area.

3.1.8.3 Farmers' Attitudes to River Pollution

330. The farmers' survey explored the attitudes of famers towards pollution of the River's waters and its sources. The majority of responses (82%) indicated wastewater as the main pollution stream, followed by industries (11%) and garbage (5%). A minority of responses (less than 2%) indicated agricultural chemicals as sources of water pollution. Also, during the survey, it was noted that most of the farmers consider that pollution is coming from the Upper Litani Basin rather than the Lower basin.

331. Farmers were asked to rate their approval of four statements regarding pollution on a scale of 1 (strongly agree) to 5 (strongly disagree). The results are shown in Table 3-41. Overall, the group of 57 farmers agreed that the River water's pollution is a concern, but that fertilizers and pesticides are not a main contributor to this problem (47% disagree that there is a negative effect of agricultural inputs on water quality. Irrigation with the nutrient-rich water was not viewed inconvenient by 44% of the surveyed farmers. Farmers tended to agree (72%) that over-fertilization could negatively influence the soil quality.

Table 3-41. Weighted-average Scores on Farmers' Attitudes towards River Water Pollution

	1- Strongly Disagree → 5- Strongly Agree
The Litani River water is polluted	4.35
Fertilizers and pesticides negatively influence the River's water quality	2.68
Irrigation with nutrient-rich River water is beneficial to the soil and crops	3.19
Overuse of fertilizers and pesticides negatively influences soil quality	3.84

332. Farmers also face an array of environmental problems that negatively influence their cultivation practices. The most cited problems, as per the survey, were irrigation water quantities and quality (30% of responses), soil fertility issues (9%) and soil salinity (7%). With regard to practices, 35% of the interviewed farmers revealed that they practice fertigation, and 80% do not regularly perform soil analysis.

3.1.9 Summary of Identified Pollution Pressures

333. The pollution pressures studied as part of the Business Plan are evaluated quantitatively and qualitatively. It is important to mention that the pathway of contamination reaching the river and the scale and nature of the pressure are key determinants in the evaluation of the pressure.

334. It is noteworthy, though evident, that larger population and more economic activities, such as in Zones 4 and 5, result in greater pollution discharges and loads; however, it is not amiss that when this is combined with poor or inadequate public infrastructure and poor governance in land use and enforcement of rules, the pollution pressure is unmitigated and will find a pathway to pollute land, surface water and ground water.

The pollution pressures are summarized in Table 3-42 and Figure 3-9.

Table 3-42. Summary of the Pollution Pressure Levels across the Zones

Pressure / Zone	Solid Waste	Municipal Wastewater	Industrial Wastewater	Agriculture	Recreational Activities
Zone 1					
Zone 2					
Zone 3					
Zone 4					
Zone 5					

Low Pressure
Medium Pressure
High Pressure

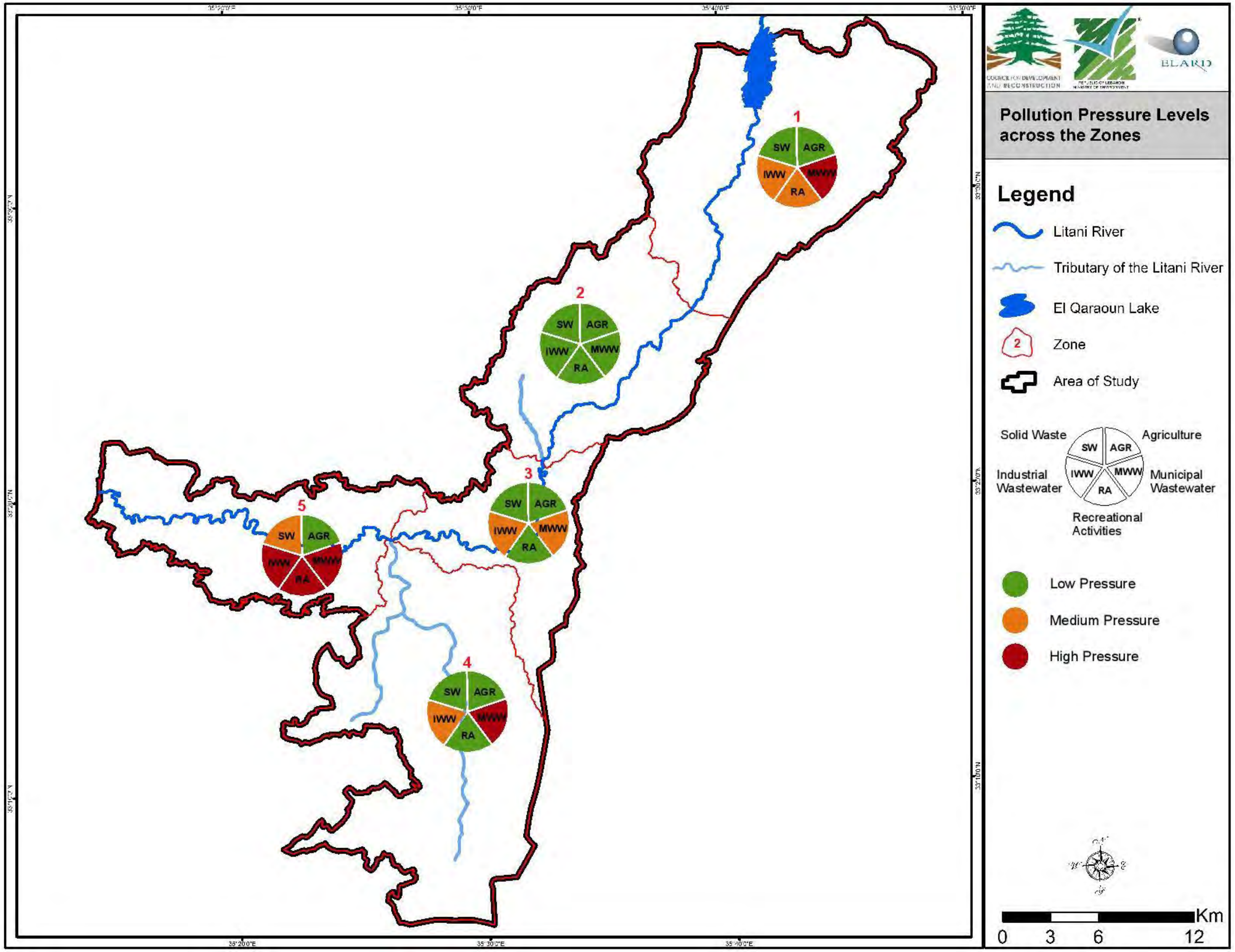


Figure 3-9. Summary of the Pollution Pressure Levels across the Zones

3.2 STATE OF RIVER ECOLOGY, WATER AND SEDIMENT QUALITY

335. Studies that reported on surface water and sediments' quality in the Lower Litani River and its tributaries were compiled and analyzed, as shown in Table 3-43. Samples taken across time, i.e. different years and seasons, and space, i.e. different locations, are expected to give insights on the state and variation of pollution in the water bodies of the Lower Litani catchment area.

336. It is essential to note that the various studies' sampling locations, along with the sampled parameters do not cover all areas of interest in the Lower Litani River Basin. In many instances, the areas of interest are found covered with insufficient consistency and repetitiveness in the parameters tested, or, the same parameter is tested for in various studies but covered in different locations. This has led to, in some cases, finding an exceedance of a certain parameter but not enough data to trace the parameter in a keystone area downstream. This inconsistency in data collection should be corrected for by establishing a scientific and effective water and sediment water quality monitoring program that is consistently adhered to.

Table 3-43. Studies with Water and Sediment Analysis Results

Study	Sampling Year(s)	Matrix
Diab 2016	2015	River Water
ELARD 2018	2018	River Water, River Sediments, Spring Water
Houri *et al* 2007	2004	River Water
IDRC 2007	2003-2006	River Water, River Sediments
Kodeih 2016	2016	River Water, Spring Water
LRA 2007-2014	2007-2014	River Water
Nehme *et al* 2014	2012	River Water, River Sediments
Nehme *et al* 2014a	2013	River Water
OPTIMA 2006	2005	River Water

337. The samples' analysis results were compiled in one spreadsheet where each reported result was included as one entry. For example, a sample analyzed for five parameters resulted in five entries. An example of the entries of the spreadsheet appears in Figure 3-10. Each entry had the following attributes:

- ID: A numeric ID was given to each entry;
- Study: Author name and year of publication;
- Sample ID/Description: As it appears in the source document;
- Year: Year of sample collection;
- Season: WET or DRY, where WET signifies that a sample was collected in the months between December and May inclusive, and DRY is attributed to the samples collected in the months between June and November inclusive;
- Matrix: Surface Water, Sediments, Spring Water;

- Type of Parameter;
- Parameter and Unit;
- Geographical Coordinates;
- Result;
- Sub-Watershed

ID	STUDY	Sample ID / Description	YEAR	SEASON	MATRIX	Type of Parameter	Parameter and Unit	RESULT	Latitude	Longitude	Sub-watershed
4687	ELARD_Field_Sampling	W-SP2	2018	Dry	Surface Water	Chemical (C)	Dissolved Oxygen (mg/l)	8.52	33.4944640	35.6595060	SW-03

Figure 3-10. Example of a Data Entry in the Water and Sediment Results' Database

338. Each sample was assigned to one of the 11 sub-watersheds within the Study Area based on its location. Two sub-watersheds (SW-06 and SW-11) were further sectioned to give emphasis to certain tributaries or sources of pollution located within those two sub-watersheds. The analysis results from close locations for the same parameter were averaged for the specific years and seasons during which they were collected. The sub-watersheds or sections, represent the space dimension in the analysis of the results, while the year and season represent the time dimension. The sections are drawn over the Study Area for reference as shown in Figure 3-11.

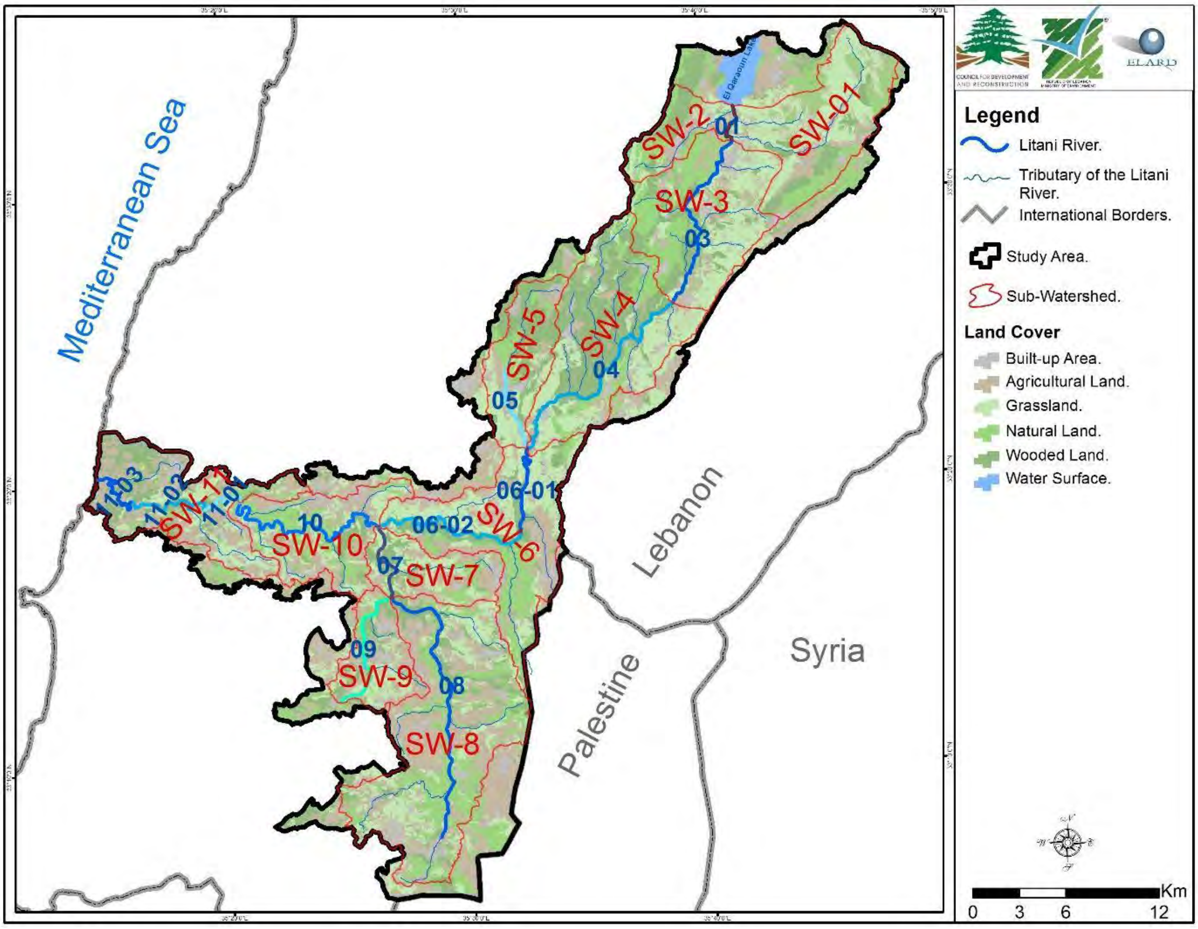


Figure 3-11. Sub-watersheds and Sections Drawn over the Lower Litani River and Tributaries

339. The database contains 3,854 entries, which were compiled from the nine different sources that are listed in Table 3-43. Studies with Water and Sediment Analysis Results. Given that different studies report the parameters differently, provide measurements in different scales and record the geographical locations in different coordinate systems or through map depictions, the data were treated to harmonize parameters' listing and measurement units. The geographical coordinates were also harmonized, or were determined using the images provided in the studies in which the coordinates were not explicitly provided. The database retains the original sample identification, which the authors of the various studies had given the samples. The data were entered into Microsoft Excel, and analyzed using Excel's Pivot Table tools to create summary tables and charts.

340. The following sub-sections provide a summarized and visual overview of the overall state of surface water quality, and sediment quality across the different sections of the water bodies of the Lower Litani River catchment area.

341. It is important to note that several assumptions were made by the authors of this report in analyzing the data. Where recent results provide a different conclusion from past results, the newer data was favored. Inconclusive results are duly noted. The methodology used to generate the conclusions appearing in sections 3.2.1 and 3.2.2 is explained briefly within the sub-sections and in details in Appendix F, which also contains the summary tables of the analysis. Detailed reports of the analysis with charts and explanation of the assumptions made were separately generated.

342. Applicable water quality guidelines for various parameters and for different end uses of water – aquatic health, bathing, drinking and irrigation – were collected from the national and international guideline values and permissible levels. As for the sediments, the river sediment results were compared to the reference world averages and Dutch intervention values for soil and sediments. The guidelines against which previous and the most recent water and sediment results were compared to are presented in Table G-8 and Table G-9 of Appendix G.

3.2.1 State of River Water Quality

343. The Lower Litani River Basin consists of eleven sub-watersheds. For the purpose of viewing and analyzing the data to reveal the influence of certain pressures, two sub-watersheds were further divided into two or three parts yielding fourteen river sections in total. The sequence in which the water streams are numbered is intended to show how the different main river sections or sub-watersheds and tributaries link together or feed into each other. This water course sectioning illustrates how the state of water quality varies along the river from the Qaraaoun Dam, all the way to its outlet in Qassmieh. The different sections are described in Table 3-44.

Table 3-44. Sections of the Lower Litani River

Section Number	Section Name	Description	Influencing Sub-watersheds
01	Main River Section 01	Extends from the Qaraaoun Dam to the point just before a tributary joins the Main River.	SW-01 & SW-02
03	Main River Section 03	Starts down the River from Section 01 at Sohmor and extends all the way to Dellafi bridge. It includes five tributaries that intersect with the Litani River main course. This section includes many quarry sites.	SW-01, SW-02 & SW-03
04	Main River Section 04	Extends from Dellafi Bridge down right before the intersection of a main Litani River tributary in Mazraat Doumiat. This section is also characterized with many quarries and springs.	SW-01, SW-02, SW-03 & SW-04
05*	Jarmaq River Section 05	Jarmaq River and its tributaries starting in Rihane area. It flows to the point where it intersects with the main Litani River course in Mazraat Doumiat.	SW-05
06-01	Main River Section 6-01	Section of the River extending from Khardali Bridge to Taybeh Pumping Station. This section contains two tributaries and is characterized by olive mills. The largest tributary originates in Bent Jbayl and intersects in Deir Mimas with the main course.	SW-01, SW-02, SW-03, SW-04, SW-05 & SW-06-01
06-02	Main River Section 06-02	Extends West of the Taybeh Pumping Station to Wadi el Hujeir just before a tributary from Wadi Al Saluki joins with the main Litani River course. This section has springs located on or near the main river course.	SW-01, SW-02, SW-03, SW-04, SW-05, SW-06-01 & SW-06-02
07*	Qaaqaaiyet Ej Jisr Tributary Section 07	Extends from the point where two tributaries from Bent Jbayl meet to flow towards Qaaqaaiyet Ej Jisr until the main tributary meets the main Litani River at Qaaqaaiyet Ej Jisr. This section includes many municipal dumpsites.	SW-07, SW-08 & SW-09
08*	Nhair Tributary Section 08	Originates in Aaytaroun, flows through Wadi Slouki until it joins in with both Section 09 and 07 in Touline. This section includes many dumpsites and quarry sites.	SW-08
09*	Jaouz Tributary Section 09	Passes through Qalaouyieh, Khirbet Selm, and Soultaniyeh, before joining with the tributary of Wadi Slouki.	SW-09
10	Main River Section 10	Starts from Qaaqaaiyet Ej Jisr and extends west to Tayr Falsay. The section contains various dumpsites and touristic establishments alongside the river.	SW-01, SW-02, SW-03, SW-04, SW-05, SW-06-01, SW-06-02, SW-07, SW-08, SW-09 & SW-10
11-01	Main River Section 11-01	Extends from Tayr Falsay area to the point before the Maaroub tributary joins the main Litani River course. This area is saturated with restaurants and touristic establishments along the riverbanks.	SW-01, SW-02, SW-03, SW-04, SW-05, SW-06-01, SW-06-02, SW-07, SW-08, SW-09, SW-10 & SW-11-01

Section Number	Section Name	Description	Influencing Sub-watersheds
11-02	Main River Section 11-02	After the Maaroub tributary intersection with the main Litani River course until Bourj Rahhal Tributary intersects with the main Litani River. This section includes various touristic establishments as well as agricultural fields.	SW-01, SW-02, SW-03, SW-04, SW-05, SW-06-01, SW-06-02, SW-07, SW-08, SW-09, SW-10, SW-11-01, & SW-11-02
11-03	Main River Section 11-03	The last section starts from Bourj Rahhal bridge all the way to the Litani River outlet at sea. This area is mainly agricultural.	SW-01, SW-02, SW-03, SW-04, SW-05, SW-06-01, SW-06-02, SW-07, SW-08, SW-09, SW-10, SW-11-01, SW-11-02, & SW-11-03

*** Tributary Section**

344. The data collected on the biological state of the river is limited to a unique sampling event in the dry season of the year 2016 (Kodeih, 2016) in the reviewed literature. The ELARD sampling campaign complements the above findings with results for E. coli and Fecal Coliform exceeding National (NL 161:2016) and International (WHO, 2011) standards for drinking water. The biological state of the river water quality is found to be poor in all of the sub-watersheds with exceedances of Enterococci, Fecal Coliform, and Total Coliform for the respective drinking and bathing standards; with the addition to an exceedance of irrigation standards for wastewater reuse categories I, II, and III (Lebanon-FAO Proposed Guidelines) in the sub-watersheds 06-01 and 11-03.

345. Between 2003 and 2018, from the reviewed literature sampling events up until the ELARD 2018 campaign, the physico-chemical condition of the Lower Litani River varies considerably. The chemical quality of the Lower Litani River, where aquatic standards apply, has shown poor and inadequate levels to support aquatic life with exceedances in BOD levels to the standard in all sampled sub-watersheds unanimously. Nitrite, a highly leachable compound usually found in fertilizers and sewage, exceeds aquatic standards in all sub-watersheds for the exceptions of sub-watershed 03 and the dry season concentrations in sub-watershed 07. Where physico-chemical parameters are detected in the Lower Litani River across the sampling events and years, following the respective standards for swimming, no exceedances have been found.

346. The quality of the Litani River surface water is considered poor for drinking usage according to National and International standards. Aside from high turbidity and total dissolved solids exceeding drinking standards, the majority of findings point towards exceedances of Nitrate and Nitrite for drinking water standards and detection of Sulfate and Potassium in the Litani River Water in most sub-watersheds.

347. Based on a study done in the Lower Litani River Basin, strong correlation is found between sulfate and potassium, most likely due to potassium sulfate used by farmers. Sulphate, Phosphate, Nitrate, Nitrite, COD, Ammonium, Magnesium, Chlorides, and Sodium are detected along the sampling events analyzed and fall within the usual range of water for irrigation use. Potassium, Calcium and Carbonate have been also detected all along the

sampled sites in the LLB and show notable exceedance of the FAO usual range of water for irrigation use.

348. Copper along with Zinc, are detected at high concentrations in five sub-watersheds (03, 06-01, 10, 11-01, 11-03) during the wet and dry seasons, making the river water quality inadequate for aquatic life in all cases of detection with an exception of Zinc found in one instance complying with the aquatic standard in sub-watershed 11-01 and 11-03. The following metals have been repeatedly detected across many sub-watersheds exceeding drinking standards and contributing to the poor quality of the Litani River water: Cadmium, Iron, Lead, Chromium, and Mercury. Cadmium and Chromium seem to be correlated and linked to the same source due to their detection in various sub-watersheds (03, 06-01, 06-02, 11-01, and 11-03) simultaneously at high concentrations. The latter also exceeds the FAO proposed guidelines of water for irrigation use for wastewater reuse (Lebanon-FAO Proposed guidelines (2010)). In sub-watershed 06-01 and 06-02, an unusual amount and variety of metals are detected, some of which exceeding drinking (Lead, Mercury, Aluminum, Cadmium, and Chromium) and irrigation guidelines (Arsenic, Cadmium, and Chromium). Other metals worth noting are found either complying with given standards or no standards apply such as: Silver, Barium, Copper, Manganese, Vanadium and Nickel. Vanadium in the form of Vanadium Oxide and Zinc are both components of steel used for alloys, which can also be found in auto parts, springs and ball bearings. Chromium is mainly used in steel making and Lead results from burning fossil fuels, and the manufacture of batteries and metal products. Although there could be various uses and sources to the above detected metals ending up in the surface water, industrial discharge and municipal solid waste open dumps and burning, and leaching could also be major contributors. The July 2006 War was also a potential source of metals in soil and consequently in water as a result of the munitions used: smear samples taken by UNEP from a number of locations following the war showed elevated levels of heavy metals, originating from the source of explosion (i.e., bombs) or from the targets. These were probably carried to the River from nearby targeted sites.

349. Organic compounds are only found and reported in the 2018 ELARD sampling campaign. Although this was a one-time sampling event, the given data confirms the presence of such compounds and highlights the importance of future monitoring of water quality all along the Litani River Basin. Pentachlorobenzene, generally found in pesticides, is detected in sub watersheds 03, 04, 06-01, 06-02, and 11-03 and can be generated when organic compounds are burned or exposed to a large source of energy. Through open burning of municipal waste, chlorobenzenes can be formed and released into the environment. Following the municipal survey, it was found that dumpsites practice open burning which could be contributors to chlorobenzene detection. Petroleum hydrocarbons are only found in the surface water sampled in sub-watershed 03. TPH C21-C32 is found in crude oil and automotive gasoline. It is found in higher concentrations in unleaded gasoline than it is found in the leaded counterpart, both of which are readily used in gas stations in the area. Petroleum hydrocarbons are toxic, and have high motility in their environment potentially reaching groundwater. Sub-watershed 06-02 contains

detected phenols, PCBs, and volatile halogenated hydrocarbons other than the already mentioned chlorobenzenes. Furthermore, three types of volatile hydrocarbon compounds are detected in sub-watershed 11-01: Trichloroethane, Ethylbenzene, and o-Xylene. Urban run-off is suspected to be the main contributor along with waste leachate and agricultural runoff where such sources are present.

350. The state of surface water quality in the River and its tributaries is summarized in Table 3-45 and Figure 3-12.

Table 3-45. State of Surface Water Quality in the Lower Litani River and its Tributaries

State / River Section	Aesthetic	Metals	Biological	Physico-chemical
Main River Section 01	Poor	No Analysis Results	Average	Average
Main River Section 03	Average	Poor	Poor	Average
Main River Section 04	Good	Good	Poor	Average
Main River Section 06-01	Average	Poor	Poor	Poor
Main River Section 06-02	Average	Average	Poor	Average
Qaaqaaiyet Ej Jisr Tributary Section 07	Average	No Analysis Results	No Analysis Results	Good
Main River Section 10	Average	Poor	Average	Average
Main River Section 11-01	Average	Poor	Poor	Poor
Main River Section 11-02	Average	Good	Poor	Average
Main River Section 11-03	Average	Poor	Poor	Poor

Good
Average
Poor
No Analysis Results

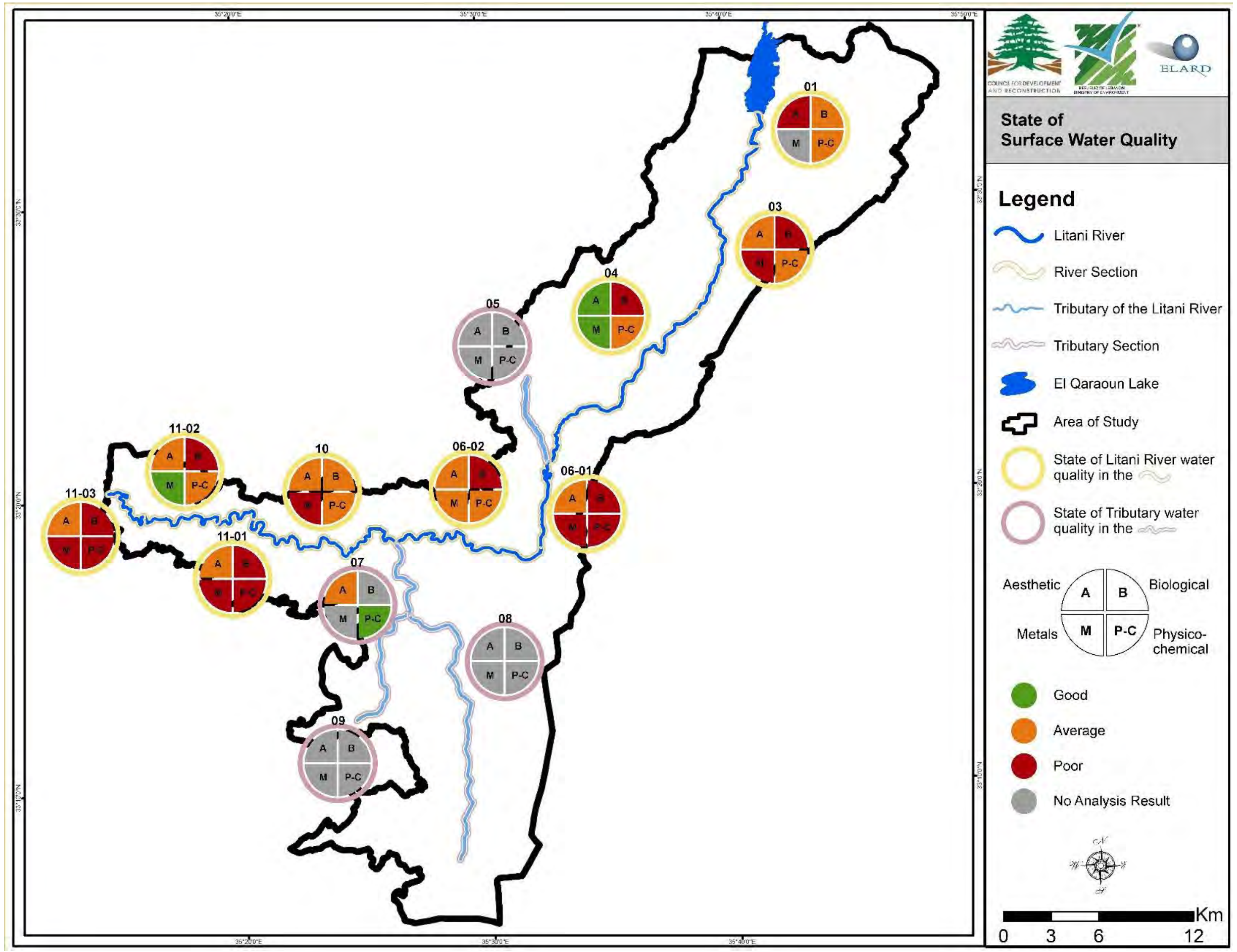


Figure 3-12. State of Surface Water Quality in the Lower Litani River and its Tributaries

3.2.2 State of River Sediments Quality

351. The sediments' results allow for general conclusions to be drawn regarding the heavy metals detected and those exceeding world average standards for metals in river sediments. The sediment quality data are attributed to the years 2004-2018, and portray results for both wet and dry seasons. The most recent 2018 wet season sampling campaign conducted by ELARD tested sediments for traces of pesticides, phenols and a wide range of hydrocarbons and other micro-pollutants. The results from past and more recent studies are shown in summary tables by river section in Appendix F, Table F-12 through Table F-20 and Appendix G, Table G-6 for the ELARD 2018 results. The detected concentrations for metals were compared to the world averages or the Dutch intervention values for soil and sediments where world averages were missing (Table G-9). Micro-pollutant concentrations are reported as detected and pertain to one sampling campaign only.

352. Table 3-46 presents the metals that were found exceeding the world average in the different sections in summary.

353. Cadmium, detected in all sub-watersheds except for sub-watersheds 04, 06-02, and 11-02, exceeds the World Average in all instances (Chapman 1996-UNESCO/WHP/UNEP). The detection of Chromium is simultaneous with that of Cadmium with concentrations found below the World Average standards except for in sub-watershed 06-01. Cadmium is a trace metal from pesticides and phosphate fertilizers and is found exceeding the standards both in surface water and in sediment samples. Silver, Aluminum, Iron, Lead, and Manganese are all detected in the following sub watersheds: 03, 06-01, 10, 11-01, and 11-03; no exceedances have been noted with the exception of Lead exceeding World Averages in both sub-watershed 10 and 11-03. The trend in which the latter metals are detected raises suspicion on a joint source of pollution common to Silver, Aluminum, Iron, Lead, and Manganese. Section 06-01 of the main Litani River, after Khardali Bridge, shows exceedances in the following parameters: Aluminum, Arsenic, Cadmium, Chromium, Manganese, Strontium, Titanium, Yitrium and Zinc. The July 2006 Conflict is a probable source of heavy meatls, as mentioned in Section 3.2.1. Furthermore, traces of organic compounds, phthalates, and PAH are detected. Sub-watersheds 06-01 and 06-02 host several olive mills mainly in Deir Mimas and Kfar Kila. The tributary, where MSW is dumped coming from Yohmor (Nabatiye), is associated with the factors leading to the presence of heavy metals. The river sediments of sub-watershed 07 are exceeding world averages in Arsenic concentration. Sub-watersheds 10, and 11-01/02/03 are all part of a heavily agricultural and touristic zone, showing exceedances in heavy metals concentrations. Although the agricultural survey has portrayed overuse of pesticides, all were found to be below detection limits.

Table 3-46. Metals' Presence and Exceedances in River Sediments across the Different Sections

Sub-Watershed/Section	Ag	Al	Al_2O_3	As	Ba	Cd	Co	Cr	Cu	Fe	Fe_2O_3	Ga	Mn	MnO	Ni	Pb	Rb	Sr	TiO_2	V	Y	Zn	Zr
03	X	X		X	X	**X**	X	X	X	X			X		X	X				X		X	
04			**X**						X		X				X			X	X		X	X	X
06-01	X	X	**X**	**X**	X	**X**	X	**X**	X	X	X	X	X	**X**	X	X	X	X	**X**	X	**X**	**X**	X
06-02					X		X	X	X						X					X		X	
07			X	**X**					X		X			X	X		X	X	X		X	X	X
10	X	X			X	**X**		X	**X**	X			X		X	**X**						X	
11-01	X	X			X	**X**		X	X	X			X		X	X						X	
11-02			X	X					X		X	X		X	X		X	X	**X**		**X**	X	X
11-03	X	X	X	X	X	**X**		X	X	X	X	X	X	X	X	**X**	**X**	X	X		**X**	**X**	X

Bolded entries show exceedance of the standards

354. The results of analysis of sediment samples for organic pollutants are shown in Table 3-47. It is noteworthy that these results are from a one-time sampling campaign (ELARD 2018) and there are no past results to compare against.

355. Sub-watershed 03 is the first area that receives water from the Qaraaoun Lake through the Jezzine Tunnel Outlet, where the releases are adhoc and provided on request from the Qassmieh Irrigation Project. As there are very few sources of direct industrial discharges upstream of this point, it is deemed that the sediments of sub-watershed 03 reflect cumulative pollution from the Qaraaoun Lake water discharging at this point.

Table 3-47. Organic Compounds Detected in River Sediments across the Different Sections in June 2018

	River/Tributary Section	
	03	**06-02**
Miscellaneous Organic Compounds		
Biphenyl		X
Petroleum Hydrocarbons		
EPH (C12-C16)	X	
EPH (C16-C21)	X	X
EPH (C21-C30)	X	X
EPH (C30-C35)	X	X
EPH (C35-C40)	X	X
EPH Sum (C10-C40)	X	X
Phenols		
Cresols (sum)	X	
p-Cresol	X	
Phenol	X	
Phthalates (sum)		
Bisethylhexylphtalate	X	X
Phtalates (sum)	X	X
Polycyclic Aromatic Hydrocarbons		
Benzo(b)fluoranthene	X	
Naphthalene		X
PAH 10 VROM (sum)		X
PAH 16 EPA (sum)	X	X
Phenanthrene		X
Pyrene		X

3.2.3 State of Groundwater Quality (Public Wells)

356. The quality of water extracted from public wells is studied using records of samples collected and analyzed by the South Lebanon Water Establishment (SLWE) for the period from January 2016 to May 2018. Analysis results of samples from 36 wells within the Study Area, from the South and Nabatiye Governorates, were compiled and summarized for the parameters showing exceedances, as shown in Table 3-48. It is evident that bacteriological pollution of public wells is prevalent, indicating the contamination of groundwater through seepage of sewage water into the tapped aquifers.

3.2.4 State of Spring Water Quality

357. The quality of water from springs is studied using a limited number of samples collected and analyzed by the SLWE for the period from August 2016 to March 2018. Analysis results of samples from three springs – Ain ez Zarqa, Aaychiyeh, and Qsaibeh – were compiled and summarized, as shown in Table 3-49. Contamination with Total Coliform and E. coli is apparent, indicating that the quality of water supplies of communities is compromised due to poor handling of wastewater.

358. Further to the secondary data from the SLWE, and as part of this study, two samples were collected from Ain Al Dayaa in Machghara and Ain ez Zarqa. The results are shown in Table 3-48. The presence of Barium in both springs is noted, as well as the presence of Vanadium in low quantities in Ain ez Zarqa. The sources of Ba and V in spring water should be investigated further.

359. In terms of bacteriological quality, the detection of high TDS, Total Coliform and Fecal Coliform in both springs, and Enterococci sp. in Ain ez Zarqa is further evidence of the contamination of the spring water with raw sewage. Nitrate levels in Ain ez Zarqa were also noted to be above the US EPA Drinking Water Standards, where nitrate is an indication of agricultural pollution.

360. Given the importance of Ain ez Zarqa in water supply of nearby villages and in feeding water to the Awali Conveyor at a later stage, the protection of the catchment area of Ain ez Zarqa and curbing pollution of this water source should be a priority.

Table 3-48. Summary of Groundwater Analysis Results of Public Wells

	Zone 2				Zone 3				Zone 4				Zone 5			
	No. of exceedances	No. of samples	% Exceedance	No. of wells sampled	No. of exceedances	No. of samples	% Exceedance	No. of wells sampled	No. of exceedances	No. of samples	% Exceedance	No. of wells sampled	No. of exceedances	No. of samples	% Exceedance	No. of wells sampled
Total Coliform	1	1	100%	1	13	17	76%	5	12	16	75%	10	102	178	57%	20
E. coli	0	1	0%	1	6	17	35%	5	6	16	38%	10	32	176	18%	20
Pseudomonas	--	--	--	--	8	13	62%	4	13	15	87%	9	79	150	53%	19
Acidity	1	6	17%	3	--	--	--	--	--	--	--	--	--	--	--	--
Ca Hardness	--	--	--	--	--	--	--	--	1	10	10%	10	3	83	4%	18
Chloride	--	--	--	--	--	--	--	--	--	--	--	--	1	82	1%	18
Fluoride	--	--	--	--	--	--	--	--	3	10	30%	10	1	82	1%	18
Iron	--	--	--	--	--	--	--	--	2	21	10%	10	1	86	1%	18
Mg Hardness	--	--	--	--	1	8	13%	3	2	10	20%	10	2	83	2%	18
Nitrate	--	--	--	--	--	--	--	--	1	21	5%	10	--	--	--	--
Nitrite	--	--	--	--	--	--	--	--	3	21	14%	10	--	--	--	--
Orthophosphate	--	--	--	--	--	--	--	--	--	--	--	--	1	82	1%	18
Total Hardness	--	--	--	--	--	--	--	--	1	10	10%	10	1	83	1%	18
Total Phosphate	--	--	--	--	--	--	--	--	--	--	--	--	2	56	4%	16

	Zone 2				Zone 3				Zone 4				Zone 5			
	No. of exceedances	**No. of samples**	**% Exceedance**	**No. of wells sampled**	**No. of exceedances**	**No. of samples**	**% Exceedance**	**No. of wells sampled**	**No. of exceedances**	**No. of samples**	**% Exceedance**	**No. of wells sampled**	**No. of exceedances**	**No. of samples**	**% Exceedance**	**No. of wells sampled**
Turbidity	--	--	--	--	--	--	--	--	5	21	24%	10	2	178	1%	20

Table 3-49. Summary of Water Analysis Results of Springs

	Zone 1 – Ain ez Zarqa				Zone 2 - Aaychiyeh				Zone 5 - Qsaibeh			
	No. of exceedances	**No. of samples**	**% Exceedance**	**No. of springs sampled**	**No. of exceedances**	**No. of samples**	**% Exceedance**	**No. of springs sampled**	**No. of exceedances**	**No. of samples**	**% Exceedance**	**No. of springs sampled**
Total Coliform	2	2	100%	1	0	1	0%	1	2	2	100%	1
E. coli	2	2	100%	1	0	1	0%	1	2	2	100%	1
Pseudomonas	--	--	--	--	--	--	--	--	1	1	100%	1

3.2.5 State of River Ecology

361. The state of the river's health from an ecocentric perspective was not assessed as part of this study. Such an assessment requires the undertaking of an ecological baseline study that would investigate the presence, proliferation and health of indicator species – aquatic fauna and flora, benthic and plankton varieties, and seasonal monitoring of the river's biodiversity.

362. All pollution pressures stated in section 3.1 can result in stressing the river's and watershed's health if the pollution intensity and load over time exceed the capacity of the river to 'clean' itself. It is evident from the water and sediment quality that anthropogenic activities are leaving a trace, and therefore the first pre-requisite to restoring the river's health is to reduce waste loads from all sources. Communities, economic agents and local governments should be aware that the river is not a waste repository, and that its integrity is vital to the local environment's health.

363. The quality of the river's water and its 'health' status are also largely dependent on the quantity of water in the river course. Water diversions, such as the stretch of river after the Qaraaoun Dam and after the dam in Zrariyeh, mess with the river's flow regime and stress the ecosystem to adapt to low-flow conditions which may cause imbalances in the micro-environments of the watershed. Structural diversions may also have unintended consequences for downstream communities and river sedimentation. Failure to study and understand the river's ecosystem can lead to incomplete comprehension of the effects from water diversions and water stress.

364. Ecological restoration of the Lower Litani river needs careful studying and should commence from an ecological baseline study, followed by setting a long-term restoration program that is led by technical water managers, supported by consistent monitoring of physical indices and water chemistry, data interpretation and scientific assessment of improvements and investments, leading to informed decision making. In an attempt to kick-start river ecology restoration in the Upper Litani basin and Qaraaoun Lake, a Dutch mission (Outboter and Moria, 2018) proposed a principles-based prioritization strategy for ecological restoration (February 2018):

    0. Waste load reduction to stop the flow of nutrients and pollutants to the river

    1. Establishing a healthy hydrological function through maintaining base flow and stream bed morphology, and establishing the water balance within the watershed (groundwater and surface water).

    2. Ensuring that nutrient loading does not exceed the carrying capacity of the river

    3. Reducing toxicological pressures.

3.3 SITUATION ANALYSIS: POLLUTION PRESSURES VERSUS STATE OF RIVER WATER AND SEDIMENT QUALITY

365. Thorough examination of the river water quality across the river and tributary sections has revealed and mirrored contaminant trends related to municipal, agricultural and industrial pressures. It is notable that the bacteriological state throughout the entirety of the Lower Litani River with the exception of Sections 01 and 03, where the river is dry for most of the year, is poor and exceeds national and international drinking standards. The major driver behind the poor bacteriological state of the surface water quality is wastewater discharge in the main river course, or its tributaries.

366. It is significant to note that during the sampling campaign the river looked extremely turbid with a brownish color mostly in all sampling sites and the field team has been informed by locals on site that this could be due to attempts of clearing accumulated sections upstream by locals by excavating and letting the sediments flow downstream.

367. The heavy metals detected in the river sediments along the main river bed are also portrayed in the river water. The middle section (Sub-watersheds 06-01/02) shows the most diversity and types of heavy metals detected in river water.

368. Olive mills are heavily present in the Lower Litani area; although it is important to note that the operation of such an industry is seasonal (up to 60 days per year), traces of phenols, in river sediments were detected. The presence of phthalates, EPH, and PAHs in sediments indicates the effect from urban runoff, municipal discharge and leachate from municipal waste dumps. Phthalates are a residue from plastics, which can leach from plastic (PVC mainly) wastes. Sources of TPH are numerous and TPH can be found in municipal wastewater, urban runoff, crude oil and gasoline. Phenols along with BOD, COD, and TSS are identified as an olive pressing pollutant in wastewater. However, due to the close proximity of the detection area and the point where occasionally on scheduled instances water from the Upper Litani/Qaraaoun Lake mixes with the Lower Litani, phenols and organic pollutants could have originated from the Upper Litani Catchment Area.

3.3.1 Pollution Loads of Tested Parameters

369. Based on the most recent water analysis results obtained for the 2018 dry season (see Appendix G) and the flow values measured at the time of sampling, the daily loads of the different parameters were calculated. This was done by first converting the flow values into daily flow figures, then multiplying the daily flow by the pollutant concentrations. The results are shown in Table 3-50. The calculation of the loading of various pollutants serves to uncover the parameters that might have been dismissed because they are within the standards for one or more uses. The latter metals are circulating in the water at below standard concentrations, but that will eventually settle onto the river bed, accumulate and then flag as exceeding soil standards or world averages in sediments. Olive mills and other industries being in close proximity to tributaries or even the main river course have been reflected in the presence of related pollutants in the sediment analysis. Parameters such as phenols (attributed to olive mills runoff), TPH and heavy metals (pollutants resulting

from various industrial activities), are flowing in the main river course (Table 3-50) and are detected in the sediments as well (Table G-6).

Table 3-50. Estimated Daily Load Values of the Different Pollutants in June 2018

	Calculated Daily Load									
Sample	**SP03**	**SP04**	**SP05**	**SP06**	**SP07**	**SP09**	**SP10**	**SP11**	**SP12**	**SP13**
Flow (l/s)	**583**	**202**	**1,000**	**1,160**	**1,160**	**799**	**799**	**1,260**	**844**	**258**
Sub-Watershed Influences	**1, 2**	**1, 2, 3**	**1, 2, 3, 4**	**1, 2, 3, 4, 5**	**1, 2, 3, 4, 5**	**1, 2, 3, 4, 5, 6**	**1, 2, 3, 4, 5, 6**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11**
BOD_5 (kg/d)	10,560	3,491	15,984	23,432	24,408	13,807	13,462	24,494	15,897	535
Ca (kg/d)	3,978	1,330	6,117	6,746	6,532	4,156	4,101	6,053	4,047	155
Cl^- (kg/d)	905	262	1,210	1,269	1,172	967	828	1,415	875	45
COD (kg/d)	251	68	359	625	791	284	270	454	352	11
Dissolved Oxygen (kg/d)	476	163	742	860	-	594	-	922	603	15
Fe (kg/d)	-	-	7	-	-	-	4	8	4	-
HCO_3^- (kg/d)	11,666	3,909	17,885	19,038	19,331	12,633	11,943	18,507	12,397	571
K^+ (kg/d)	60	18	71	39	36	50	37	57	42	1.23
Mg (kg/d)	362	96	484	576	566	435	421	653	423	39
Na^+ (kg/d)	488	141	605	703	713	463	476	762	525	24
NO_2^- (kg/d)	5	-	-	-		-	-	-	-	0.11
NO_3^- (kg/d)	523	190	1,037	1,025	840	518	704	1,067	715	17
PO_4^{3-} (kg/d)	16	4	9	17	19	14	6	13	7	0.74
Salinity (kg/d)	10,560	3,473	15,898	18,453	17,867	11,529	11,598	17,418	11,595	513
SiO_2 (kg/d)	262	61	493	781	859	601	621	1,056	707	29
SO_4^{2-} (kg/d)	503	122	605	683	683	621	621	980	656	29
TDS (kg/d)	13,320	4,634	18,412	20,903	20,688	13,551	14,028	20,662	13,542	586
Total Hardness (kg/d)	11,415	3,718	17,280	19,234	18,648	12,150	12,012	17,854	11,813	548
Total Solids (kg/d)	166	4,732	20,365	21,358	22,185	14,563	16,282	23,129	16,458	591

	Calculated Daily Load									
Sample	**SP03**	**SP04**	**SP05**	**SP06**	**SP07**	**SP09**	**SP10**	**SP11**	**SP12**	**SP13**
Flow (l/s)	**583**	**202**	**1,000**	**1,160**	**1,160**	**799**	**799**	**1,260**	**844**	**258**
Sub-Watershed Influences	**1, 2**	**1, 2, 3**	**1, 2, 3, 4**	**1, 2, 3, 4, 5**	**1, 2, 3, 4, 5**	**1, 2, 3, 4, 5, 6**	**1, 2, 3, 4, 5, 6**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11**
TSS (kg/d)	166	98	397	449	1,494	1,008	2,251	2,460	2,917	5
o-Xylene (g/d)	-	-	-	-	-	-	-	-	12	-
1, 1, 1-Trichloromethane (g/d)	-	-	-	-	-	-	-	-	190	-
1, 1-Dichloroethane (g/d)	-	-	-	-	-	-	68	-	-	-
Ba (g/d)	1,911	768	3,024	3,612	3,417	2,485	2,554	4,136	3,573	169
Cr (g/d)	121	-	-	-	-	-	-	-	-	-
Ethylbenzene (g/d)	-	-	-	-	-	-	-	-	9.48	-
Nitrobenzene (g/d)	-	-	-	-	-	-	-	87	-	-
Pentachlorobenzene (g/d)	0.86	0.24	1.04	1.66	1.27	1.04	0.97	-	-	0.04
TPH C21-C32 (g/d)	1,157	-	-	-	-	-	-	-	-	-
Trichloroethane (sum) (g/d)	-	-	-	-	-	-	-	-	190	-
V (g/d)	111	44	-	-	-	-	-	-	321	5
Zn (g/d)	-	-	-	-	-	-	-	-	649	-

3.3.2 Linkages between Pollution Pressures and State of Water and Sediment Quality

370. The poor bacteriological state of the Lower Litani portrayed throughout various sampling events across the years and seasons is an indicator of habitual and continuous wastewater discharge throughout the study area. Although the Lower Litani Study Area is not as heavily industrialized like the Upper Litani region, the exceedance in BOD, TSS, and the high turbidity is indicative of industrial (mostly rock-cutting, quarrying and sand washing activities) and municipal discharges.

371. Repeated exceedances in ammonia and phosphates, especially in the coastal region of the Lower Litani are indicative of a strongly dependent economy on agriculture in the region, and a runoff of pollutants that have travelled along the river course. During the wet season when agricultural runoff is highest, exceedances are detectable through the elevated levels of phosphates, sulphates, and nitrates. Heavy metals in the sediments, especially Cadmium, which is a common trace element in pesticides and phosphate fertilizers, are also indicative of agricultural pollution.

372. Some organic pollutants of concern were found in the most recent sampling conducted in 2018. While these results cannot be generalized, as these compounds were not analyzed for but once, a note is due. For instance, the occurrence of phenols in sediments and water indicate the presence of olive mills effluent accumulating throughout time in the river sediments.

3.3.3 Suitability of Current-State River Water Quality for Different Uses

373. As noted in Appendix F, the state of water quality was determined to be good, average or poor based on the number of exceedances of standards or guideline values for different end uses. In this section, the exceedances were counted within the category of end use to determine whether the surface water is fit, moderately fit or totally unfit for maintaining aquatic life, swimming, drinking without treatment or irrigation. Some assumptions were made to arrive at the color coding that appears in the map and visuals associated with the determination of suitability of the surface water for various end uses. For example, water quality was the decisive factor on whether the water is fit for swimming or not without considering low-flow issues, which are a concern during the dry season when swimming could be practiced.

374. Swimming in the Litani River in some stretches or drinking directly from the River's waters is not recommended due to the bacteriological counts in the waters. The possibility of having a 'healthy' aquatic life that is able to survive in the waters of the Litani uncompromised is average, however a word of caution is warranted here since very few aquatic health parameters were measured. Irrigation from the Litani River waters and those of the tributaries is commonly practiced, however some restrictions need to be applied on the crops that can be watered using these sources due to presence of fecal coliforms in some sections. From a physico-chemical point of view the water is generally fit for irrigation with slight to moderate restrictions.

375. The suitability of water for the various indicated uses is shown for the different sections in Table 3-51 and Figure 3-13.

Table 3-51. Suitability of the Lower Litani River Water for Different End Uses

River Section / **Uses**	**Aquatic**	**Swimming**	**Drinking**	**Irrigation**
Main River Section 01				
Main River Section 03				
Main River Section 04				
Main River Section 06-01				
Main River Section 06-02				
Qaaqaaqiyet Ej Jisr Tributary Section 07				
Main River Section 10				
Main River Section 11-01				
Main River Section 11-02				
Main River Section 11-03				

Fit for Indicated Use
Moderately Fit for the Indicated Use
Unfit for the Indicated Use
No Analysis Result

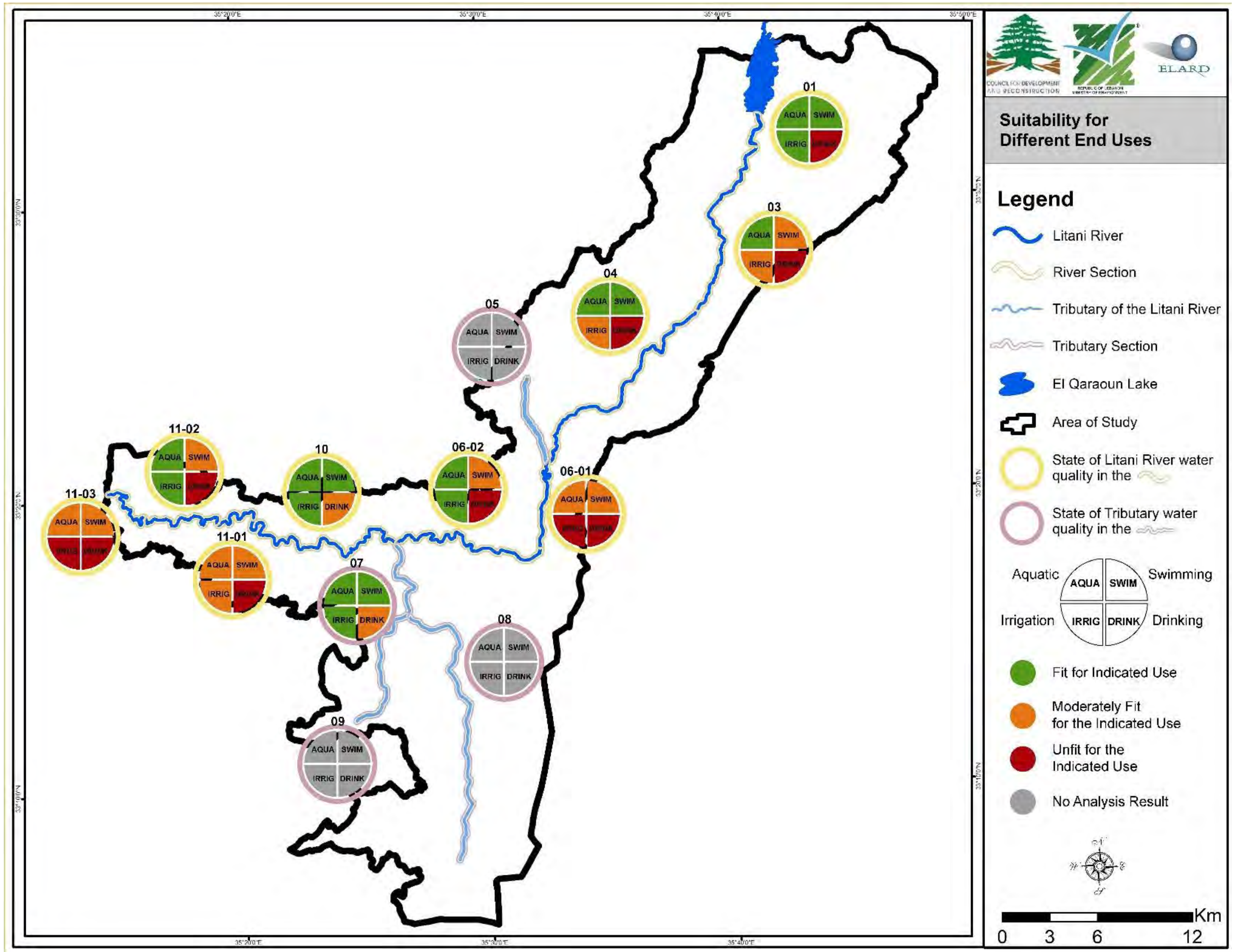


Figure 3-13. Suitability of the Lower Litani River Water for Different End Uses

4. THE ENABLING ENVIRONMENT

4.1 INSTITUTIONAL FRAMEWORK

376. The institutions involved in the overall management, infrastructure development and monitoring of activities from an environmental viewpoint in the solid waste, wastewater, agriculture and human settlement sectors are overviewed in this section. In addition to this institutional overview, the overall mandates of the public stakeholders and roles of non-public stakeholders are presented in Appendix H.

4.1.1 Solid Waste Sector

377. Several governmental institutions play regulation, facilitation, and oversight roles in the process of environmental safeguarding and integrated solid waste management in Lebanon, causing institutional hindrances to relevant plans' and projects' implementation in the public sector due to overlapping responsibilities. The legal framework assigns the Ministry of Environment (MoE) with the responsibility of regulating the sector and the municipalities with collection and disposal of waste within their municipal jurisdiction as dictated by Law No. 118/1977. In addition, the Council for Development and Reconstruction (CDR), in coordination with the MoE, was appointed by the Council of Ministers (CoM) to develop a country-wide plan and to launch international tenders for its implementation, thus presenting a clear overlap in institutional responsibilities.

378. The Ministry of Environment oversees the implementation of the ISWM Framework Law that was passed by the Parliament in October 2018 as Law No. 80/2018. This law brings the various stakeholders together into a single independent Solid Waste Management Authority responsible for planning and decision making at the national level. The Authority is to be headed by the MoE, and includes members from relevant public authorities as well as the private sector. Until the Framework Law enters fully into force, fragmentation in responsibility remains.

379. Non-governmental organizations (NGOs) also play an important role in the solid waste management sector across Lebanon by spreading awareness, implementing projects, building the communities' and local authorities' capacities, and monitoring the government's performance in solid waste management.

380. The role and responsibilities of the major players in the solid waste sector are reviewed in Table 4-1 below.

Table 4-1. Major Stakeholders in the Solid Waste Sector

Institution	Role & Responsibilities
CDR	- Implementation of national planning & infrastructure projects - Mobilising external financing for projects within the investment plan - Implementation of projects related to SWM on a large scale in Greater Beirut and parts of Mount Lebanon (Collection, sorting, treatment and landfilling through private contractors), and in Zahlé, Tripoli and Baalbeck (through the World Bank SWEMP project)

Institution	Role & Responsibilities
	- Preparation and Implementation of the SWM master plan
OMSAR	- Financing and implementation of projects for collection, sorting, composting and landfilling (through EU funding) in rural areas - Management of Lebanese Governemnt funding for the operation and maintenance of SWM facilities constructed through grants
Ministry of Environment (MoE)	- Setting the strategy related to solid waste management - Setting master plans, proposing decrees and promulgating ministerial decisions related to solid waste management - Setting & monitoring compliance with environmental standards, specifications and guidelines - Assessment and Approval of EIAs and other environmental studies - Monitoring & controlling environmental protection; preservation of natural sites & amenities - Prevention of pollution, protection of wildlife & preservation of environmental balance - Managing natural resources & amenities - Coordination & encouragement of environmental awareness programmes
Ministry of Interior and Municipalities (MoIM) / Municipalities and Unions of Municipalities	- Enforcing legislation - Contribution to strengthening decentralisation & activation of local government - Supervision of municipal federations & ensuring conformity with administrative & financial regulations - Providing technical assistance & support to municipal federations (or unions) - Cooperation & coordination with other administrations on issues related to municipal & rural affairs - Implementation of waste management activities
Ministry of Finance (MoF)	- Allocation of budgets to municipalities through the Independent Municipal Fund
Ministry of Public Health (MoPH)	- Protection of public health & prevention of the spread of diseases - Formulation of laws & regulations pertaining to all fields of public health
International Donor Organisations and Funding agencies	- European Union as a main funding agency for OMSAR and ESFD projects - E.g. USAID, Italian Development Cooperation, Spanish Agency for International Development Cooperation, UNIFIL, etc., with implementation through international NGOs - Financing environmental project activities including solid waste projects for sorting and composting of waste at municipal levels (through OMSAR, ESFD or through NGOs such as YMCA, Pontifical Mission, CHF International, Mercy Corps, etc.)
National and Local NGOs	- Raising funds - Undertaking awareness campaigns - Implementation of environmental projects at the local & national levels

4.1.2 Wastewater Sector

381. Major players in the Wastewater Sector are the Ministry of Energy and Water and the Regional Water Establishments, the CDR, Ministry of Public Health and Ministry of Environment, the Directorate General of Urban Planning, Municipalities and the international donor organizations supporting wastewater infrastructure.

4.1.3 Agriculture Sector

382. The Ministry of Agriculture (MoA) is the main institutional player in the field of agricultural development and regulation of the pesticides and fertilizers. The MoA through its 2015-2019 strategy, is aiming to improve the value chains and increase the value-added for products of plant origin by strengthening the management of agricultural inputs including pesticides and fertilizers.

383. Many projects were targeted by the MoA to improve the overall performance of the agricultural sector and improve livelihoods of rural and farming communities by promoting good agricultural practices thus, aiming to achieve sustainable food security, agriculture and rural development. Brief descriptions of some of the current projects that are relevant to the management of agrochemicals are provided in Section 5.7.1.

384. Besides MoA, MoE is responsible for the pesticides regulated under international conventions such as Methl Bromide and POPs.

385. The Litani River Authority (LRA), as per Law No. 221/2000, continues to manage and exploit irrigation water within its field of exploitation (South Bekaa and South Lebanon). Therefore, it is responsible for irrigation management of Qasmiyeh-Ras el Ain scheme. In addition to water distribution in these schemes, LRA plays an important role in monitoring water quality through its Environmental Unit who also has an objective of building capacities to be able to detect pollutants and their sources at an early stage, by finding a legal framework to monitor factories, agricultural activities, crushers and liquid and solid wastes.

386. Furthermore, Canal 800 is planned to provide water from Qaraaoun Lake to irrigate about 13,250 ha of the agricultural highlands of the western sheds of Southern Lebanon (250 to 800 m a.s.l. elevation) in addition to providing drinking water for about 100 villages. Once completed, Canal 800 irrigation schemes will be managed by the LRA.

4.1.4 Informal Tented Settlements

387. Since the beginning of the Syrian conflict in 2011 a large number of displaced refugees moved to Lebanon for safety. Some of those displaced families dwell in informal tented settlements that increase the environmental pressures on the Lower Litani Basin, however the majority are renting houses. In order to properly respond to the various stresses imposed by the Syrian conflict on Lebanon, several public administrations, international organizations, and NGOs play a major role in managing the livelihood of displaced persons in tented settlements.

Table 4-2. Major Stakeholders in Managing Response to Displaced Refugees & Settlements

Institution	Role & Responsibilities
Ministry of Social Affairs (MoSA)	- Main governmental entity in charge of the overall coordination of the refugee response in Lebanon
Ministry of Interior and Municipalities (MoIM) / Municipalities and Unions of Municipalities	- Ensuring security and protection - Enforcing legislation - Providing technical assistance & support to municipal federations (or unions)
Ministry of Public Health (MoPH)	- Protection of public health & prevention of the spread of diseases - Formulation of laws & regulations pertaining to all fields of public health
Ministry of Environment (MoE)	- Conducting studies to assess the environmental impact of the Syrian refugees in Lebanon - Determine priority intervention targets
United Nations	- Several agencies of the UN play a major role such as the UNHCR, UNICEF, UNDP, UN-HABITAT, and coordinating international initiatives and funding
International Donor Organisations and Funding agencies	- E.g. USAID, Italian Development Cooperation, Spanish Agency for International Development Cooperation, etc.
National and Local NGOs	- Raising funds - Implementation of human relief and assistance projects at the local & national levels

4.2 LEGAL FRAMEWORK

388. This sub-section examines the legal framework that governs the overall management of the pollution pressures that influence the current and future state of the Litani River basin, summarizing and listing the regulations related to:

- solid waste and wastewater from municipal, industrial and healthcare sources,
- various industrial and non-industrial classified establishments,
- quarries,
- recreational establishments and their buildings,
- informal settlements,
- agricultural water use, pesticides and fertilizers usage, and
- cross-sectoral themes related to assessment studies, financing, governance and law enforcement.

4.2.1 Solid Waste Sector

389. An ***Integrated Solid Waste Management Framework Law*** was drafted in 2005, approved by the Council of Ministers in January 2012, transferred to the Parliament through Decree No. 8003/2012 and enacted by Parliament in October 2018 as Law No. 80/2018. It represents the most comprehensive legal text that promulgates a well-structured, legal and institutional framework for solid waste management in Lebanon. The law defines solid waste management responsibilities and institutional framework, planning, permitting, information management, environmental insurance, private sector participation,

financing and cost recovery mechanisms. It addresses several waste management principles that are widely accepted internationally such as: Principles of ISWM, Proximity Principle, Polluter Pays Principle, Producer Responsibility and Precautionary Principle.

390. The ISWM law is structured in seven main parts:

- Part 1 addresses the general principles and provisions for ISWM. It includes the purpose and scope of the law, definitions, in addition to the principles and priorities of Integrated SWM.
- Part 2 details the roles and responsibilities of SWM including the institutional framework. It consists of four sub-sections: Planning, General Responsibilities, Commissioning and Execution, and Information Management.
- Part 3 addresses the activities involving non-hazardous SWM.
- Part 4 deals with hazardous SWM including the rules governing its import, export and transit.
- Part 5 tackles the financing, cost recovery and incentives for SWM in three sub-sections.
- Parts 6 and 7 set the penal provisions, and transitional and final provisions of the draft framework law.

391. A review of the current legislative framework governing the SW sector reveals the following (Mansour *et al.*, 2017):

- Prior to the enactment of the ***Integrated Solid Waste Management Framework Law***, the MSW sector was governed by fragmented legal and institutional frameworks compounded by a lack of a national policy, strategy or plans that defined overall goals and provided direction to MSW initiatives or programmes. Lebanon relied on indirectly related legislation such as public health acts or anti-litter decrees, or early regulations which assigned the responsibility of MSW management to the municipalities.
- Enforcement of regulations remains relatively weak and responsibilities are ill-defined with minimal coordination between authorities. Enforcement is practically non-existent mostly due to staffing constraints, lack of proper training, low levels of fines, and political interferences. Equally important is the lack of awareness of regulations amongst personnel who are supposed to enforce them; i.e. health inspectors, police officers, as well as the general public that is supposed to abide by them.

The 2010 MoE Strategy for SWM

392. Implementation of the legislation to achieve proper solid waste management was set on course through the SWM Master Plan put in 2006 by the CDR and MoE and decreed by the Government through CoM Decision No. 55/2010.

393. In 2009, a Ministerial Committee was assigned by the Council of Ministers to address the emerging Solid Waste Management problems at the national level (short and long term). The main mandate of this Committee was to review the 2006 Master Plan and propose new adaptable solutions for the current context noting that the available landfill capacity

has shrunk and search for new technology is needed for the short and long terms. The Committee proposed the following actions:

- Build Waste-to-Energy (WtE) facilities including sorting and landfilling of rejects for the major cities;
- Adapt the CDR/MoE Master Plan of 2006 to allow for the introduction of new technologies such as WtE in urban settings;
- Provide financing through BOT contracts for 20 years on condition that gate fees should not exceed US$55/t and electricity to be sold at US$0.11/kWh;
- Provide incentives to municipalities to host such facilities.

The 2013 Draft National SWM Plan

394. As per the SWM Strategy set forth in 2010, the MoE and CDR jointly prepared a draft SWM plan in 2013 in response to an urgent need to devise a plan that can be effectively implemented across the country, however the plan was not endorsed due to several political obstacles that Lebanon was suffering from during that period. The draft plan focused namely on the following issues:

- Dividing Lebanon into seven service regions, with four WtE facilities to be constructed in three of them (South Lebanon and Nabatiye/ North/ Beirut and Mount Lebanon).
- Assigning the municipalities with the responsibility of solid waste collection and sweeping, and developing a standard reference for contractors to be adopted by all municipalities across Lebanon.
- Government financing of solid waste management treatment facilities as well as provision of incentives to municipalities that will host such facilities.
- Calling for international tenders for the WtE facilities, and determining a site for the disposal of waste generated from the incineration plant allocated for South Lebanon and Nabatiye governorates.
- Adopting an integrated approach in solid waste management, and expediting the promulgation of the draft SWM law and relevant decrees prepared by the MoE.
- Calling for tenders for international consultants to oversee the construction, maintenance, and operation of the waste management treatment facilities.

395. In January 2015 CoM issued Decision No. 1, amending CoM Decision No. 46/2014, in an attempt to reprioritize solid waste management in Lebanon. The decision redefined the distribution of the service areas, set waste recovery targets via recycling, composting, and energy generation; requesting contractors to propose the waste treatment technology to be used, and limiting the proposed landfill sites to those identified by the MoE.

396. Following the MSW collection and disposal crisis in the areas of Greater Beirut and Mount Lebanon in 2015, and that was triggered by the surpassed landfilling capacity of the Naameh Landfill and its final closure in May 2016, the MoE Circular No. 8/1/2015, later amended by Circular No. 7/1/2017, was issued providing guidance on integrated solid waste management, and MSW sorting. In January 2018, a new policy on ISWM approved

by the CoM was issued setting specific tasks and principles in order to provide a holistic solution for the solid waste sector in Lebanon. The main principles pointed out in the ISWM policy are:

- Considering the Environmental Protection Law No. 444/2002 as the basis for future activities related to SWM.
- Recovering as much as possible of waste through material or energy recovery.
- Ensuring the fundamental role of the MoE in managing the solid waste sector in Lebanon in partnership and cooperation with other relevant public administrations and communities.
- Administrative decentralization of solid waste management.
- Affirming the central government's duties in allocating the required resources.
- Equitable development in all of the service areas.
- Adopting internationally proven technologies and standards for waste management and treatment.
- Implementing outreach and awareness programs across Lebanon to disseminate the principles of ISWM amongst the public.

397. Legal texts that set rules and responsibilities for solid waste management are shown in Table 4-3, along with a brief description of their relevant content.

Table 4-3. Legislation Pertinent to Solid Waste

Legislation	Date	Brief Description
Decree No. 2775	1928	- Dumping of pollutants into public water courses is prohibited
Decree No. 7975	1931	- Waste should not be dumped around houses, but be buried or removed by the municipality
Decision No. 425/1	1971	- Garbage must be placed in plastic bags for disposal - Waste must not be dumped on the street or other public places - It is the responsibility of municipalities to collect waste
Decree No. 8735	1974	- Preservation of public cleanliness - Municipalities are responsible for collection and disposal of domestic wastes - Wastes should not be transported in open vehicles and should not be dumped in public places - Tightly-closed containers should be used for waste storage - Disposal sites must obtain the approval of the Health Council of the Governorate
Law No. 118	1977	- Municipalities and/or Unions of Municipalities are responsible for waste collection and disposal within their jurisdictions
Law No. 64	1988	- Environmental protection against hazardous waste that could harm air, water, biodiversity, soil, and people. States fines for activities that result in pollution and hazards to the environment and public health.
Decree No. 8006	2002	- Definition and Classification of the Types of Health Care Institution Wastes and their Methods of Disposal; amended by Decree No. 13389/2004

Legislation	Date	Brief Description
Decree No. 9093	2002	- Offers incentives to municipalities to host waste management facilities or landfills
Law No. 444	2002	- Environment Protection Law indicating the necessity to conduct EIAs for development projects. The Law also states that it is the duty of every person to preserve the environment from pollution sources. Disposal sites must be designed and managed within established guidelines and principles.
Decree No. 8633	2012	- Defining the scope and stages of the national EIA process. All projects and facilities intended for the management and treatment of solid waste require the submission of an EIA study
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth
Law No. 80/2018	2018	It sets the framework for Integrated Solid Waste Management based on the principles of Law No. 444/2002. The law includes the following: - Priorities of integrated solid waste management (considers the principle of preventive action and minimizing solid waste generation as a priority) - Preventing random disposal, open dumping and burning of solid waste - The "Polluter Pays Principle" - Responsibility of the producer - Solid waste present on private and public properties - Sorting at source
Circular No. 8/1	2015	- Sets guidelines concerning the Integrated Management of Domestic Solid Waste to the Attention of Municipalities, Unions of Municipalities, Qaim'maqams and Governors. - Includes guidelines on sorting at source and composting. - Includes a list of recycling centers throughout Lebanon. - Amended by Circular No. 7/1/2017
CoM Decision No. 1	2015	- Modifies the guidelines for Integrated Solid Waste Management in Lebanon. - States that any municipality can implement a SWM project under the supervision of a technical team led by the Minister of Interior and Municipalities. The team should include representatives from the Ministries of Environment, Finance and OMSAR, as well as the CDR and a number of specialists.
CoM Decision No. 1	2016	- Reinforces the rights of all municipalities and municipal federations to take responsibility for the management of their solid waste. - Appoints the Ministers of Finance (MoF) and Interior and Municipalities (MoIM) to prepare a law incorporating incentives for municipalities which have a waste treatment facility, or a sanitary landfill commissioned within their cadastral boundaries. While this called-for law is being developed, each of the municipalities currently hosting a landfill or waste treatment facility will be allocated 8 million USD. Municipalities sending their waste to the facility shall contribute to this amount to the municipality hosting the facility.
MoE Decisions No. 1294/1 and 1295/1	2017	- Setting environmental guidelines for the - transportation of hazardous and infectious waste from healthcare institutions - establishment and operation of sterilization facilities for the treatment of hazardous and infectious waste

Legislation	Date	Brief Description
CoM Decision No. 45	2018	- Sets a new Integrated Solid Waste Management (ISWM) policy for Lebanon
Decree 5605	2019	- Aims at promoting sorting at the source of MSW
Decree 5606	2019	- Sets the principles of hazardous waste management

4.2.2 Wastewater Sector

398. Legal texts that set rules and responsibilities for wastewater management are shown in Table 4-4, along with a brief description of their relevant content.

Table 4-4. Legislation Pertinent to Wastewater

Legislation	Date	Brief Description
Decree No. 2761	1933	- Provides guidelines related to Wastewater Management and Disposal; related to pollution caused by the discharge of liquid waste - Emphasizes the prohibition of direct or indirect wastewater discharges and waste disposal into water streams
Decree No. 8735	1974	- Bans the discharge of the sanitary tanks' contents and wastewater of houses, shops and industrial firms within the water courses, the sea shore, the protection zone of springs and rivers, winter channels, or within a sewage network not technically accomplished and not licensed. It also prohibits drilling of bottomless pits for wastewater discharging and obliges the owner of a pit that was previously dug to seal it off. - Municipalities are responsible for solid waste and wastewater pollution abatement - Owners of septic tanks should ensure that wastewater from septic tanks does not leak out. It obliges industrial firms to pre-treat their wastewater before discharging it into the environment.
Law No. 216	1993	The MoE prepares in coordination with concerned administrations the detailed studies to preserve the environment against wastewater leakages to aquifers, spring and irrigation water. This is done after the Ministry surveys all the constructions whose wastes are a potential threat to the environment. Replaced by Law No. 667/1997.
Decree No. 5343	1994	*Responsibilities of the Environment Service at the MoEW* The Department for Wastewater Discharge within the Environment Service at the MoEW is responsible to study the geological and hydrological nature as well as the permeability, quality and type of soil intended for wastewater capture in addition to studying the sewage networks (primary, secondary or tertiary lines), the connection networks, the treatment plants and the outlets.
MoE Decision No. 52/1	1996	Specifying the National Standards for Environmental Quality and the Environmental Limit Values for Air and Water
Law No. 221	2000	MoEW is appointed to prepare the Wastewater Master Plan, continuously update it and submit it to the CoM. MoEW can choose the location of the wastewater treatment plants and the discharge outlets.

Legislation	Date	Brief Description
MoE Decision No. 3/1	2005	Environmental Guidelines for the establishment and operation of small-scale wastewater treatment plants
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth
Law No. 77	2018	The new Water Law in Lebanon includes the following: Master plan for water resources and water basins, preserving the quality of water, financial regulations of the water sector, sanitation, and compensation for pollution, management of public water utilities, addressing natural hazards that can affect the water sector and, violations and penalties.

399. Other important legal texts which regulate the wastewater collection pits and which are still applicable include: Legislative Decree No. 16/L-1932 (articles 19, 20, 21, 22), Decree No. 6600 (7 May 1930), and Decree No. 7975 (5 May 1931).

4.2.3 Industrial, Classified and Non-Classified Non-Industrial Establishments

400. Legal texts issued that address permitting and operations of classified and industrial establishments are listed in Table 4-5.

Table 4-5. Legislation Pertinent to Classified and Industrial Establishments

Legislation	Date	Brief Description
Legislative Decree No. 21/L	1932	- Classification of facilities posing danger, harm to health and nuisance
Decree No. 4917	1997	- Amendments to classification of facilities posing danger, harm to health and nuisance (Legislative Decree No. 21/L/1932)
Decree No. 5243	2001	- Classification of industrial establishments
Decree No. 8018	2002	Specifies the permitting rules, procedures and conditions for the creation and operation of an industrial establishment: (a) a schematic that precisely shows the wastewater discharging means, (b) a complete study on the quantity of wastes generated by the factory including used water, and (c) the discharge means that will not pollute surface water or aquifers.
Decree No. 9765	2003	- Monitoring, inspection and penalties associated with industrial establishments

MoE Decisions	2000-2010	- Wastewater Discharge Limit Values (MoE Decision No. 8/1/2001)
		- Environmental Guidelines for the Permitting of the Construction and Operation of:
		  - Tanneries (MoE Decision No. 75/1/2000)
		  - Residential buildings within boundaries (right-of-way) of MoE protected rivers (MoE Decision No. 90/1/2000)
		  - Fruit and Vegetable Conserves (Cold storage, pickling, cooking, packaging) (MoE Decision No. 5/1/2000)
		  - Meat and Poultry Waste Treatment Factories by Cooking or Dry Fermentation (MoE Decision No. 3/1/2001)
		  - Slaughterhouses (MoE Decision No. 4/1/2000)
		  - Liquid Fuel Distribution Stations (MoE Decision No. 5/1/2001)

Legislation	Date	Brief Description
		- Cattle, Poultry and Other Animal Rearing Farms (Rabbits, Pigs, etc.) (MoE Decision No. 16/1/2001 & MoE Decision No. 9/1/2004 to specify minimum setback distances in non-zoned areas) - Cheese, Yogurt, Butter and Other Dairy Products (MoE Decision No. 29/1/2001) - Building Blocks (MoE Decision No. 60/1/2001) - Plastic manufacturing (MoE Decision No. 61/1/2001) - Glass manufacturing (MoE Decision No. 15/1/2002) - Rubber manufacturing (MoE Decision No. 16/1/2002) - Hot concrete mixing (MoE Decision No. 4/1/2005) - Olive mills for the production of olive oil, and reuse of olive mill wastewater in irrigation (MoE Decisions No. 100/1/2010, 101/1/2010 and 102/1/2010) - Bakeries and pastry manufacturing (MoE Decision No. 103/1/2010) - Jewellery manufacturing (MoE Decision No. 104/1/2010) - Coffee roasteries, mixed nuts and sweets (MoE Decision No. 105/1/2010) - Textile manufacturing (MoE Decision No. 106/1/2010) - Various environmental obligations required from establishments whose processes generate wastewater. These obligations include for example the treatment of liquid industrial wastes before their discharge in accordance with set national environmental standards or the separation of domestic wastewater from other types of wastewater and their discharge in the sewage network, or the separation of the raw materials and oils from the cooling and heating water to reduce its pollution, or not throwing used oils in the sewage network or in water courses and separating them from raw materials.
MoE Decision No. 590/1	2015	Procedure for decision-making on the environmental aspects of permit applications for industrial establishments
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth

4.2.4 *Quarries*

401. Legal texts issued that address permitting of quarry sites to guarantee their proper operations are listed in Table 4-6.

Table 4-6. Legislation Pertinent to Quarries

Legislation	Date	Brief Description
Decree No. 8803	2002	- Organization of quarries and crushers, amended by Decrees No. 13389/2004 and 2523/2009
MoE Decisions No. 182/1, 183/1, 184/1, 185/1 and 186/1	1997	- Documentation and conditions required for the operation of: - Quarries for rocks used in crushers and rubble material - Pits for sand or gravel material extraction - Quarries for rocks used in the manufacture of mosaics - Quarries for stone used in buildings & building blocks - Quarries for rocks used in cement manufacturing

Legislation	Date	Brief Description
MoE Decisions No. 16/1, 17/1, 18/1, 19/1 and 20/1	2009	- Documentation and conditions required for permitting of the operation of: - Crushers of gravel (not located within quarry sites) - Quarries for rocks used in crushers and rubble material - Pits for sand or gravel material extraction - Quarries for rocks used in the manufacture of mosaics - Quarries for stone used in buildings & building blocks And which are located in non-classified areas as per Decree No. 8803/2002 and its amendments Replaced by MoE Decisions No. 52/1, 53/1, 54/1, 55/1, 56/1 and 57/1, issued in 2011.
MoE Decisions No. 46/1, 47/1, 48/1 and 49/1	2009	- Levelling and ordering of lands used as quarry sites - Specification of performance guarantees to ensure works related to levelling and ordering of lands are carried out - Permitting procedures for the rehabilitation of quarry sites - Definition and listing of large construction projects
MoE Decisions No. 136/1, 137/1, 138/1, 139/1 and 140/1	2010	- Procedure for identification of small quarries that are operated by classified establishments - Form for documenting daily activities of quarry operations - Form for the pledge declaration - Forms for receipts with serial numbers to track operations and volume of extracted material from quarry sites and crushers
MoE Decisions No. 52/1, 53/1, 54/1, 55/1, 56/1 and 57/1	2011	- Documentation and conditions required for permitting of the operation of: - Single gravel crushers (not located within quarry sites) that are required for public or private construction projects - Quarries for rocks used in crushers and rubble material - Pits for gravel material extraction - Pits for sand or industrial sand - Quarries for rocks used in the manufacture of mosaics - Quarries for stone used in buildings & building blocks And which are located in non-classified areas as per Decree No. 8803/2002 and its amendments
MoE Decision No. 190/1	2018	- Documentation and conditions required for permitting of the operation of small quarries that are operated by classified establishments

4.2.5 Recreational Establishments

402. Legal texts issued that address building and management of recreational establishments are listed in Table 4-7.

Table 4-7. Legislation Pertinent to Recreational Establishments

Legislation	Date	Brief Description
Law	1950	Operation of hotels, amusement parks, restaurants, cafes and bars
Decree No. 15598	1970	General conditions for the construction and operation of touristic establishments

Legislation	Date	Brief Description
Law No. 646	2004	Amendment of Legislative Decree No. 148/1983 – Building Code
Decree No. 11958	2004	Protection, prevention against accidents and safety in construction
Decree No. 15874	2005	Application Decree of the Building Code
Law No. 121	2010	Establishment of the Wadi El Hujeir Nature Reserve

4.2.6 Informal Tented Settlements

403. Legal texts issued that address the Syrian conflict and consequent refugees' influx to Lebanon and related impacts are shown in Table 4-8.

Table 4-8. Legislation Pertinent to Managing Response to Displaced Refugees & Settlements

Legislation	Date	Brief Description
Decision No. 50/1	2014	- Establishment of an internal committee at MoE for the assessment of the environmental impacts of the Syrian refugees in Lebanon and determining priority interventions
CoM Decision No. 1	2013	- Establishment of a central security unit by the MoIM - The security units to include representatives from the MoSA, MoPH, and MEHE
Decision No. 146	2013	- Formulation of a committee to coordinate humanitarian response - Preparation of a needs assessment response for the refugees and hosting communities, as well as developing a financing mechanism for that purpose - Amended by Decisions no. 72/2014 and no. 75/2014
Decision No. 242	2013	- Issued by MoIM to improve coordination and to conduct bi-weekly meetings to follow up on security, environmental, technical, and humanitarian issues related to the Syrian refugees in the Cazas of Nabatiye, Bent Jbayl and Sour
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth

4.2.7 Agriculture Sector

404. The Lebanese Ministry of Agriculture has been actively reviewing and amending old laws and creating new laws and decrees that aim to re-organize the trade of fertilizers, pesticides and animal feeds. Laws and decrees include production, manufacturing, importing, distributing and use of fertilizers and pesticides.

405. Under the 2010-2014 strategy of the MoA, a number of achievements was accomplished related to agrochemicals. A number of legislative texts (laws, decrees, decisions and regulations) have been issued to regulate the handling of the different production inputs such as fertilizers, seeds, agricultural pesticides, veterinary drugs, etc.

406. Lists of some recent, actively implemented legislative texts that organize the import, trade, use, analysis and regulation of the agricultural pesticides and fertilizers markets are provided in Table 4-9 and Table 4-10. The Ministry has reviewed and issued new licenses that allow or disallow some practices. A pesticides committee composed of private sector and public sector agents from different ministries namely the Environment, Public Health, Economy & Trade, in addition to Agriculture is actively reviewing pesticide usages, laying down conditions on safety of use, rates, toxicity, safe pre-harvest intervals, new licenses for practicing the profession, in addition to recording and controlling violations.

407. The Ministry of Agriculture has worked to ban the use of pesticides that are harmful to the environment and human health. The lists of banned pesticides as per the different MoA legislative decisions are shown in Appendix E, Table E-2. Despite the ban on the legal entry of certain agricultural compounds, it is understood that some banned products continue to find their way into the Lebanese agricultural market.

Table 4-9. Legislation related to Agricultural Pesticides

Legislation	Date	Legal Text Title/Content Description
MoA Decision No. 396/1	27-Nov-1997	Banning the naming of more than one trade name for the pesticide imported from the same producer in the country of origin
MoA Decision No. 92/1	2-May-1998	Pesticides labels specifications
MoA Decision No. 94/1	20-May-1998	Ban of import of some pesticides (see see Appendix E, Table E-2)
MoA Decision No. 262/1	26-Sep-2001	Ban of import permission for some pesticides (see see Appendix E, Table E-2)
MoA Decision No. 316/1	31-Oct-2001	Withdrawing the ban for import of a pesticide (Fenamiphos)
MoA Decision No. 10/1	10-Jan-2003	Pesticides' analysis
MoA Decision No. 36/1	28-Jan-2003	Non application of the Decree No. 10/1 dated 10/1/2003 (pesticides' analysis)
MoA Decision No. 228/1	26-Aug-2003	Pesticides trade names
MoA Decision No. 43/1	17-Feb-2004	Entrance control for the imported pesticides
MoA Decision No. 326/1	15-Oct-2004	Activation of Kfarchima laboratory for pesticides' analysis
MoA Decision No. 59/1	26-Feb-2005	Regulating the entrance, registration and use of pesticides in Lebanon
MoA Decision No. 2/1	04-Jan-2006	Regulation of pesticides' import
MoA Decision No. 376/1	28-Aug-2008	Ban of import of some pesticides of Chinese origin
MoA Decision No. 554/1	19-Dec-2008	Internal regulation of the Pesticides Committee
MoA Decision No. 570/1	24-Dec-2008	Ban of import of some pesticides (see see Appendix E, Table E-2)
Decree No. 49/1	05-Feb-2009	Amendment of the Decree No. 326/1 dated 15/10/2004 (Activation of Kfarchima laboratory for pesticides' analysis)
MoA Decision No. 50/1	05-Feb-2009	Amendment of the Decision No. 554/1 dated 19/12/2008 (Internal regulation of the Pesticides' Committee)
MoA Decision No. 51/1	05-Feb-2009	Amendment of the Decision No. 2/1 dated 4/1/2006 (Regulating the pesticides' importation)

Legislation	Date	Legal Text Title/Content Description
MoA Decision No. 52/1	05-Feb-2009	Endorsement of the documents for the pesticides' registration by Lebanese embassies
MoA Decision No. 53/1	05-Feb-2009	Establishment of a scientific committee for pesticides review
MoA Decision No. 280/1	13-Jun-2009	Regulating the entrance, registration and use of bio-products for pests' control in Lebanon
MoA Decision No. 42/1	28-Jan-2010	Establishment of inspection committees for stores and selling places
MoA Decision No. 79/1	13-Feb-2010	Ban of import of some pesticides (see Appendix E, Table E-2)
MoA Decision No. 67/1	13-Feb-2010	Establishment of a Pesticide Residues Committee
MoA Decision No. 78/1	13-Feb-2010	Amendment of the Decision No. 2/1 dated 4/1/2006 (Imposition of use of wooden pallets)
MoA Decision No. 69/1	13-Feb-2010	Endorsement of pesticides registration documents in Lebanon
MoA Decision No. 227/1	15-May-2010	Establishment of inspection committees for stores and selling places
MoA Decision No. 308/1	24-Jun-2010	Amendment of the Decision No. 554/1 dated 19/12/2008 (Internal regulation for the Pesticides Committee)
MoA Decision No. 309/1	24-Jun-2010	Cancellation of registration and ban of import of some pesticides (see see Appendix E, Table E-2)
MoA Decision No. 310/1	24-Jun-2010	Regulating the registration of imported and locally prepared pesticides and their use
MoA Decision No. 311/1	24-Jun-2010	Importation of pesticides
MoA Decision No. 307/1	24-Jun-2010	Registration of some biological pesticides
MoA Decision No. 496/1	21-Sep-2010	Regulating sampling methods and transportation of the samples for imports
MoA Decision No. 674/1	29-Oct-2010	Ban of import of a specific pesticide (Abamectin)
MoA Decision No. 868/1	14-Dec-2010	Amendment of Decision No. 79/1 dated 13/02/2010 (Allowing sale of some banned pesticides until expiry date)
MoA Decision No. 112/1	25-Jan-2011	Decision regarding pricing of pesticides
MoA Decision No. 294/1	21-Feb-2011	Ban of import and registration of some growth regulators
MoA Decision No. 48/1	25-Jan-2012	Control of the use of raw materials from antibiotics (joint decision with the Ministry of Health)
MoA Decision No. 369/1	30-Apr-2012	Establishment of inspection committees for stores and selling places
MoA Decision No. 403/1	08-May-2012	Prevent the registration and import of an agricultural pesticide
MoA Decision No. 545/1	16-Jun-2012	Decision concerning extension of registration time for pesticides
MoA Decision No. 546/1	16-Jun-2012	Mechanism to allow the preparation and packing of pesticides allowed in Lebanon
MoA Decision No. 850/1	12-Sep-2012	Ban of import of a specific pesticide (Hexoconazole)
MoA Decision No. 143/1	02-Jul-2014	Ban of import of some pesticides (see Appendix E, Table E-2)

Legislation	Date	Legal Text Title/Content Description
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth

Table 4-10. Legislation related to Agricultural Fertilizers

Legislation	Date	Legal Text Title/Content Description
MoA Decision No. 68/6	8-Jan-1968	Organize the trade of fertilizers, pesticides and animal feed
Decree No. 15695	21-Sep-1970	Identification of regulatory texts related to trade, manufacture, packaging, import and sale of fertilizers
MoA Decision No. 13/1	23-Nov-1992	Allowing the import of all kind of agricultural fertilizers and peat moss
MoA Decision No. 90/1	5-Apr-2000	Import conditions of agricultural fertilizers
Decree No. 147/1	5-Jul-2000	Amendment of the Decree No. 90/1 dated 5/4/2000 (Import conditions of agricultural fertilizers)
MoA Decision No. 210/1	13-Jul-2004	Laboratory analysis required for peat moss importation
Decree No. 342/1	23-Oct-2004	Amendment of the Decree No. 210/1 dated 13/7/2004 (Laboratory analysis required for peat moss importation)
MoA Decision No. 82/1	7-Mar-2007	Import of natural (organic) fertilisers fermented and non-fermented
MoA Decision No. 790/1	29-Jul-2011	Pre-clearance conditions for fertilizer sales and soil amendments
MoA Decision No. 791/1	29-Jul-2011	Classification of fertilizers and soil amendments
MoA Decision No. 792/1	29-Jul-2011	Pre-clearance conditions for fertilizer importation and soil amendments
MoA Decision No. 896/1	8-Oct-2011	Pre-clearance conditions for the profession of packing and packaging of fertilizers and soil amendments
MoA Decision No. 507/1	6-Jun-2012	Decision about the conditions for the registration of fertilizers and soil amendments in circulation in Lebanon
Decree No. 9092	10-Oct-2012	Decree of the Rules of Procedure of the Fertilizer Committee
MoA Decision No. 1004/1	15-Oct-2012	Conditions of license to use the profession of manufacture and / or preparation of fertilizer and soil amendments
Decree No. 9375	27-Dec-2012	Amendment of Decree No. 15695
MoA Decision No. 244/1	11-Mar-2013	Decision to form fertilizers committee
MoA Decision No. 250/1	26-May-2013	Selection of the fertilizers committee consultants
MoA Decision No. 1041/1	8-Nov-2013	Decision concerning the regulation of the import of fertilizers and soil amendments
MoA Decision No. 1042/1	8-Nov-2013	Regulation of the import of fertilizers and soil amendments in Lebanon

Legislation	Date	Legal Text Title/Content Description
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth

4.2.8 Cross-sectoral and Environmental Governance

Legislation	Date	Brief Description
Law No. 444	2002	- Environmental Protection Framework Law
Decree No. 8633	2012	- Procedures for conducting Environmental Impact Assessment (EIA) studies
Decree No. 8213	2012	- Strategic Environmental Assessment (SEA) for draft policies, programs and plans in the public sector
Decree No. 8471	2012	- Environmental compliance for facilities (environmental auditing)
Law No. 251	2014	- Assigning environmental prosecutors as full-time public attorneys and judges for arbitration in cases relevant to environmental matters
MoE Decisions	2015-2016	- Procedure for the revision of - Initial Environmental Examination (IEE) reports (MoE Decision No. 260/1/2015) - Environmental Impact Assessment (EIA) and their Scoping reports (MoE Decision No. 261/1/2015) - Complaints on MoE decisions on EIA reports (MoE Decision No. 262/1/2015) - Strategic Environmental Assessment (SEA) reports and their Scoping reports (MoE Decision No. 589/1/2015) - Environmental Audit (EA) reports (MoE Decision No. 189/1/2016) - Deadlines for environmental compliance applications for: - Industrial establishments listed in Decree No. 8471/2012 (MoE Decision No. 539/1/2015) - Classified non-industrial establishments listed in Decree No. 8471/2012 (MoE Decision No. 540/1/2015) - Conditions for classifying consulting firms that undertake IEEs, EIAs, SEAs and EA studies (MoE Decision No. 588/2015)
Law No. 63	2016	- Budgeting for the Implementation of pollution curbing projects in the Litani River basin from source to mouth
Decree No. 3989	2016	- Creation of an Environmental Law enforcement unit or police force, and setting its structure, role and responsibilities
Decree No. 167	2017	- Application of Article 20 of Law No. 444/2002 (incentives for environmental investments and activities)
Decision No. 1281	2017	- Procedure for benefiting from tax reductions for entities who carry out environmental protection activities

4.3 FINANCIAL FRAMEWORK

408. Financing for development projects in the solid waste, wastewater and agriculture sector is examined in this sub-section.

4.3.1 Solid Waste Sector

409. An average of 34% out of the annual budget of the MoIM is spent on solid waste management. Most of the funds are disbursed directly from the Independent Municipal Fund to the solid waste contractor, which is the case of the Greater Beirut and Mount Lebanon. Major solid wastes contracts are overseen by CDR, and financed by the Independent Municipal Fund which is managed by the Ministry of Finance. The solid waste sector consumed the largest share of the CDR's budget with US$2,878 Million spent between 1992 and 2016. Since 2002, fiscal incentives are provided to municipalities which host waste management facilities and landfills within their boundaries thus reducing the burden on municipal budgets.

410. The proposed 2010 CDR/MoE Master Plan was envisaged to cost between US$885 and 1,881 Million. The 2006 SWM Master Plan was also expensive at the time: Its cost was set to range between US$286 and 694 Million which led the CDR to seek alternative funding sources through loans and grants. The European Commission provided an original funding of 14.2 Million euros that were later increased by 14 Million euros under SWAM 1 and 21 Million euros under SWAM II (which was later cancelled). These projects included small to medium scale sorting and composting facilities, as well as landfills in some cases. However, the SWAM II funding was canclled. Alternative sources of funding could be from: 1) the GoL, 2) a new project for environmental management of the Litani River Basin, currently under preparation by the MoE with World Bank funding (National Comprehensive Environmental Management Program: Phase- 1 Litani River Basin); or 3) the EU's TADWIR fund in case its coverage is expanded from BML to cover the LRB.

411. The 2006 Master Plan which was decreed by the Government established that SWM investment, operation and maintenance costs related to treatment and disposal would be centrally-funded, while solid wastes collection and transport costs would be funded through the municipal budgets.

412. Given the high bill of proper solid waste management, there is a need to increase the recycling and composting rates which would allow some cost recovery and increase the life span of the proposed landfills. Composting and recycling cover more than 50% of the cost in Jbeil and 30% in Zahlé.

413. Improved waste management systems in the different zones would result in additional expenses to provide for the additional services. The Unions of Municipalities and municipalities could request additional financing from the Central Government to cater for this increase. Given that the Council of Ministers have issued several decrees to finance the Operation and Maintenance of the SWM facilities built by OMSAR (US$15 Million for three years and later added for the additional facilities that became operational), all Unions could use this precedence and request financing for the O&M of their facilities from the Central Government. This request can be justified by the fact that the CoM have previously issued a decision (CoM Decision No. 88 dated 27/11/2007) stating that waste collection is the responsibility of the municipalities while treatment and disposal costs are to be borne by the Central Government.

414. Options for financing could also include the following measures:

1. Improving collection rate of direct charges imposed by municipalities;
2. Funds and or taxes collected by the State, private organisations or public institutions and re-distributed to each municipality;
3. Introduction of supplemental excise taxes on specific commodities whose disposal necessitates specific waste management services to finance SWM costs (such as petroleum and bituminous products, motor vehicles and engines, organic compounds, electric and electronic products, motor vehicles and engines, tires, etc.;
4. Funds collected by the State for all municipalities (Independent Municipal Fund);
5. Grants and loans;
6. Revenues from municipal property rentals;
7. Fines or penalties; and
8. Donations.

4.3.2 Wastewater Sector

415. The MoEW is the central governmental institution responsible for wastewater management in Lebanon, however the CDR is considered as the main proponent in carrying out investments for the construction of wastewater infrastructure. In this regard, the CDR has implemented wastewater projects worth US$953 Million from 1992 till 2016, out of which 51% of the funds are from foreign sources. This is partly due to the fact that Lebanon is bound by a number of regional initiatives such as the 1976 Barcelona Convention for Protection against Pollution in the Mediterranean Sea and Horizon 2020-De-polluting the Mediterranean Sea by 2020 which explains the foreign involvement in the wastewater sector. The MoEW also transfers some of its appropriations to cover the operation and maintenance costs of the Regional Water Establishments who operate the WWTPs in their service areas.

416. Currently, there are no wastewater tariffs. International organizations such as GIZ and USAID have assisted the MoEW and RWEs in defining wastewater tariff levels that would allow recovery of the incurred O&M costs.

4.3.3 Agriculture Sector

417. The MoA budget for 2017 was US$ 49.7 Million which is 0.28% of the national budget. About 90% of this budget covers staff salaries and rent, and only 3% is spent on agricultural development projects. The financing of projects related to agricultural development in Lebanon is mostly from donors' grant and loans.

418. Another source of financing is from the budgets of the MoEW, LRA, MoE, IDAL and others who spend parts of their budgets on agricultural projects and initiatives related to irrigation infrastructure, rural development, and export.

419. The agriculture sector receives international assistance from bi-lateral funding organizations such as the Italian Cooperation and multi-national parties such as the FAO and UNDP, in addition to some local community contributions.

4.3.4 Informal Tented Settlements

420. According to the UNHCR, Lebanon required in 2017 around US$2 Billion in monetary funds in order to cover and provide minimum humanitarian aid to the Syrian refugees. Moreover, based on reports prepared by the MoE, UNDP, and the EU approximately US$189 Million are needed to mitigate the environmental impacts of the Syrian conflict and associated human displacement on the country and to implement a state-wide environmental management plan for that purpose[6]. This presents a financial burden on the Lebanese economy, especially when funding requirements are not met. Major donors and funding sources mainly include contributions from the local governmental agencies, UN agencies, as well as international governmental and non-governmental organizations.

[6] EASC 2014 report

5. POSSIBLE RESPONSES AND MITIGATION MEASURES

5.1 SOLID WASTE SECTOR

5.1.1 Existing Programs and Projects

421. The decision to close, cap, rehabilitate or transfer waste in any existing dump or to prevent waste littering on the Litani River banks or any of its tributaries necessitates the availability of proper waste management initiatives and alternatives. Fortunately, initiatives for the management of solid wastes in Zones 1 to 5 are available and underway, yet sanitary landfills are currently non-existent. These are further outlined in Table 5-1 and described below.

Table 5-1. Existing Projects for SWM serving Zones 1 to 5

Zone	Location	Latitude	Longitude	Status	Capacity (t/day)	Type of Treatment	Waste Coming from	Funding
1	Joub Jannine	33.628299	35.785951	Operational	100	Sorting and composting, sanitary landfill	Union of Municipalities of Al Bouhayra (UMB)	EU and Joub Jannine Municipality
1	Qaraoun	33.546558	35.719211	Operational	50	Sorting	Qaraoun, Sohmor, Machghara, Baaloul	Qaraoun Municipality, UNDP and Mercy Corps
3	Qlaiaa	33.337810	35.556520	Operational	6	Sorting and composting	Qlaiaa	USAID
4	Aaytaroun	33.14530	35.488040	Operational	12	Sorting and composting	Aaytaroun, Blida, Hanine	EU, USAID
4	Khirbet Selm	33.212910	35.419901	Operational	10	Sorting and composting	Khirbet Selm	USAID
4	Meiss Ej Jabal	33.168600	35.493700	Operational	10	Sorting and composting	Mays Ej Jabal	USAID/ Municipality
4	Qabrikha	33.257200	35.473610	Operational	20	Sorting and composting	Qabrikha, Touline, Sawwane, Houla, Markaba, Bani Hayaine, Talloussa, Aadchit, Qantara, Rabb Et Talatine Taybeh, Marjaayoun	EU, USAID
4	Taybeh Marjaayoun	33.278700	35.500920	Non-Operational	10	Sorting and composting	Taybeh Marjaayoun	USAID
4	Chaqra	33.173426	35.47917	Operational		Sorting	Chaqra	Municipality
4	Bint Jbeil	33.10181	35.41277	Operational	50	Sorting and composting	Union of Municipalities of Bint Jbeil	Cooperazione Italiana ROSS Emergency Program

Zone	Location	Latitude	Longitude	Status	Capacity (t/day)	Type of Treatment	Waste Coming from	Funding
5	Zrariyeh	33.359941	35.333281	Non-Operational	10	Sorting and thermal treatment	Zrariyeh, Kfar Roummane, Kousaibe, Aadchit	Green Ecotech
5	Ain Baal	33.240401	35.285653	Operational	100-150	Sorting and composting	27 municipalities of Sour caza	USAID/EU/ World Bank
5	Kharayeb	33.361992	35.295583	Operational		Sorting	Kharayeb	Municipality
5	Borj Rahhal	33.322319	35.263269	Operational		Sorting	Borj Rahhal	Municipality
5	Saida	33.538038	35.36137	Operational	550	Sorting, composting, and RDF	16 municipalities of the Saida-Zahrani Area, Jezzine and Beirut cazas	IBC

1- Joub Jannine sorting and composting facility

422. The EIA for this facility was completed and approved by the MoE in 2016 and the facility was built in 2017 with financing from OMSAR under SWAM I project. The facility entails a sanitary landfill and a mechanical-biological treatment (MBT) that includes the following components: an administrative unit, weighing station, waste reception area, sorting facility (capacity of 100 tons per day), a windrow composting facility, maturation and curing area, leachate and wastewater collection tanks. The available equipment in the plant are the following: bag opener, trommel screen of 5 cm, inclined and horizontal conveyor belts, two magnetic separators, a wood chipper, a baling press, a compost turning machine and compost refining screen. The sanitary landfill has a capacity of 50 t/d and receives the waste rejects coming out of the sorting and composting plant. It is designed to last for 10 years and consists of a cell having an area of 10,000 m^2 that can be later expanded.

423. The operation and maintenance tender for the MBT facility and sanitary landfill were both awarded to Hammoud Est. The SWM complex is operational and serves the following villages from the Union of Municipalities of Bouhaira -West Bekaa which includes Aaytanit, Ain Et Tineh, Ain Zebdeh, Baaloul, Bab Mareaa, Joub Jannine, Kefraya, Khirbet Qanafar, Lala, Libbaya, Machghara, Maydoun-Loussia, Qaraaoun, Qelaya, Saghbine, Sohmor, Yohmor, Zilaya.

424. The operation of the SWM complex in Joub Jannine has provided an integrated SWM solution for most Zone 1 municipalities that form part of the West Bekaa caza and consequently, dumps that have a negative impact on the pollution of the Litani River or any of its tributaries can be closed in place or transferred to Joub Jannine sanitary landfill.

425. A study is currently underway for the installation of a biofilter at the composting facility, and funding is to be sought. A leachate treatment plant will also be constructed by Mercy Corps with EU fuding.

2- Implementing a sorting at source programme and building a storage facility for recyclables in Qaraaoun

426. The project consisted of the support of five municipalities in West Bekaa (in Zone 1) namely Qaraaoun, Lala, Khirbet Qanafar, Saghbine and Sohmor in ensuring the availability of the needed infrastructure to implement a sorting at source programme. A feasibility study was conducted by UNDP in 2017 for the provision of separate waste collection bins and trucks and the construction of two storage facilities for processing of collected recyclables for later sale in the recycling market. An awareness campaign was also conducted as part of the process to separate waste at source into wet and dry components. Wet components would be collected and sent to Joub Jannine facility, whereas the dry component which includes the recyclables would be transferred to the storage center in Qaraaoun or Sohmor for further sorting. Manual sorting of recyclables would take place at the storage center and recyclables would be baled and sold to the recycling industries available in Bekaa. The project entailed the supply of around 2,300 color-coded 240-liter containers (Green and Red) and the provision of seven pick-up trucks (capacity 8 m^3) for the transport of recyclables to the storage center that was constructed in Qaraaoun. The

storage center is constructed on a concrete structure with a metallic hangar and equipped with a baling machine, a sorting platform, a generator and a skid steer loader. The total cost for implementation of this project was estimated at US$ 508,000. Financing for the sorting and storage center was secured through Qaraoun Municipality and UNDP for construction (USD 100,000 – 30% covered by the Municipality), and through Mercy Corps and UNDP for equipment (USD 50,000). The facility is currently receiving recyclable waste from Kefraya, Baaloul, Ain Zebdeh, Machghara and part of Joub Jannine in addition to the initial 5 villages.

3- Qlaiaa sorting and composting facility

427. The facility is very old and was built in 2002 through USAID financing. The facility serves the village of Qlaiaa in Zone 3 and has a capacity of 6 t/d. The facility includes a manual sorting platform for separating recyclables from organics which are then diverted to a rotating drum composter. Separated recyclables are sold whereas compost coming out of the drum after 3 to 4 days is screened and left to mature for a period of 30 days after which compost is bagged and delivered to local farmers.

3- Aaytaroun sorting and composting facility

428. The facility is very old and was built in 2002 through USAID financing. This facility was hit during the 2006 Israeli war and was refurbished and re-equipped back in 2006 by ESFD. The facility serves the villages of Aaytaroun, Blida and Hanine in Zone 4 and has a capacity of 12 t/d. The facility includes a manual sorting platform for separating recyclables from organics which are then diverted to two rotating drum composters. Separated recyclables are sold whereas compost coming out of the drums after 3 to 4 days is screened and left to mature for a period of 30 days after which compost is bagged and delivered to local farmers. The facility is also equipped with a baling press, a shredder and an industrial weighing scale.

4- Khirbet Selm sorting and composting facility

429. The facility is very old and was built in 2002 through USAID financing. The facility serves the village of Khirbet Selm and surrounding villages in Zone 4. The facility has a capacity of 10 t/d and is equipped with a manual sorting platform for separating recyclables from organics and two rotating drum composters. Compost coming out of the drums after 3 to 4 days is screened through a refining trommel and left to mature for a period of 30 days after which compost is bagged and delivered to local farmers. The facility was assisted by OMSAR in 2009 and received a baling press and a plastic shredder and later on, O&M costs were covered through the O&M fund available at OMSAR for sustaining operation of constructed SWM facilities.

5- Meiss Ej Jabal sorting and composting facility

430. The facility is very old and was built in 2002 through USAID financing. The facility serves the village of Mays el Jabal in Zone 4. The facility has a capacity of 10 t/d and is equipped with a manual sorting platform for separating recyclables from organics and two rotating drum composters (one of them is non-operational). Compost coming out of the drum after

3 to 4 days is screened through a refining trommel and left to mature for a period of 30 days after which compost is bagged and delivered to local farmers.

6- Qabrikha sorting and composting facility

431. The facility was originally built in 2002 through USAID financing and was later refurbished by OMSAR. The facility at first included a sorting platform and two composting drums that were later removed due to high maintenance costs and inability of the municipality to operate the facility. In 2011, through OMSAR, the facility was remodeled and its capacity was increased from 10 t/d to 20 t/d. A sorting conveyor line was added to the sorting platform, while the composting drums were removed and the composting technology changed from drum to windrow composting and expanded in capacity. The facility was also equipped with a small windrow turning machine, a baling press, a shredder and an industrial weighing scale. The facility currently serves 13 villages in Zone 4 as indicated in Table 5-1. Recyclables are sold in the local market whereas compost is screened, bagged and distributed to farmers. Rejects from the facility are distributed to several dumps of the served municipalities.

7- Taybeh Marjaayoun sorting and composting facility

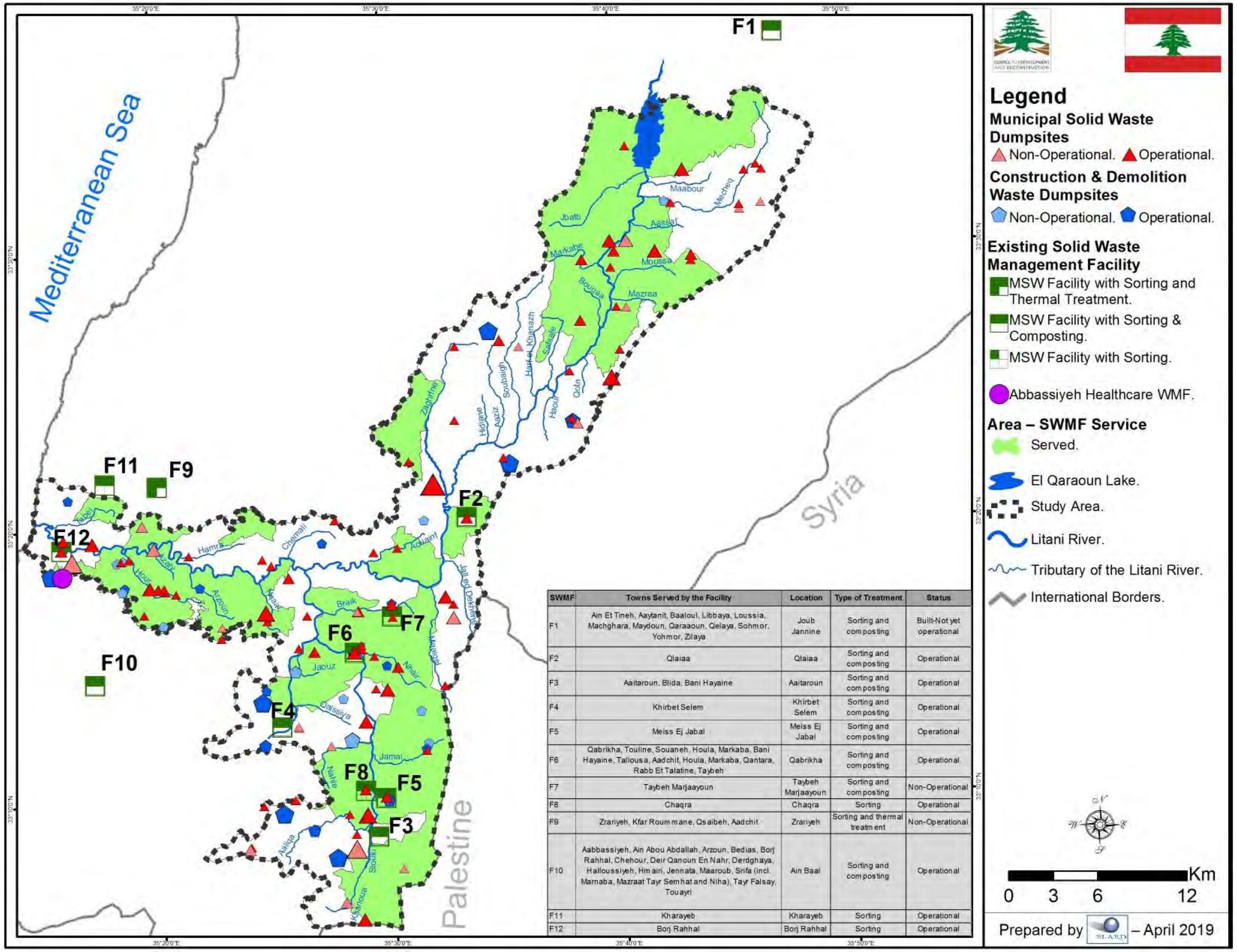
432. The facility is very old and was built in 2002 through USAID financing. The facility is currently non-operational and used to serve the village of Taybeh in Zone 4 and had a capacity of 10 t/d. The facility included a manual sorting platform for separating recyclables from organics which are then fed to 20 small rotating drum composters. These were not properly operated as they required continuous electric supply to keep them rotating and consequently, they were damaged and out of service.

8- Zrariyeh Green Ecotech facility

433. The facility was built by a private investor in 2014. The facility has a capacity of 10 t/d and serves the villages of Zrariyeh, Kfar Roummane, Kousaibeh and Aadchit. The facility is a sorting and thermal treatment facility which includes a mechanical sorting line, shredder for organic waste and a pyrolysis reactor. The facility converts waste to coal and generates syngas which is used internally to provide power to the facility. The facility's operation has been officially stopped by MoE, and thus it is no longer considered operational.

9- Ain Baal sorting and composting facility

434. The facility was built in 2009 through financing from USAID, OMSAR and the Union of Municipalities of Tyre. The facility has a capacity of 100-150 t/d and is currently serving 27 municipalities. It consists of a mechanical sorting line and a tunnel composting facility. Equipment available include a weigh bridge, bag opener, three sorting lines, trommel screens, four presses, 10 tunnel composters (each 50 m long) supplied with air blowers, biofilters, refining compost screens and equipment for reducing the volume of recyclables. The facility receives financing from OMSAR fund for operation and maintenance of constructed facilities. The facility is operated by Al Bonyan Company since 2011. Rejects from the facility (around 40 to 50 t/d) are sent to multiple dumps in the area after the closure of Ras el Ain dump in Tyre.



SWMF	Towns Served by the Facility	Location	Type of Treatment	Status
F1	Ain Et Tineh, Aaytanit, Baaloul, Libbaya, Loussia, Machghara, Maydoun, Qaraaoun, Qelaya, Sohmor, Yohmor, Zilaya	Joub Jannine	Sorting and composting	Built-Not yet operational
F2	Qlaiaa	Qlaiaa	Sorting and composting	Operational
F3	Aaitaroun, Blida, Bani Hayaine	Aaitaroun	Sorting and composting	Operational
F4	Khirbet Selem	Khirbet Selem	Sorting and composting	Operational
F5	Meiss Ej Jabal	Meiss Ej Jabal	Sorting and composting	Operational
F6	Qabrikha, Touline, Souaneh, Houla, Markaba, Bani Hayaine, Tallousa, Aadchit, Houla, Markaba, Qantara, Rabb Et Talatine, Taybeh	Qabrikha	Sorting and composting	Operational
F7	Taybeh Marjaayoun	Taybeh Marjaayoun	Sorting and composting	Non-Operational
F8	Chaqra	Chaqra	Sorting	Operational
F9	Zrariyeh, Kfar Roummane, Qsaibeh, Aadchit	Zrariyeh	Sorting and thermal treatment	Non-Operational
F10	Aabbassiyeh, Ain Abou Abdallah, Arzoun, Bedias, Borj Rahhal, Chehour, Deir Qanoun En Nahr, Derdghaya, Halloussiyeh, Hmairi, Jennata, Maaroub, Srifa (incl. Marnaba, Mazraat Tayr Semhat and Niha), Tayr Falsay, Touayri	Ain Baal	Sorting and composting	Operational
F11	Kharayeb	Kharayeb	Sorting	Operational
F12	Borj Rahhal	Borj Rahhal	Sorting	Operational

Figure 5-1. Solid Waste Dumpsites as Sources of Pollution Pressure and Existing SWMF in the Study Area

5.1.2 Prospective Programs and Projects

435. Some initiatives for the management of solid wastes in Zones 1 to 5 are planned as part of the EU-financed SWAM I whereas remaining projects were identified previously and are currently on hold requiring financing after the cancellation of SWAM II projects as outlined in Table 5-2.

Table 5-2. Planned Projects for SWM in Zones 1 to 5

Zone	Project description	Funding Source	Estimated amount	Status
3&4	Construction of a sanitary landfill in Nabatiye	Not available	€ 2,177,000	Project on hold after cancellation of SWAM II
	Construction of a sorting and composting facility for Bent Jbayl and Marjaayoun	Not available	€ 2,135,000	Project on hold after cancellation of SWAM II
	Construction of a sanitary landfill for Bent Jbayl and Marjaayoun	Not available	€ 2,471,000	Project on hold after cancellation of SWAM II
5	Rehabilitation of Ras el Ain dump in Tyre	Not available	€ 4,424,000	Project on hold after cancellation of SWAM II
	Construction of sorting and composting facility in Sahel El Zahrani	PROMARE (EU)	Unknown	Project still in the study and planning phase

5.1.2.1 Zones 3 & 4

1- Construction of a sanitary landfill in Nabatiye

436. This project complements the construction of a sorting and composting facility in Kfour Nabatiye which was built by OMSAR in 2012 to serve the Nabatiye district. The project consists of building a sanitary landfill of capacity 75 t/d to receive the waste rejects coming out of the Kfour facility. The landfill should be designed to last for 10 years and should consist of three cells having an area of 15,000 m^2 that can be further expanded. This project was previously earmarked under the EU-financed SWAM II project but is currently on hold after cancellation of this project. Once financing is secured, the EIA and design of the facility can be initiated (consultant recruited under OMSAR), and a tender launched. The estimated cost of constructing and equipping the landfill with the necessary waste maneuvering equipment is around 2,177,000 euros. Once a landfill is built and the sorting and composting facility in Kfour is operated, all waste dumps that are putting pressure on the pollution of the Litani River in this zone (Zones 3 and 4) can be closed in place or transferred to the constructed sanitary landfill given their relatively small volumes.

2- Construction of a sorting and composting facility for Bent Jbayl and Marjaayoun

437. This project consists of building of a sorting and composting facility for the Bent Jbayl and Marjaayoun districts serving three Unions of Municipalities (Bent Jbayl, Jabal Aamel and Qalaa). This project was previously earmarked under the EU-financed SWAM II project and is currently on hold after the cancellation of this project. Once financing is secured, the EIA and design of the facility can be initiated (consultant is already on board under

OMSAR), and a tender for the construction of the facility is launched. The facility should be designed to have a capacity of 250 t/d to cater for the waste coming out from both districts and should be equipped with the necessary sorting and composting equipment (weighbridge, horizontal and inclined conveyors, bag opener, trommel screens magnetic separator, ballistic separator, compost turning machine, refining screens and a biofilter). The facility should be built on a concrete structure covered with a metallic hangar that will house the administrative building, sorting area, composting area and maturation and curing areas. The estimated cost of constructing and equipping this facility with the necessary equipment is around 2,135,000 euros.

3- Construction of a sanitary landfill for Bent Jbayl and Marjaayoun

438. This project complements the construction of a sorting and composting facility for Bent Jbayl and Marjaayoun described above. The project consists of building a sanitary landfill of capacity 100 t/d that will receive the waste rejects coming out of the sorting and composting plant. The landfill should be designed to last for 10 years and should consist of four cells having an area of 20,000 m^2 that can be further expanded. This project was previously earmarked under the EU-financed SWAM II project but is currently on hold after cancellation of the project. Once the financing is secured, the EIA and design of the facility can be initiated (consultant recruited under OMSAR), and a tender launched. The estimated cost of constructing and equipping the landfill with the necessary waste maneuvering equipment is around 2,471,000 euros. Once the landfill is built and the sorting and composting facility is operated, all waste dumps that are a pollution pressure on the Litani River in Bent Jbayl and Marjaayoun districts (Zones 3 and 4) can be closed in place or transferred to the newly constructed sanitary landfill given their relatively small volumes.

5.1.2.2 Zone 5

1- Rehabilitation of Ras el Ain dump in Tyre and building a sanitary landfill for the district

439. This solution consists of two complementary projects: the rehabilitation of the closed Ras El Ain dump in Tyre that was operational for more than 25 years and serving as the main dump for the Tyre district and the construction of a sanitary landfill to serve the Tyre caza.

440. The rehabilitation process consists of assessing site conditions and conducting preliminary studies to determine actual volumes, and characteristics of wastes and of the dump, in addition to constructing two cells of the sanitary landfill having a surface area of 10,000 m^2 with all needed protection (composite liner system and soil protection measures, drainage layers, perforated pipes and sump pits for leachate collection, active harnessing of gases) and transferring the waste rejects from the rehabilitation process to the newly formed cells of the landfill. This project was also earmarked under the EU-financed SWAM II project and is currently on hold after cancellation of the project. Once the financing is secured, the design of the facility can be initiated as the land has already been expropriated by the Lebanese Government, and a tender for the rehabilitation and closure of the dump is launched.

441. The other project consists of the construction of a sanitary landfill serving the Tyre caza (capacity 100 t/d). This sanitary landfill should be designed to last for 10 years and should

consist of five cells having an area of 25,000 m^2 that can be further expanded. This project was not earmarked under any existing project and funding should be secured to take care of the proper disposal of waste rejects coming out from the sorting and composting facility. Once funding is secured, the EIA and design of the facility can be initiated, and a tender launched. The estimated cost of constructing and equipping the landfill with the necessary waste maneuvering equipment is around US$ 3.5 Million. Once a landfill is built and the sorting and composting facility is operated, all waste dumps that are putting pressure on the pollution of the Litani River in Zone 5 can be closed in place or transferred to the newly constructed sanitary landfill given their relatively small volumes. The estimated cost of rehabilitating the dump and constructing and equipping the landfill with the necessary waste maneuvering equipment is around US$ 9.0 Million.

2- Construction of a sorting and composting facility for Sahel El Zahrani

442. This project consists of building of a sorting and composting facility for Sahel El Zahrani Union of Municipalities. This project is also earmarked under the EU financed PROMARE project. The EIA and design of the facility have started (consultant is already on board), and a tender for the construction of the facility can be launched (prepared with OMSAR). The facility should have a capacity of 150 t/d to cater for the waste coming out from all municipalities of Sahel El Zahrani Union of Municipalities and should be equipped with the necessary sorting and composting equipment (weighbridge, horizontal and inclined conveyors, bag opener, trammel screens magnetic separator, ballistic separator, compost turning machine, refining screens and a biofilter). The facility should be built on a concrete structure covered with a metallic hangar that will house the administrative building, sorting, composting, maturation and curing areas. The estimated cost of constructing and equipping this facility with the necessary equipment is around 1,890,000 euros.

3- Construction of a sanitary landfill for Sahel El Zahrani

443. This project complements the construction of a sorting and composting facility for Sahel El Zahrani Union of Municipalities described above. The project consists of building a sanitary landfill of capacity 75 t/d to receive the waste rejects coming out of the sorting and composting plant. The landfill should be designed to last for 10 years and should consist of three cells having an area of 15,000 m^2 that can be further expanded. This project was not earmarked under any existing project and funding should be secured to take care of the proper disposal of waste rejects coming out from the sorting and composting facility. Once this issue is resolved, the EIA and design of the facility can be initiated, and a tender launched. The estimated cost of constructing and equipping the landfill with the necessary waste maneuvering equipment is around 2,177,000 euros. Once a landfill is built and the sorting and composting facility is operated, all waste dumps that are putting pressure on the pollution of the Litani River in Zone 5 can be closed in place or transferred to the newly constructed sanitary landfill given their relatively small volumes.

5.1.3 Proposed Responses to Pressures from Solid Waste per Study Zone

5.1.3.1 Zones 1 & 2

For Municipal Solid Waste

1- The availability of an alternative solution to waste dumping is essential for the closure/rehabilitation or transfer of any dump. An Integrated solution for Municipal Solid Waste Management in Zone 1 is under implementation. Two major initiatives are taking place: the EU supported the initiative of the Union of Municipalities of Bouhaira to build a sorting and composting facility in Joub Jannine that serves the Union villages and currently a sanitary landfill was built to complement that facility. A small cell in this landfill can be devoted to transferring the wastes already present in existing dumps that are putting pressure on the Litani River in this zone (dumps D22, D10 and D3) and in Zone 2 (D34) to the new landfill with a purpose for rehabilitation. The integrated SWM project in this zone is operational. US$1.2 Million is ineeded for annual O&M of the Joub Jannine complex (see Table 5-3).

2- Stop waste dumping at Majdel Balhis, Sohmor, Ain Et Tineh and Rihane Jezzine dumps (D3, D10, D22 and D34). Waste dumping at the four small dumps can be stopped and all incoming waste can be transferred to the Joub Jannine integrated waste management complex.

3- Close the dumps in Majdel Balhis, Sohmor, Ain el Tineh and Rihane Jezzine dumps (D3, D10, D22 and D34). Two possibilities exist: transfer the waste to the Joub Jannine landfill or close the dumps in place (excavate, line, cap and close). The volume of waste in these four dumps is relatively small and is estimated at around 2,800 m^3 of waste. These can increase or decrease with time since open burning is practiced to reduce the volume of wastes. The decision to close or transfer the dump to another location depends on the intended future use for the location of the dump and the availability of a location to transfer the wastes into. In case of on-site closure and capping of the dump, wastes can be moved and piled in a smaller area one third the original size. A 30-cm layer of gravel and 50-cm layer of low permeability soil will be needed to cover the dump to facilitate gas migration, minimise water infiltration into the dump and minimise surface runoff to the river. The cost for this action is estimated at US$34,000 (Appendix J, Table J-3 → Table J-6) or 12.10 US$/$m^3$. Another option is to excavate the wastes and move them to Joub Jannine sanitary landfill. This option would cost around US$71,500 or 25.80 US$/m^3. Monitoring of proper operations is suggested and is expected to be incorporated in the supervising Consultant's costs.

For Medical Waste

1- No issues with medical waste management were identified in Zones 1 and 2 as the only hospitals present in this zone (West Bekaa and Marjaayoun Governmental Hospitals) are currently treating their infectious waste in Aabbassiyeh treatment centre through a contract with a local company (SAFE Contracting). For primary health care centres, an agreement can be made with either arcenciel in Zahle or with SAFE Contracting in Aabbassiyeh to treat their relatively small quantity of infectious waste (cost varying from 1 to 2 US$/kg depending on quantity).

For Direct Dumping of Wastes in the River

1- Direct dumping and disposal of waste (MSW, slaughterhouse and industrial wastes) in the river should be completely banned. This can be done by enforcing and applying legislation through penalties where applicable. Individuals and industries should be encouraged to dispose of their wastes through the proper channels. Municipalities, through their police force can play a major role in control and monitoring. An indicative cost of US$44,000 over 1 year is suggested to carry out training, awareness and monitoring activities at the local level (see Table 5-3).

5.1.3.2 Zone 3 & 4

For Municipal Solid Waste

1- Presence of alternative solutions: This zone covers mainly three districts: Nabatiye, Marjaayoun and Bent Jbayl. Alternative waste management solutions were identified and earmarked under SWAM II but unfortunately the cancellation of the project jeopardized the plan. The construction of a sanitary landfill for Nabatiye district (capacity 75 t/d) will complement the Kfour sorting and composting facility while a new integrated solid waste management complex is conceived for Bent Jbayl and Marjaayoun. This complex includes the construction of a sorting and composting facility (capacity of 250 t/d) and a sanitary landfill having a capacity of 100 t/d. The capital cost of the proposed solutions in these two zones is estimated at 6.78 M euros (Appendix J, Table J-7 → Table J-9). Financing for this plan is currently not available (was secured previously under SWAM II project) but can be pursued with the new EU financed Tadwir project. Land expropriation costs could reach US$2 Million. Complementary activities to sustain the operation and maintenance of the facilities are estimated to cost US$3.3 Million per year. Contractual costs could be in the order of US$400,000 and annual complementary activities in the order of US$150,000.

2- Stop waste dumping at Yohmor (Nabatiye), Aadchit el Qoussair, Bani Haiyane, Kounine, Deir Siriane, Houla, and Rabb Et-Talatine dumps (D48, D67, D61, D75, D52, D44, and D50). Once the alternative solution for waste management in these two zones is enacted, dumping of waste in these dumps is supposed to stop.

3- Closure of the seven dumps listed above. Two possibilities exist: transfer the waste to the sanitary landfills or close the dumps in place (excavate, line, cap and close). The volume of waste in these seven dumps is relatively small and is estimated at around 6,650 m^3 of waste. These can increase or decrease with time since open burning is practiced to reduce the volume of wastes. The decision to close or transfer the dump to another location depends on the intended future use for the location of the dump and the availability of a location to transfer the wastes into. In case of on-site closure and capping of the dump, wastes can be moved and piled in a smaller area one third the original size. A 30-cm layer of gravel and 50-cm layer of low permeability soil will be needed to cover the dump to facilitate gas migration, minimise water infiltration into the dump and minimise surface runoff to the river. The cost for this action is estimated at US$76,500 or 11.50 US$/m^3 (Appendix J, Table J-10 → Table J-16). Another option is to excavate the wastes and move them to Nabatiye or Bent Jbayl/Marjaayoun sanitary landfills. This option would cost around US$133,500 or 20.08 US$/m^3. Monitoring of proper operations is expected to be covered under the supervising Consultant's costs.

For Medical Waste

1- No issues with medical waste management were identified in Zones 3 and 4 as the only hospitals present in this zone (Mays ej Jabal and Bent Jbayl Governmental Hospitals) are both currently treating their infectious waste through a contract with arcenciel. For primary health care centres, an agreement can be made with either arcenciel in Zahle or with SAFE Contracting in Aabbassiyeh to treat their relatively small quantity of infectious waste in their sterilization centres (cost varying from 1 to 2 US$/kg depending on quantity).

For Direct Dumping of Wastes in the River

1- Ban direct dumping of waste (MSW, slaughterhouse and industrial wastes) in the Litani River or any of its tributaries. This can be done by enforcing and applying legislation and penalties where applicable. Municipalities, through their police force can play a major role in control and monitoring. Enforcement of anti-littering, education and awareness, etc. is estimated to cost US$ 44,000 over a year for Zones 3 and 4.

5.1.3.3 Zone 5

For Municipal Solid Waste

1- Presence of alternative solutions: This zone covers mainly two portions of the Zahrani and Tyre cazas. Alternative waste management solutions are currently not available as a result of the cancellation of the SWAM II project. These include the rehabilitation and closure of Ras El Ain dump, construction of a sanitary landfill in Tyre caza and the construction of a new integrated solid waste management complex for Sahel El Zahrani. This complex includes the construction of a sorting and composting facility (capacity of 150 t/d) and a sanitary landfill (capacity of 75 t/d). The cost of the proposed solutions in this zone is estimated at US$ 14.6 Million (Appendix J, Table J-17 → Table J-20). Financing for this plan is being studied under the EU-financed PROMARE project. Land expropriation costs for building the Sahel el Zahrani complex and the new sanitary landfill in Tyre could reach US$4 Million. Complementary activities to sustain the operation and maintenance of the facilities are estimated to cost US$ 2.9 Million per year. Contractual costs could be in the order of US$400,000 and complementary activities in the order of US$185,000.

2- Stop waste dumping at Borj Rahhal, Bedias, Deir Qanoun En-Nahr, Maaroub, Hmairi, Sir El Gharbiyeh and Srifa (D126, D116, D113, D108, D107, D106 and D94): Once the alternative solutions for waste management in this zone are enacted, disposal of waste in these dumps is supposed to stop.

3- Closure of the seven dumps listed above. Two possibilities exist: transfer the waste to the sanitary landfills or close the dumps in place (excavate, line, cap and close). The volume of waste in these six dumps is relatively small and is estimated at around 9,150 m^3. These can increase or decrease with time since open burning is practiced to reduce the volume of wastes. The decision to close or transfer the dump to another location depends on the intended future use for the dump and the availability of a location to transfer the wastes into. In case of on-site closure and capping of the dump, wastes can be moved and piled in a smaller area one half or one third the original size. A 30-cm layer of gravel and 50-cm layer of low permeability soil will be needed to cover the dump to facilitate gas migration, minimise water infiltration into the dump and minimise surface runoff to the river. The cost for this action is estimated at US$102,500 or 11.20 US$/m^3 (Appendix J, Table J-21 → Table J-27). Another option is to excavate the wastes and move them to Ras El Ain or Sahel el Zahrani sanitary landfills. This option would cost around US$139,000 or 15.19 US$/m^3. Monitoring of proper operations is expected to be covered under the supervising Consultant's costs.

For Medical Waste

1- Medical waste from hospitals and dispensaries in this zone should be properly segregated at the point of generation in order to reduce the volume of infectious waste. Segregated wastes from this zone can be easily collected and sent for proper disposal at the Aabbassiyeh sterilization centre. For primary health care centres, an agreement can be made with either arcenciel in Saida or with SAFE in Aabbassiyeh to treat their relatively small quantity of infectious waste in their sterilization centres (cost varying from 1 to 2 $/kg depending on quantity).

For Direct Dumping of Wastes in the River

1- Ban direct dumping of waste (MSW, slaughterhouse and industrial wastes) in the Litani River or any of its tributaries. This can be done by enforcing and applying legislation by applying penalties. Municipalities, through their police force can play a major role in control and monitoring. Enforcement of anti-littering, education and awareness, etc. is estimated to cost US$ 22,000 annually for Zone 5.

5.1.4 Screening of Proposed Responses to Pressures from Solid Waste

444. Based on the analysis laid out in previous sections and the information on current and planned projects, responses for each solid waste pressure were studied for implementation by Zone. Specific measures or activities are proposed considering the current and planned measures being implemented or marked for implementation by actors for better management of solid waste. For each proposed measure, the parties responsible for its implementation, the cost, timeframe and potential funding sources were outlined as per Table 5-3, Table 5-4 and Table 5-5. Detailed costs' breakdowns for each measure are shown in Appendix J in a series of tables (Appendix J, Table J-1 → Table J-27).

Table 5-3. Screening of the Proposed Responses to Pressures from Solid Waste Disposal in Zones 1 & 2

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
Pollution of the Litani River in Zone 1 from solid waste disposal practices	1-Operate and maintain the solid waste management facility in Joub Jannine (Sorting and Composting Facility and sanitary landfill-capacity 100 t/d)	*Technical*	MBT Facility and landfill were built and equipped. O&M was awarded to a contractor	-	-	OMSAR and UMB (Union of Municipalities of Bouhaira)	-	-	EU
		Financial	Funding for construction was made available through EU under SWAM I	O&M funding secured through OMSAR	Sustain operation of the facility. Part of the budget secured from the national budget for the first three years. The other part from UMB and municipalities	OMSAR, UMB and municipalities	around 25$/tonne (US$ 920,000/year)	Starting 2019	National Budget (secured) + UMB's Budget and municipal budgets
		Administrative	Project managed by OMSAR and UMB	OMSAR will be the responsible administrator	Supervision of proper O&M	OMSAR/UMB	Overhead	Starting 2019	OMSAR Budget & UMB Budget
		Institutional/ Governance	None	UMB and OMSAR will be overseeing the management of the SWM facility	OMSAR/ UMB to provide qualified personnel to ensure proper O&M of the SWM complex	OMSAR/UMB	Overhead	2018-2021	OMSAR Budget & UMB Budget
		Training & Capacity Building	Awareness campaigns on waste sorting at source implemented	Follow up on waste sorting rates	Sustain awareness efforts, follow up on waste sorting rates; Training on management of landfills	OMSAR MoE	US$ 20,000	2018-2020	OMSAR Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Monitoring		OMSAR/UMB to monitor operation of landfill	Monitoring of the quality of operations and outputs by OMSAR	OMSAR/MoE	Overhead	2018-2021	OMSAR Budgets
		Legal	None	None	Enforce implementation of Law 80/2018 and Decree 5605/2019	MoE	Overhead	Unknown	MoE Budget
	2-Closure of Ain El Tine Dump (D22)	*Technical*	None	Alternative solution for proper SWM is available (SWM complex in Joub Jannine)	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1500 m^3 of waste	Ain El Tineh Municipality	US$16,500 or US$ 33,500	2019-2020	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2019-2020	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
	3-Closure of Sohmor dump (D10)	*Technical*	None	Alternative solution for proper SWM is available (SWM complex in Joub Jannine)	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 250 m³ of waste	Sohmor Municipality	US$ 4,000 or US$ 11,500	2019-2020	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2019-2020	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	4-Closure of Majdel Balhis Dump (D3)	*Technical*	None	Alternative solution for proper SWM is available (SWM complex in Joub Jannine)	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 500 m³ of waste	Majdel Balhis Municipality	US$ 6,500 or US$ 12,000	2019-2020	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2019-2020	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
Pollution of river from waste littering	5-Ban direct waste disposal in Litani (Municipalities/ individuals/ industries) (Zones 1 & 2)	*Technical*	None	Alternative solution for ISWM is being prepared	Ban waste disposal in River and apply Polluter Pays Principle	Municipalities		2019	Municipal Budgets
		Financial	None	None	Imposing penalties	MoE and Municipalities	None		MoE Budget and Municipal Budgets
		Administrativ e	None	None					
		Institutional/ Governance	None	None	Municipalities of Zone 1 responsible for preventing pollution	Municipalities	None	2019	Municipal budgets
		Training & Capacity Building	None	None	Awareness campaigns on the damages of disposal in River	MoE	US$ 20,000	2019	MoE/ Municipalities/ Local NGOs

Pressure or Source	**Responses**	**Nature of Measures**	**Current measures being undertaken**	**Planned Measures**	**Proposed Measures**	**Responsible Parties for Proposed Measures**	**Cost of Proposed Measures**	**Timeframe**	**Potential Funding Source**
		Monitoring	None	None	Monitor disposal in rivers. Capacity building of staff needed for monitoring	Municipalities	US$24,000	2019	MoE / Municipalities / Local NGOs
		Legal	Decisions and decrees for proper cleanliness and banning waste disposal exist	None	Apply and enforce legislation / Polluter Pays Principle	MoE and Municipalities	None		MoE / Municipalities / Local NGOs
Pollution of the Litani River in Zone2 from solid waste disposal practices	1-Closure of Rihane Jezzine Dump (D34)	*Technical*	None	None	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2)- 560 m^3 of waste	Rihane Jezzine Municipality	US$7,000 or US$ 15,500	2019-2020	Municipal budget
		Financial	None	None	Secure budget	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2019-2020	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets

Table 5-4. Screening of the Proposed Responses to Pressures from Solid Waste Disposal in Zones 3 & 4

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
Pollution of the Litani River in Zones 3 & 4 from solid waste disposal practices	1-Build a sanitary landfill for Nabatiye caza (75 t/d)	*Technical*	Sorting and composting facility was built		Build a sanitary landfill serving the caza of Nabatiye (75 t/d) under Tadwir Procure equipment to operate the landfill	OMSAR and Union of Municipalities of Chqif (UoC)	€ 2.2 M including equipment	2019-2020	EU -OMSAR through Tadwir
		Financial	None	Launch tender and award contract to operate the facility	Secure funding for operation	OMSAR and UoC	US$ 0.42 Million /year for O&M	2019-2020	OMSAR/ National Budget
		Administrative		Secure financing	Prepare contracts for monitoring construction and operation	OMSAR	US$ 200,000	2019	OMSAR
		Institutional/ Governance	MoE	MoE/Unions of Municipalities of Chqif	Union of Municipalities to be the responsible institution	Unions of Municipalities	Overhead	2012-2014	Municipal Budget
		Training & Capacity Building	None	None	Awareness campaigns on waste sorting at source and proper operation of facilities to be completed	MoE/ Municipalities	US$ 25,000	2019	MoE Budget/ Municipal Budget
		Monitoring	None	None	Recruit a supervisor	MoE/OMSAR	US$ 50,000	2019	MoE
		Legal	None	None	Apply and enforce legislation	MoE	Overhead	Unknown	MoE Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
	2-Build a solid waste management facility including sorting, composting and landfilling in Bent Jbayl /Marjaayoun	*Technical*	Project was earmarked under SWAM II	Secure financing Prepare EIA, design the facility	Build the complex (Sorting, composting and landfilling) Operate the complex (S-C 250 t/d whereas L - 100 t/d)	OMSAR/MoE/UoM (Jabal Aamel, Bent Jbayl and Qalaa)	€ 4.32 M	2019-2021	Donor Agencies/National Budget
		Financial		Launch tender and award contract to build the facility	Secure funding for operation	Unions of Municipalities	US$ 2.82 Million /year for O&M	2021-2022	OMSAR/National Budget
		Administrative		Secure financing Prepare EIA and design, expropriate land	Prepare contracts for construction and operation	OMSAR/MoE/Unions of Municipalities	US$ 2.0 Million for expropriation and US$ 200,000 for contracts		National Budget
		Institutional/ Governance	MoE, OMSAR and EU	Unions of Municipalities of Jabal Aamel, Bent Jbayl and Qalaa	Unions of Municipalities	Unions of Municipalities	Overhead	2019-2021	Municipal Budget
		Training & Capacity Building	None	None	Awareness campaign on waste sorting at source to be completed	MoE/ Municipalities	US$ 25,000	2020	MoE Budget/ Municipal Budget
		Monitoring	None	None	Recruit a supervisor	MoE/OMSAR	US$ 50,000	2020	MoE/OMSAR
		Legal	None	None	Apply and enforce legislation	MoE	Overhead	Unknown	MoE Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
	3-Closure of Yohmor (Nabatiye) Dump (D48)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 500 m^3 of waste	Yohmor Municipality	US$ 6,500 or US$ 12,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	4-Closure of Aadchit El Qoussair Dump (D67)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1500 m^3 of waste	Aadchit Municipality	US$ 16,500 or US$ 18,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contracto r		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	5-Closure of Bani Haiyane dump (D61)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 50 m^3 of waste	Bany Haiyane Municipality	US$ 1,500 or US$ 3,500	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrativ e	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contracto r		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	6-Closure of El Kounine Dump (D75)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1000 m^3 of waste	Kounine Municipality	US$ 11,500 or US$ 24,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	7-Closure of Deir Siriane Dump (D52)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1100 m^3 of waste	Deir Siriane Municipality	US$ 12,500 or US$ 17,500	2020-2021	Municipal budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	8-Closure of Houla Dump (D44)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1000 m³ of waste	Houla Municipality	US$ 11,500 or US$ 24,500	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2020-2021	Within Contractor contract

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
	9-Closure of Rabb Et-Talatine Dump (D50)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Nabatiye, Bent Jbayl and Marjaayoun	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1500 m^3 of waste	Rabb Et-Talatine Municipality	US$ 16,500 or US$ 33,500	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MoE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MoE	Overhead		MoE Budget
		Legal	None	None	Apply and enforce legislation	MoE/ Municipalities	Overhead		MoE Budget / Municipal Budgets
Pollution of river from waste littering	10-Ban direct waste disposal in Litani	*Technical*	None	None	Ban waste disposal in River and apply Polluter Pays Principle	Municipalities		2019	Municipal Budgets

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Financial	None	None	Imposing penalties	MoE and Municipalities	None		MoE Budget and Municipal Budgets
		Administrative	None	None					
		Institutional/ Governance	None	None	Municipalities of Zones 3 & 4 to be the responsible institutions for preventing pollution	Municipalities	None	2019	Municipal budgets
		Training & Capacity Building	None	None	Awareness campaigns on the damages of disposal in river	MoE	US$ 20,000	2019	MoE/ Municipalities/ Local NGOs
		Monitoring	None	None	Monitor disposal in rivers. Capacity building of staff needed for monitoring	Municipalities	US$ 24,000	2019	MoE / Municipalities / Local NGOs
		Legal	Decisions and decrees for proper cleanliness and banning waste disposal exist	None	Apply and enforce legislation / Polluter Pays Principle	MoE and Municipalities	None		MoE / Municipalities / Local NGOs

Table 5-5. Screening of the Proposed Responses to Pressures from Solid Waste Disposal in Zone 5

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
Pollution of the Litani River in Zone 5	1- Rehabilitation and closure of Ras el Ain and building a new sanitary landfill for the Tyre district	*Technical*	Financing was cancelled	Seek financing	Rehabilitate and close the dump Build a sanitary landfill for the Tyre district	OMSAR and Union of Municipalities of Tyre (UoT)	US$ 5,500,000 and US$ 3,500,000	2019-2020	Donor Agencies/National Budget
		Financial	Secure funding for project	Launch tender and award contract to build a sanitary landfill and rehabilitate Ras el Ain dump		OMSAR and UoT		2019-2020	Donor Agencies/National Budget
		Administrative		Resolve issues related to SWAM II	Prepare contracts for monitoring construction and operation	OMSAR	US$ 400,000	2019-2020	OMSAR
		Institutional/ Governance		MoE/OMSAR/Union of Municipalities of Tyre to be the responsible institutions		Unions of Municipalities	Overhead	2019-2020	Municipal Budget
		Training & Capacity Building	None	None	Awareness campaigns on waste sorting at source to be completed	MOE/ Municipalities	US$ 35,000	2019-2020	MOE Budget/ Municipal Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Monitoring	None	None	Recruit a supervisor	OMSAR	US$ 100,000	2019-2020	OMSAR
		Legal	None	None	Apply and enforce legislation	MOE	Overhead	Unknown	MOE Budget
	2-Build a solid waste management facility (sorting and composting) and a sanitary landfill for Sahel El Zahrani Municipalities	*Technical*	Sorting and composting facility to be financed under PROMARE Landfill Project was previously earmarked in SWAM II	Secure financing for the landfill Prepare EIA, design the facility and build the complex	Build the sorting and composting facility Build a sanitary landfill for Sahel el Zahrani (capacity 75 t/d)	PROMARE/OMSAR/MOE/ UoM of Sahel el Zahrani	€ 4.1 Million	2019-2021	PROMARE Donor Agencies/National Budget
		Financial		Secure funding of € 1.9 Million Launch tender and award contract to build the facility	Secure funding for operation	Unions of Municipalities	US$ 2.83 Million/year for O&M	2019-2021	Donor Agencies/National Budget - OMSAR
		Administrative	Finalizing agreements	Prepare EIA and design, expropriate land	Prepare contracts for construction and operation	OMSAR/Union of Municipalities	US$ 2.0 Million for expropriation and US$ 200,000 for contracts		National Budget
		Institutional/ Governance	OMSAR and EU	Unions of Municipalities	Unions of Municipalities	Unions of Municipalities	Overhead	2019-2021	Municipal Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Recruit a supervisor	MOE / OMSAR	US$ 50,000	2020-2021	OMSAR
		Legal	None	None	Apply and enforce legislation	MOE	Overhead	Unknown	MOE Budget
	3-Closure of Borj Rahhal Dump (D126)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1800 m^3 of waste	Borj Rahhal Municipality	US$ 19,500 or US$ 20,500	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
	4-Closure of Bedias Dump (D116)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 50 m³ of waste	Bedias Municipality	US$ 1,500 or US$ 3,500	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets
	5-Closure of Deir Qanoun En-Nahr dump (D113)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 4500 m³ of waste	Deir Qanoun En-Nahr Municipality	US$ 47,500 or US$ 55,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			

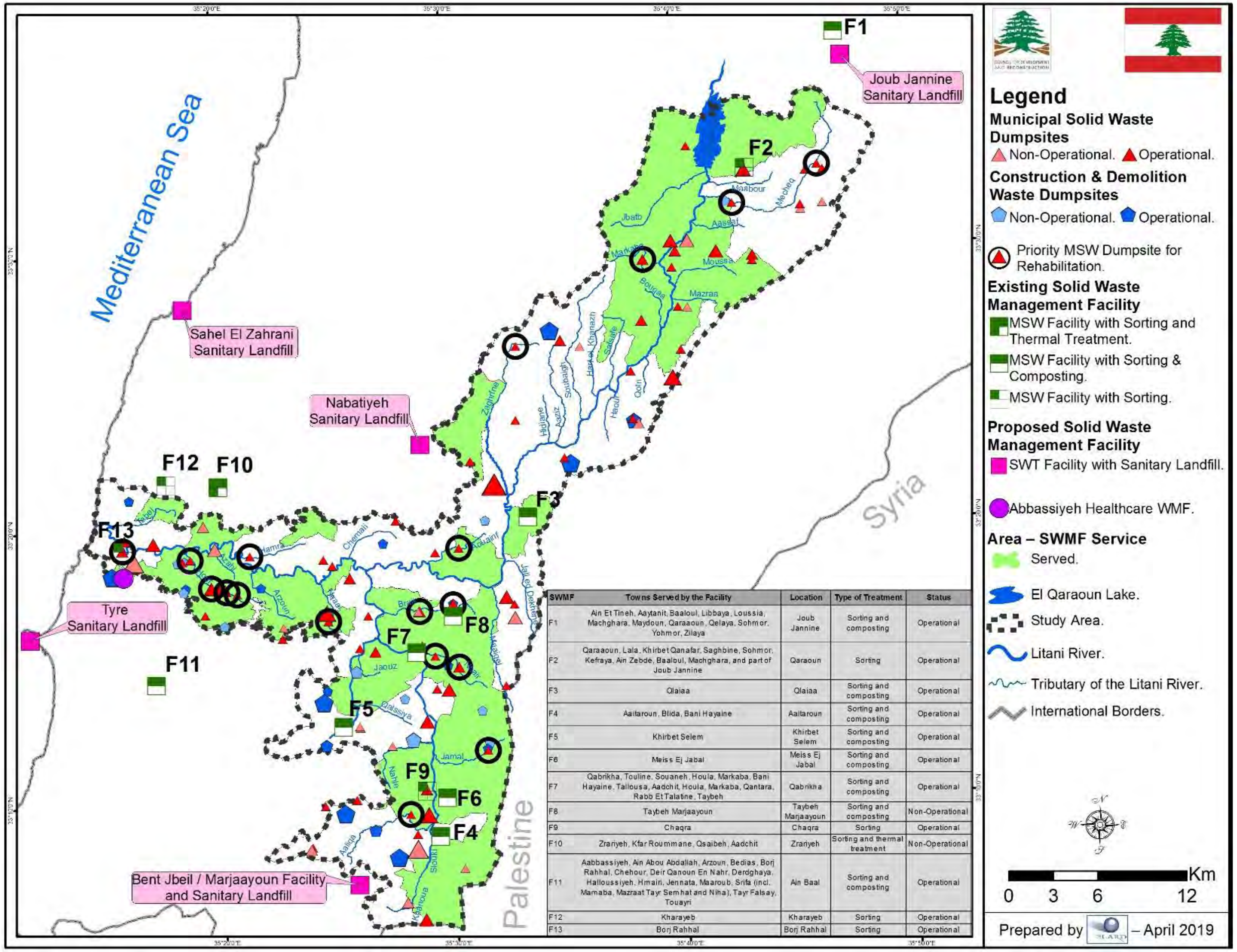
Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets
	6-Closure of Maaroub Dump (D108)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 600 m³ of waste	Maaroub Municipality	US$ 7,500 or US$ 14,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring	MOE/contractor		2020-2021	Within Contractor contract

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
					during closure operations				
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets
	7-Closure of Hmairi Sour Dump (D107)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 600 m^3 of waste	Hmairi Municipality	US$ 7,500	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets
	8-Closure of Sir El Gharbiyeh Dump (D106)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 1000 m^3 of waste	Sir El Gharbiyeh Municipality	US$ 11,500 or US$ 24,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Cost of Proposed Measures	Timeframe	Potential Funding Source
	9-Closure of Srifa Dump (D94)	*Technical*	None	Alternative solutions for proper SWM are being prepared for Tyre and Zahrani cazas	Transfer to sanitary landfill (Option 1) or Close the dump in place (Option 2) - 600 m^3 of waste	Srifa Municipality	US$ 7,500 or US$ 14,000	2020-2021	Municipal budget
		Financial	None	None	Secure needed funds	Municipality			
		Administrative	None	None	*Alternative should be available*				
		Institutional/ Governance	None	None					
		Training & Capacity Building	None	None	Health and Safety monitoring during closure operations	MOE/contractor		2020-2021	Within Contractor contract
		Monitoring	None	None	Monitor gases and settlement	MOE	Overhead		MOE Budget
		Legal	None	None	Apply and enforce legislation	MOE/ Municipalities	Overhead		MOE Budget / Municipal Budgets
Pollution of river from waste littering	10-Ban direct waste disposal in Litani	*Technical*	None	None	Ban waste disposal in River and apply Polluter Pays Principle	Municipalities		2019	Municipal Budgets
		Financial	None	None	Imposing penalties	MOE and Municipalities	None		MOE Budget and Municipal Budgets

Pressure or Source	**Responses**	**Nature of Measures**	**Current measures being undertaken**	**Planned Measures**	**Proposed Measures**	**Responsible Parties for Proposed Measures**	**Cost of Proposed Measures**	**Timeframe**	**Potential Funding Source**
		Administrative	None	None					
		Institutional/ Governance	None	None	Municipalities of Zone 5 to be the responsible institutions for preventing pollution	Municipalities	None	2019	Municipal budgets
		Training & Capacity Building	None	None	Awareness campaigns on the damages of disposal in river	MOE	US$10,000	2019	MOE / Municipalities/ Local NGOs
		Monitoring	None	None	Monitor disposal in rivers. Capacity building of staff needed for monitoring	Municipalities	US$12,000	2019	MOE / Municipalities/ Local NGOs
		Legal	Decisions and decrees for proper cleanliness and banning waste disposal exist	None	Apply and enforce legislation / Polluter Pays Principle	MOE and Municipalities	None		MOE / Municipalities/ Local NGOs



SWMF	Towns Served by the Facility	Location	Type of Treatment	Status
F1	Ain Et Tineh, Aaytanit, Baaloul, Libbaya, Loussia, Machghara, Maydoun, Qaraaoun, Qelaya, Sohmor, Yohmor, Zilaya	Joub Jannine	Sorting and composting	Operational
F2	Qaraaoun, Lala, Khirbet Qanafar, Saghbine, Sohmor, Kefraya, Ain Zebdé, Baaloul, Machghara, and part of Joub Jannine	Qaraoun	Sorting	Operational
F3	Qlaiaa	Qlaiaa	Sorting and composting	Operational
F4	Aaitaroun, Blida, Bani Hayaine	Aaitaroun	Sorting and composting	Operational
F5	Khirbet Selem	Khirbet Selem	Sorting and composting	Operational
F6	Meiss Ej Jabal	Meiss Ej Jabal	Sorting and composting	Operational
F7	Qabrikha, Touline, Souaneh, Houla, Markaba, Bani Hayaine, Tallousa, Aadchit, Houla, Markaba, Qantara, Rabb Et Talatine, Taybeh	Qabrikha	Sorting and composting	Operational
F8	Taybeh Marjaayoun	Taybeh Marjaayoun	Sorting and composting	Non-Operational
F9	Chaqra	Chaqra	Sorting	Operational
F10	Zrariyeh, Kfar Roummane, Qsaibeh, Aadchit	Zrariyeh	Sorting and thermal treatment	Non-Operational
F11	Aabbassiyeh, Ain Abou Abdallah, Arzoun, Bedias, Borj Rahhal, Chehour, Deir Qanoun En Nahr, Derdghaya, Halloussiyeh, Hmairi, Jennata, Maaroub, Srifa (incl. Mamaba, Mazraat Tayr Semhat and Niha), Tayr Falsay, Touayri	Ain Baal	Sorting and composting	Operational
F12	Kharayeb	Kharayeb	Sorting	Operational
F13	Borj Rahhal	Borj Rahhal	Sorting	Operational

Figure 5-2. Priority Solid Waste Dumpsites for Rehabilitation and Proposed SWMF in the Study Area

5.1.5 Cost Comparison between the Current and Proposed Solid Waste Management Systems at the Municipal Level

445. The proposed solutions for better solid waste management carry a financial cost that is greater than the current costs paid by municipalities to manage their waste streams. Based on data collected from the municipalities on their waste management cost (for the year 2017), a comparison was made between the current costs and projected costs that a proper solid waste management system command. The analysis is presented hereafter.

5.1.5.1 Zone 1

446. The costs incurred for the current SWM system vary between the different municipalities in these two zones. They constitute a large proportion of the budget of the municipalities. For some municipalities, the costs take up 5% of the budget as is the case for Kfar Michki while for others it can reach up to 30% as is the case for Sohmor. When calculated based on a cost-per-tonne basis, it was noticed that small municipalities that generate small quantities of wastes (<1 tonne per day) incur relatively high expenses to manage their wastes. The cost per tonne for the management of solid wastes in the municipalities of Zone 1 varied between US$12.8 and US$77.6/tonne.

447. Figure 5-3 shows the unit costs of solid waste management incurred by the different municipalities of Zone 1 in 2017, which are plotted against the unit costs to be incurred for the proposed management system.

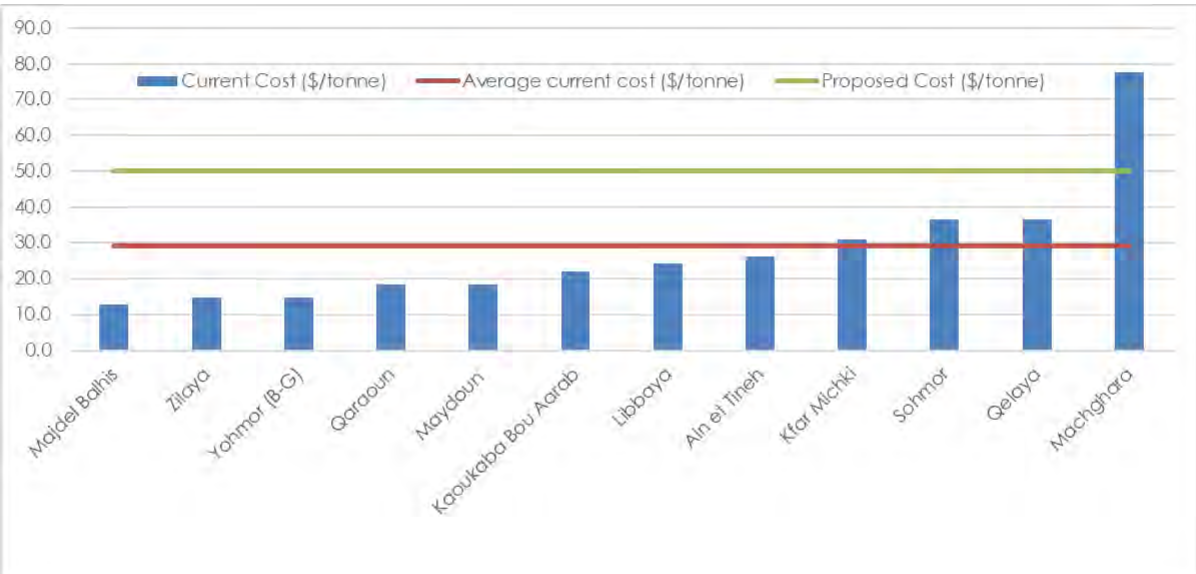


Figure 5-3. Current SWM Costs versus the Proposed Cost for Municipalities in Zone 1

448. The average cost for the management of waste in the system before the Joub Jannine SWM complex started operating was calculated to be US$29.23/tonne. When compared to the new SWM system for Zone 1 whereby waste is collected and treated in a properly operated sorting and composting facility and rejects are disposed of in a sanitary landfill (in Joub Jannine), the cost incurred became around US$50/tonne (calculated on the basis of US$10/tonne for collection, US$25/tonne for treatment and US$15/tonne for landfilling). The new system raises the expenses incurred by the municipalities from 0.55

Billion L.L. to 0.94 Billion L.L. per year. Some of these amounts are secured through OMSAR from the national budget; however, municipalities and unions of municipalities have to cooperate to secure the additional funding to cater for this deficit in order to be able to operate the system. The detailed cost calculations are shown in Appendix J, Table J-28.

5.1.5.2 Zone 2

449. The costs incurred for the current SWM system vary between the different municipalities in this zone. They constitute a large proportion of the budget of the municipalities. For some municipalities, the costs take up 5% of the budget as is the case for Dibbine while for others it can reach up to 50% as is the case for Aaychiyeh. Similar to Zone 1, when calculated based on a cost-per-tonne basis, it was noticed that small municipalities that generate small quantities of wastes (<1 tonne per day) incur relatively high expenses to manage their wastes. The cost per tonne for the management of solid wastes in the municipalities of Zone 2 varied between US$15.2 and US$ 219.2/tonne.

450. Figure 5-4 shows the unit costs of solid waste management incurred by the different municipalities of Zone 2 in 2017, which are plotted against the unit costs to be incurred for the proposed management system.

Figure 5-4. Current SWM Costs versus the Proposed Cost for Municipalities in Zone2

451. The current average cost for the management of waste in the existing system was calculated to be US$36.05/tonne. When compared to the proposed SWM system for Zone 2 whereby waste will be collected and treated in a properly operated sorting and composting facility and rejects will be disposed of in a sanitary landfill (in the Marjaayoun complex), the cost incurred becomes US$50/tonne (calculated on the basis of US$10/tonne for collection, US$25/tonne for treatment and US$15/tonne for landfilling). The proposed system will raise the expenses incurred by the municipalities from 0.45 Billion L.L. to 0.65 Billion L.L. per year. Some of these amounts will be secured through OMSAR from the national budget; however, municipalities and unions of municipalities have to cooperate to secure the additional funding to cater for this deficit in order to be able to operate the system. The detailed cost calculations are shown in Appendix J, Table J-29.

5.1.5.3 Zone 3

452. The costs incurred for the current SWM system vary between the different municipalities in this zone. They constitute proportion of the budget of the municipalities ranging from 2% (Aadaysseh) to 40% of the budget (Borj El Moulouk). When calculated based on a cost-per-tonne basis, it was noticed that small municipalities that generate small quantities of wastes incur relatively high expenses to manage their wastes. The cost per tonne for the management of solid wastes in the municipalities of Zone 3 varied between US$10.15 and US$136.9/tonne.

453. Figure 5-5 shows the unit costs of solid waste management incurred by the different municipalities of Zone 3 in 2017, which are plotted against the unit costs to be incurred for the proposed management system.

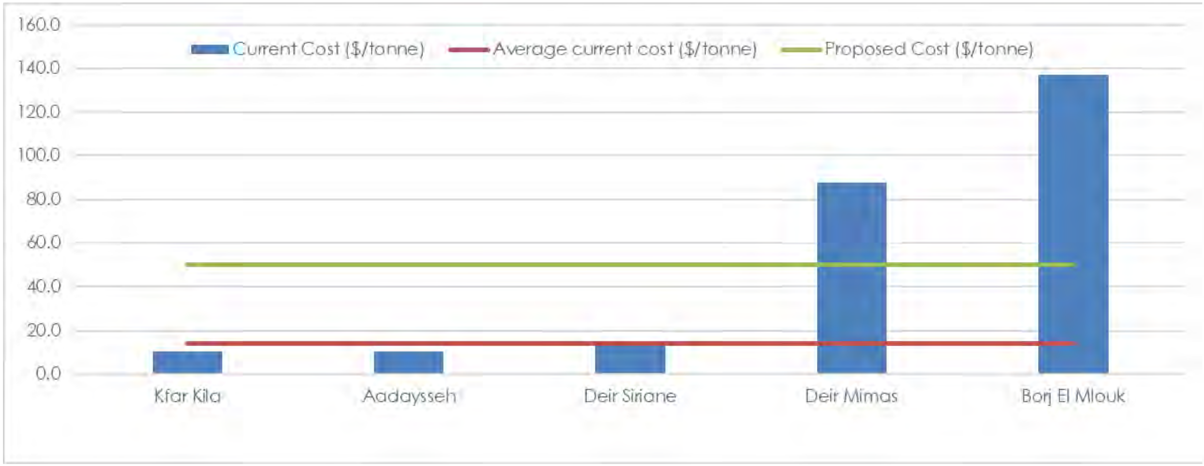


Figure 5-5. Current SWM Costs versus the Proposed Cost for Municipalities in Zone 3

454. The current average cost for the management of waste in the existing system was calculated to be US$14.07/tonne. When compared to the proposed SWM system for Zone 3 whereby waste will be collected and treated in a properly operated sorting and composting facility and rejects will be disposed of in a sanitary landfill (in Nabatiye complex and Bent Jbayl and Marjaayoun complex), the cost incurred becomes US$50/tonne (calculated on the basis of US$10/tonne for collection, US$25/tonne for treatment and US$15/tonne for landfilling). The proposed system will raise the expenses incurred by the municipalities from 0.18 Billion L.L. to 1.0 Billion L.L. per year. Some of these amounts will be secured through OMSAR from the national budget; however, municipalities and Union of municipalities have to cooperate together to secure the additional funding to cater for this deficit in order to be able to operate the system. The detailed cost calculations are shown in Appendix J, Table J-30.

5.1.5.4 Zone 4

455. The costs incurred for the current SWM system vary between the different municipalities in Zone 4. They constitute a large proportion of the budget of the municipalities. For some municipalities, the costs take up 5% of the budget as is the case for Soultaniyeh, Beit Yahoun and Taybeh while for others it can reach up to 36% as is the case for Borj Qalaouiyeh. When calculated based on a cost-per-tonne basis, it was noticed that small

municipalities that generate small quantities of wastes incur relatively high expenses to manage their wastes. The cost per tonne for the management of solid wastes in the municipalities of Zone 4 varied between US$7.3 and US$164.4/tonne.

456. Figure 5-6 shows the unit costs of solid waste management incurred by the different municipalities of Zone 4 in 2017, which are plotted against the unit costs to be incurred for the proposed management system.

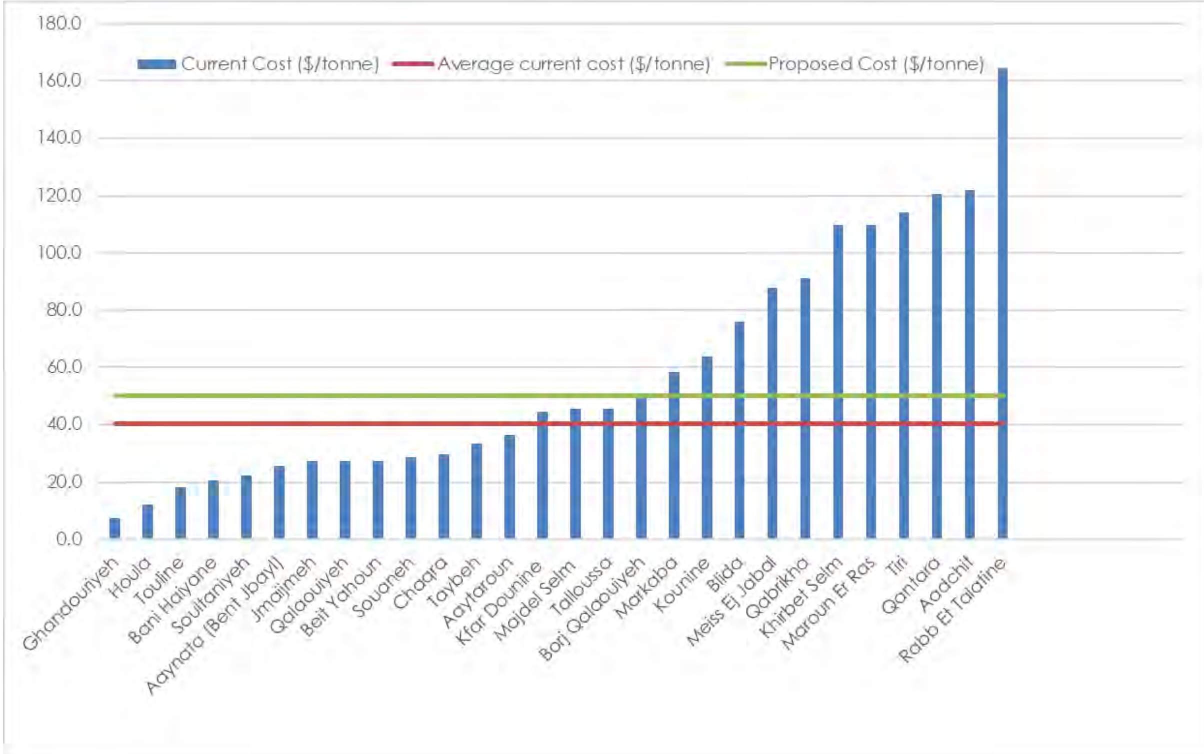


Figure 5-6. Current SWM Costs versus the Proposed Cost for Municipalities in Zone 4

457. The current average cost for the management of waste in the existing system was calculated to be US$40.4/tonne. When compared to the proposed SWM system for Zone 4 whereby waste will be collected and treated in a properly operated sorting and composting facility and rejects will be disposed of in a sanitary landfill (in Nabatiye complex and Bent Jbayl and Marjaayoun complex), the cost incurred becomes US$50/tonne (calculated on the basis of US$10/tonne for collection, US$25/tonne for treatment and US$15/tonne for landfilling). The proposed system will raise the expenses incurred by the municipalities from 1.8 Billion L.L. to 2.3 Billion L.L. per year. Some of these amounts will be secured through OMSAR from the national budget; however, municipalities and Union of municipalities have to cooperate together to secure the additional funding to cater for this deficit in order to be able to operate the system. The detailed cost calculations are shown in Appendix J, Table J-30.

5.1.5.5 Zone 5

458. The costs incurred for the current SWM system vary between the different municipalities in this zone. They constitute a large proportion of the budget of the municipalities. For some municipalities, the costs take up 7% of the budget as is the case for Qaaqaaiyet Ej Jisr while for others it can reach up to 70% as is the case for Borj Rahhal. When calculated

based on a cost-per-tonne basis, it was noticed that small municipalities that generate small quantities of wastes incur relatively high expenses to manage their wastes. The cost per tonne for the management of solid wastes in the municipalities of Zone 5 varied between US$5.9 and US$109.6/tonne.

459. Figure 5-7 shows the unit costs of solid waste management incurred by the different municipalities of Zone 5 in 2017, which are plotted against the unit costs to be incurred for the proposed management system.

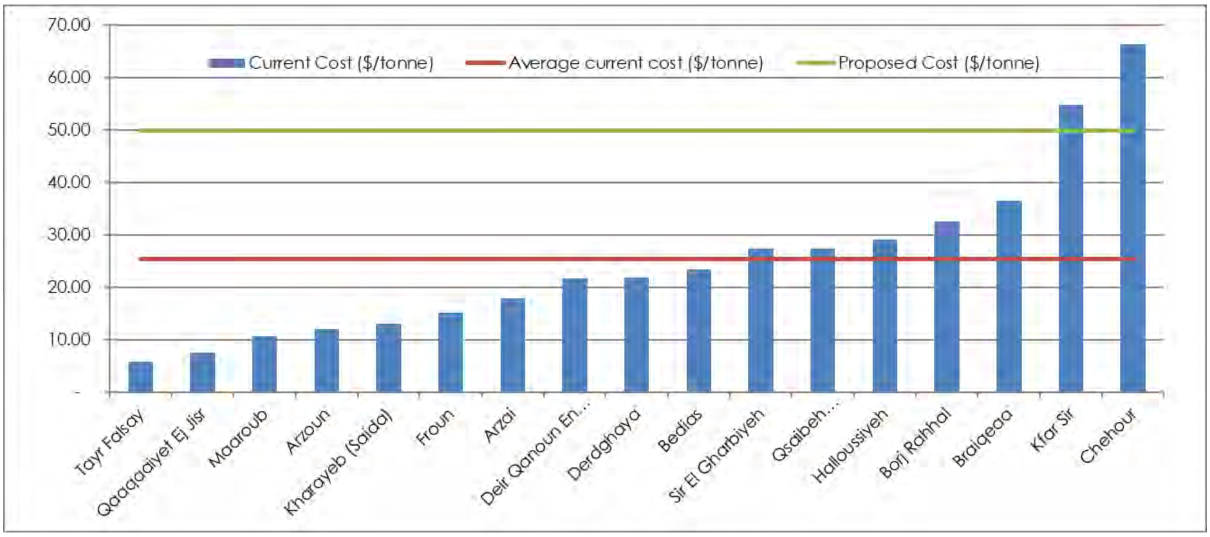


Figure 5-7. Current SWM Costs versus the Proposed Cost for Municipalities in Zone 5

460. The current average cost for the management of waste in the existing system was calculated to be US$26.1/tonne. When compared to the proposed SWM system for Zone 5 whereby waste will be collected and treated in a properly operated sorting and composting facility and rejects will be disposed of in a sanitary landfill (in Sahel El Zahrani complex and Ain Baal and Tyre sanitary landfill), the cost incurred becomes US$50/tonne (calculated on the basis of US$10/tonne for collection, US$25/tonne for treatment and US$15/tonne for landfilling). The proposed system will raise the expenses incurred by the municipalities from 1.6 Billion L.L. to 3.2 Billion L.L. per year. Some of these amounts will be secured through OMSAR from the national budget; however, municipalities and unions of municipalities have to cooperate to secure the additional funding to cater for this deficit in order to be able to operate the system. The detailed cost calculations are shown in Appendix J, Table J-31 and Table J-32.

5.2 WASTEWATER SECTOR

5.2.1 Municipal Wastewater

5.2.1.1 Existing Programs and Projects

461. The current infrastructure for collecting and treating municipal wastewater in the LLB Study Area is generally inadequate to safely handle the quantities generated and reduce its threat to the quality of surface and groundwater. Currently only 2 out of 95 localities have complete sewer network coverage, and 27 have partial coverage, ranging from 10% to 95%. The communities having partial or complete collection coverage represent 45% of the total estimated load. The remainder have no wastewater collection networks and therefore rely on cesspools.

462. The LLB Study Area is currently served by the following WWTPs – Aaytanit, Rihane, Aaychiyeh, Deir Mimas, Marjaayoun, Kaoukaba, Yohmor, Zaoutar, Kfar Sir, Wadi El Kfour, Tibnine, Qatrani (two private plants) and Sour. The operational status and treatment effectiveness, as well as actual treatment capacities of these plants are not reviewed or documented in this report. Yet, an assessment is needed to accurately reflect gaps and needed upgrades in order to tie in with, complement or restructure coverage in line with the existing master plans and Law No. 63/2016 programming.

Table 5-6. Wastewater Treatment Plants serving Villages within the LLB

Wastewater Treatment Plants	Latitude	Longitude
Aaytanit	33.545831	35.690327
Rihane	33.440566	35.547424
Aaychiyeh	33.407775	35.550646
Deir Mimas	33.303869	35.541517
Marjaayoun	33.349572	35.593014
Koaukaba	33.389266	35.647716
Yohmor (Nabatiye)	33.317915	35.507566
Zaoutar	33.316190	35.482816
Kfar Sir	33.311111	35.394889
Wadi El Kfour (Nabatiye)	33.410500	35.434806
Tibnine	33.200654	35.404948
Sour	33.298309	35.227656
Qatrani	33.430680 33.445743	35.599356 35.605833

463. Wadi El Kfour (Nabatiye) and Sour WWTPs are located outside the LLB, however serve villages within the LLB Study Area.

5.2.1.2 Prospective Programs and Projects

464. The current, most relevant and credible program for wastewater system establishment within the Study Area was decreed in 2016 with the passing of Law No. 63, and which allocated US$ 704.88 Million for capital investment in wastewater infrastructure in the entire Litani River basin to be implemented within seven years, i.e. by 2023. The funds for the

management of wastewater infrastructure are allocated to the Ministry of Energy and Water.

Table 5-7. Programmed Investments in Wastewater Infrastructure as per Law No. 63/2016

Programmed Measures	Allocated Funds	LLB Zone Applicability
Expansion of the Iaat Treatment Plant and collection networks in Baalbeck District	US$ 6.60 Million	-
Establishment of treatment plants and wastewater collection networks in North Bekaa	US$ 64.68 Million	-
Establishment of the East Zahle Treatment Plant and associated wastewater collection networks	US$ 34.32 Million	-
Completion of the wastewater collection networks in the city of Zahle	US$ 11.22 Million	-
Establishment of treatment plants in the southern areas of Central Bekaa (Zahle and West Bekaa districts)	US$ 82.50 Million	-
Expansion of the wastewater collection network in the Qaraaoun Lake area (West Bekaa district)	US$ 3.96 Million	1
Expansion of the service area of Sour Treatment Plant (aka Sour-2) to collect wastewater from coastal, inland and rural agglomerations	US$ 89.10 Million	5
Establishment of a wastewater treatment system in Halloussiyeh and collection networks for Halloussiyeh, Hmairi, Tayr Falsay and Halloussiyeh El Faouqa	US$ 7.43 Million	5
Establishment of a wastewater treatment system in Srifa and collection networks for Srifa, Bafley, Qala'et Maroun, Teffaheye, Niha and Deir Kifa	US$ 11.88 Million	5
Establishment of wastewater treatment systems for Wadi Slouki and collection networks in Froun, El Qoussair, Mazraat Azzi, Ghandouriyeh, Qantara, Deir Siriane, Aadchit, Taybeh, Aadaysseh, Rabb Et Talatine, Wadi El Slouki, Talloussa, Qabrikha, Bani Haiyane, Borj Qalaouiyeh, Touline, Khirbet Selm, Jmaijmeh, Majdel Selm, Markaba)	US$ 52.47 Million	4, 3, and 5
Establishment of a wastewater treatment system to serve the villages of Deir Mimas, Houra, and Kfar Kila	US$ 7.92 Million	3
Establishment of a wastewater treatment system in Sarafand to serve the coastal area between Qassmiyeh River and Zahrani River and inland reaching Zrariyeh, Ansar, El Nmairiyeh, and Deir El Zahrani	US$ 103.95 Million	5
Establishment of a wastewater treatment system in Braiqeaa to serve Braiqeaa, Qsaibeh, Qaaqaaiyet Ej Jisr, Jawhariyeh, Kfar Dajjal, Aadchit, Mayfadoun, Choukine, Jebchit, Harouf, Aaba	US$ 34.65 Million	5
Expansion of the service area of Nabatiye Treatment Plant (aka Nabatiye-2) to collect wastewater from Kfar Houz, Zebdine, Kfar Roummane, Midane, Nabatiye El Faouqa, Nabatiye El Tahta, Byad, Saray, Aqaide, Kfar Tibnit, Aali Et Taher and Mazali	US$ 47.52 Million	2 and 3
Establishment of a wastewater treatment and collection system for Nabaa Et Tasseh area to serve	US$ 27.72 Million	2

Programmed Measures	Allocated Funds	LLB Zone Applicability
Mazraat El Bayyad, Houmine El Faouqa, Jarjou', Arab Salim, Louaizeh, Mlikh, Aramta, Kfar Houneh		
Establishment of wastewater treatment and collection systems in El Aaychiyeh-Rihane to serve Rihane, Sejoud, Nabi Sejod and Aaichiyeh	US$ 5.94 Million	2
Establishment of wastewater treatment and collection system for Zilaya, Qelaya, Ain Et Tineh, Yohmor (B-G), Sohmor, Libbaya, Maydoun and Dellafi	US$ 15.35 Million	1
Technical studies and supervision	US$ 31.68 Million	All
Land Expropriation	US$ 66.00 Million	All

5.2.1.3 Proposed Responses to Pressures from Municipal Wastewater per Study Zone

5.2.1.3.1 Zone 1

1- Prepare the feasibility study, preliminary design, detailed design and construction documents for the wastewater treatment system and collection networks associated with the Zilaya WWTP service area, to serve 12,799 PE (2018 estimate). Construct, operate and maintain the wastewater treatment and collection system at Zilaya. Design and implement innovative means to finance and sustain the operation and maintenance of these sanitary systems.

2- Prepare the feasibility study, preliminary design, detailed design and tender documents for the wastewater collection networks and treatment system associated with the Majdel Balhis area, to serve 3,848 PE (2018 estimate) or 5,906 PE (2045 projected estimate). Construct, operate and maintain operations of the wastewater treatment and collection system at Majdel Balhis. While the Zilaya system is budgeted for through Law No. 63/2016, no budget is clearly allocated to the Majdel Balhis treatment system and associated networks.

5.2.1.3.2 Zone 2

1- Assess the coverage, operational status and treatment effectiveness of the Rihane and Aaychiyeh wastewater treatment systems. Establish networks in Sejoud and connect to the Rihane or Aaychiyeh plants. Construct, operate and maintain the operations of the wastewater treatment and collection system at Rihane-Aaychiyeh. The programming in Law No. 63/2016 allocated funds for the Rihane-Aaychiyeh wastewater treatment and collection systems.

2- Assess the feasibility of wastewater collection and treatment systems for the localities of Chbail, Mazraat Daraya, and Qatrani. It is noted that a private residential compound in Qatrani is served by two private wastewater treatment plants. These localities are not programmed for in Law No. 63/2016.

3- Assess the coverage, operational status and treatment effectiveness of the Marjaayoun Plant. Establish networks in unserved areas of Jdaideh, Dibbine, Blat, Bouyada, Qlaiaa and Borj El Mlouk and connect to the Marjaayoun Plant. The

Marjaayoun system is not programmed for in the Law No. 63/2016. Construct, operate and maintain operations of the wastewater collection system of Marjaayoun.

4- Assess the operational status and treatment effectiveness of the Kaoukaba Plant, and complete the network coverage in Kaoukaba. The treatment and collection systems in Kaoukaba are not allocated for in Law No. 63/2016.

5- Prepare the feasibility study, preliminary design, detailed design and construction documents for the wastewater treatment system and collection networks to serve 3,041 PE in Aaramta and Kfar Houneh (2018 estimate). These villages were to be served by Nabaa El Tasseh system which has allocated funding in Law No. 63/2016, but discussions with MoEW and CDR led to the understanding that these villages will be served by the Sarafand system. Construct, operate and maintain operations of the wastewater treatment and collection system at Sarafand.

6- Prepare the feasibility study, preliminary design, detailed design and construction documents for the wastewater treatment system and collection networks associated with Wadi El Jarmaq, to serve 249 PE in Jarmaq and annexed localities (2018 estimate). The Wadi El Jarmaq system does not have allocated funding in Law No. 63/2016. Construct, operate and maintain operations of the wastewater treatment and collection system at Wadi El Jarmaq. Wadi El Jarmaq would also serve parts of Kfar Roummane.

7- Prepare the feasibility study, preliminary design, detailed design and construction documents for the wastewater treatment system and collection networks associated with Srayri which is planned to serve Srayri, Dellafi, Bourghos and Qelaya from Zone 1 (1,471 PE as 2018 estimate). The Srayri system does not have allocated funding in Law No. 63/2016. Construct, operate and maintain operations of the wastewater treatment and collection system at Srayri.

5.2.1.3.3 Zone 3

1- Carry out the feasibility study, preliminary design, detailed design and construction documents for the collection networks in Kfar Roummane and Kfar Tibnit. Establishing the networks in these two localities as part of the Nabatiye wastewater treatment system is programmed in Law No. 63/2016. Assess the feasibility of establishing a network in Arnoun and connecting it to the Nabatiye Plant. While Arnoun is not covered by Law No. 63/2016, discussions with CDR and MoEW led to the understanding that Arnoun will be served by the Nabatiye system. Construct, operate and maintain operations of the wastewater treatment and collection system at Nabatiye.

2- Assess the coverage, operational status and treatment effectiveness of the Deir Mimas Plant, and assess the expansion of the network to Kfar Kila, Houra and Mazraat Doumiat. The Deir Mimas treatment and collection system has allocated funding through Law No. 63/2016. Construct, operate and maintain operations of the wastewater treatment and collection system at Deir Mimas.

3- Assess the feasibility of collection networks in Zaoutar El Gharbiyeh and Mazraat El Hamra and connection with the existing treatment plant in Zaoutar Ech-Charqiyeh or with Sarafand Plant. Servicing the locality of Zaoutar El Gharbiyeh is not earmarked for funding by virtue of Law No. 63/2016, however discussions with the CDR and MoEW led to the understanding that Zaoutar El Gharbiyeh could be serviced by the Sarafand system. Construct, operate and maintain operations of the wastewater treatment and collection system at Zaoutar.

5.2.1.3.4 Zone 4

1- Based on the feasibility study currently being prepared for the Qaaqaaiyet Ej Jisr wastewater system, discern the service areas of the Wadi Slouki and Braiqeaa wastewater systems that are allocated in Law No. 63/2016, and which is to be clarified in accordance with the current feasibility study under preparation.
2- Carry out the feasibility study, preliminary design, detailed design and construction documents for the collection networks in Maroun Er Ras, Aaytaroun, Blida, Kounine, Beit Yahoun, Mhaibib, Chaqra, Meiss Ej Jabal, Houla, Souaneh, and Qalaouiyeh, with the connection of these villages to the planned Qaaqaaiyet Ej Jisr Plant.
3- Establish wastewater collection networks in Tiri and Aaynata and connect them to the existing Bent Jbayl treatment plant. This action is not allocated funding in Law No. 63/2016.
4- Complete wastewater collection networks in Soultaniyeh and Jmaijmeh and connect them to the existing Tibnine treatment plant. This action is not allocated funding in Law No. 63/2016.

5.2.1.3.5 Zone 5

1- Expand the network coverage of the Sour wastewater treatment system, namely connecting the remainder areas of Maaroub, Borj Rahhal, Ain Abou Abdallah, Deir Qanoun En-Nahr, Jennata, Bedias, Arzoun, and new localities of Bestiyat, Derdaghaiya, Chehour, Sir El Gharbiyeh, and Kfar Dounine. Expansion of the network is allocated funding through Law No. 63/2016. The systems of Halloussiyeh and Srifa will be added to the Sour system as understood from discussions with CDR and MoEW, hence the network coverage for Sour will also be extended to include Halloussiyeh, Tayr Falsay, Hmairi and Srifa.
2- Carry out the feasibility study, preliminary design, detailed design and construction documents for the wastewater treatment system in Sarafand. Complete the networks in the two localities of Zrariyeh and Kharayeb which is programmed in Law No. 63/2016. Construct, operate and maintain operations of the wastewater treatment and collection system at Zrariyeh.
3- Verify the network status in Kfar Sir and connect the network to the existing Kfar Sir treatment plant. No allocated funding within Law No. 63/2016.

5.2.1.4 <u>Summary of Proposed Responses to Pressures from Municipal Wastewater</u>

465. The proposed responses are based on the analysis laid out in previous sections and the information on current and planned projects. It is clear that Law No. 63/2016 has laid out a wide program for infrastructure investments to address the incomplete coverage of sewage collection networks and treatment plants. A thorough assessment and municipal-

level surveying of coverage in this study revealed a few gaps some of which are referenced in feasibility studies subsequent to the Law No. 63/2016 and which have updated the studies upon which the Law was drafted.

466. The major challenges with wastewater infrastructure investments stem from technical and administrative difficulties in siting of facilities which lead to derailing the delivery of wastewater infrastructure projects, in addition to weak capacities in the implementation and successful conclusion of construction projects.

467. A major deficiency is the follow-up on the capital investments to successfully run the wastewater systems. There is a major deficiency in technical and administrative capacities to run or even supervise contractors running such facilities, at the level of central and regional administrations, coupled with chronic financial deficits, strained investment and maintenance budgets, and overall poor management of public funds. It is not unforeseen that capital investments in wastewater infrastructure may not lead to the envisaged benefits of reducing pollution loads in surface watercourses, given that operation and maintenance are largely overlooked, and often not supervised to the level needed. This technical, managerial and administrative gap is equivalent if not larger than the infrastructure investment gap, because it poses a great risk of rendering costly infrastructure investments ineffective and erodes public trust in public institutions.

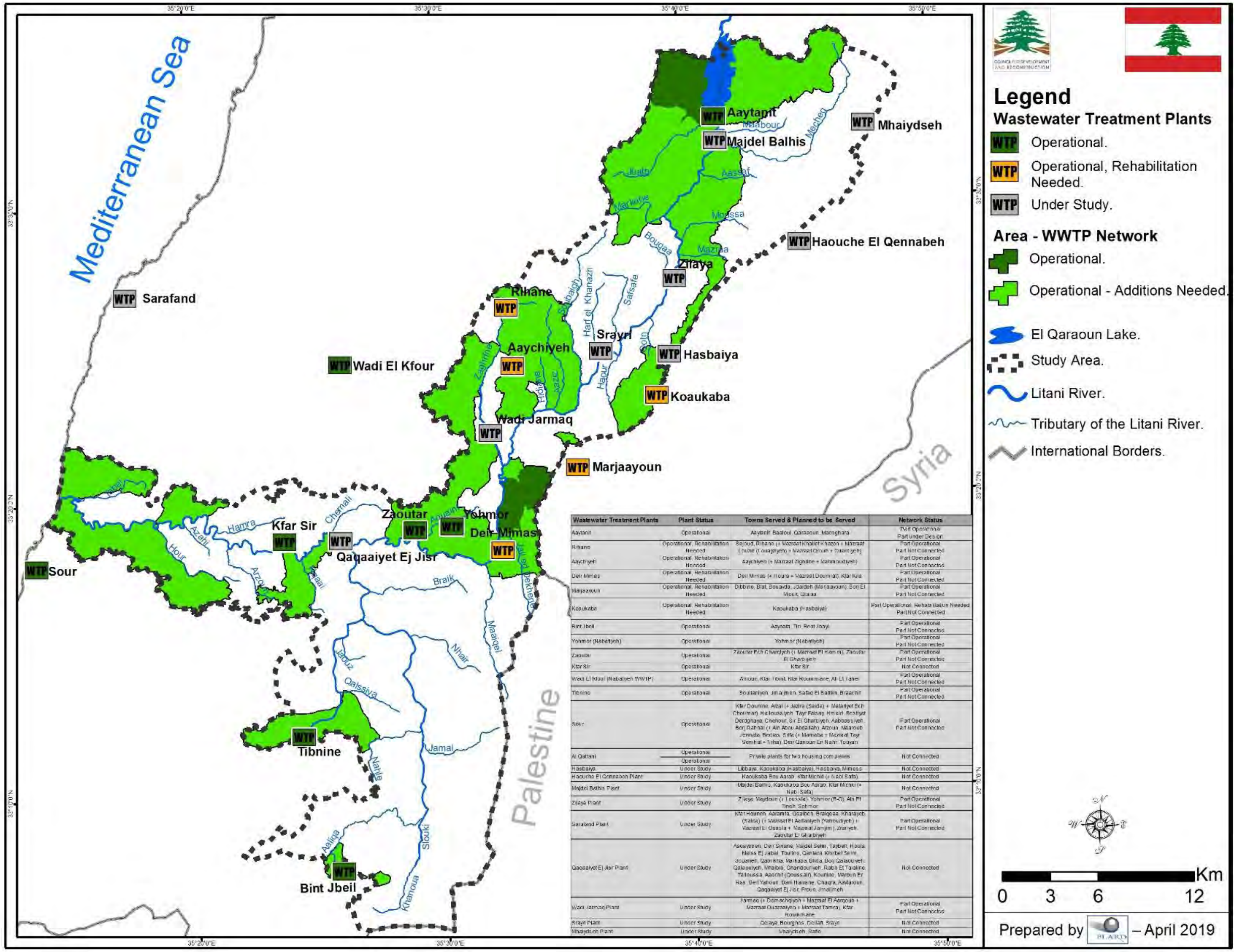


Figure 5-8. Current WWT Service Coverage and Gaps to be Addressed

Table 5-8. Proposed Infrastructure Investments in Wastewater Systems

Village	Zone	Sewer Network	Planned Discharge to New or Existing Plant	Population 2018 (#)	Population 2045 (#)	WW. Flows 2045 (m^3/d)	Network Length (km)	Investment required	
								Network	WWTP or Lifting Station
Libbaya	1	NO	Hasbaiya Plant	2,857	4,386	658	24.5	$2,500,000	
Majdel Balhis	1	NO	Majdel Balhis Plant	1,565	2,402	360	10.4	$1,090,000	$3,233,000
Kaoukaba Bou Aarab	1	NO	Majdel Balhis Plant (25%) & Haouche El Qennabeh Plant (75%)	1,320	2,026	304	8.2	$900,000	
Kfar Michki (+ Nabi Safa)	1	NO	Majdel Balhis Plant (25%) & Haouche El Qennabeh Plant (75%)	963	1,478	222	7.8	$850,000	
Qelaya	2	NO	Srayri Plant	835	1,282	192	7.7	$850,000	$7,918,000
Chbail	2	NO			0	0	2.8	$300,000	
Mazraat Daraya	2	NO			0	0	0.0	$0	
Qatrani	2	NO	Two private WWTPs (existing)	415	637	96	4.7	$500,000	
Kaoukaba (Hasbaiya)	2	50%	Kaoukaba Plant (existing) & Hasbaiya Plant	1,017	1,561	234	5.2	$275,000	
Jdaideh (Marjaayoun)*	2	70%	Marjaayoun Plant (existing)	6,086	9,342	1,401		$1,000,000	
Dibbine	2	NO	Marjaayoun Plant (existing)	1,660	2,548	382	7.5	$800,000	
Blat	2	NO	Marjaayoun Plant (existing)	1,065	1,635	245	11.1	$1,150,000	
Bouayda	2	NO	Marjaayoun Plant (existing)	169	259	39	2.1	$220,000	
Bourghos	2	NO	Srayri Plant	146	224	27	3.6	$390,000	
Dellafi	2	NO	Srayri Plant	290	445	53	2.3	$250,000	
Srayri	2	NO	Srayri Plant	200	307	37	3.4	$360,000	
Jarmaq (+ Demachqiyeh + Mazraat El Aarqoub + Mazraat Ouazaaiyeh + Mazraat Tamra)	2	NO	Wadi El Jarmaq Plant	249	382	46	6.5	$700,000	$1,300,000

Village	Zone	Sewer Network	Planned Discharge to New or Existing Plant	Population 2018 (#)	Population 2045 (#)	WW. Flows 2045 (m^3/d)	Network Length (km)	Investment required	
								Network	WWTP or Lifting Station
Yohmor (Nabatiye)	3	30%	Yohmor Plant (existing)				26.3	$1,890,000	
Zaoutar Ech-Charqiyeh (+ Mazraat El Hamra)	3	50%	Zaoutar Plant (existing)	5,573	8,555	1,283	20.2	$1,025,000	
Aaynata	4	NO	Bent Jbayl Plant (existing)	4,290	6,585	988	32.8	$3,500,000	
Soultaniyeh	4	80%	Tibnine Plant (existing)	4,171	6,403	960	26.4	$540,000	
Kfar Sir	5	NO	Kfar Sir Plant (existing)	2,239	3,437	516	27.0	$2,800,000	
						Total Investment =		**US$ 34,341,000**	

5.2.2 Industrial & Healthcare Wastewater

5.2.2.1 Existing Programs and Projects

468. The MoE has set up Lebanon Environmental Pollution Abatement Project (LEPAP) that aims to assist Lebanese industrial companies to reduce pollution and comply with the Lebanese Environment Protection Law No. 444/2002 through providing them with technical assistance and subsidized loans to invest in end-of-pipe treatment and pollution prevention.

469. The objective of LEPAP is to reduce industrial pollution in targeted industrial enterprises and to strengthen the monitoring and enforcement capabilities of the Ministry of Environment. LEPAP is a joint initiative between the MoE, the Ministry of Finance, Banque Du Liban (BDL), the World Bank and the Italian Cooperation to set up a mechanism for financing the abatement of industrial pollution in targeted industrial enterprises and to provide necessary technical assistance for ensuring the implementation and the sustainability of these interventions.

470. LEPAP provides close to zero interest rate loans for eligible industrial enterprises to implement industrial pollution abatement interventions. LEPAP also offers free technical assistance to comply with national regulations and acquire the technical approval on the loan application.

471. Industries in the Lower Litani River basin can benefit from such a project through the assistance offered in terms of environmental auditing and technical support to be able to access LEPAP loans.

5.2.2.2 Prospective Programs and Projects

5.2.2.3 Proposed Responses to Pressures from Industrial & Healthcare Wastewater per Study Zone

472. The majority of the wastewater generating industries in the Lower Litani River catchment have small production scales and cannot afford to treat their wastewaters individually because of space constraints and financial limitations. According to the MoE Decision No. 8/1/2001, industries are required to abide by wastewater discharge standards into the sewer system. To achieve this, industries are required to (pre-) treat their industrial effluents to reduce the pollution load to an acceptable level so that the wastewater can be further treated in a biological treatment plant. The degree of (pre-)treatment needed varies from one industry to the other. It may be necessary in certain cases to provide effluent neutralization before discharge into the sewer system while in others, complex (pre-)treatment involving dissolved air flotation, chemical-physical treatment or anaerobic/aerobic treatment is needed.

(Pre-)treatment of industrial effluents belonging to the Priority Groups of industries

473. The adoption of (pre-)treatment technologies at industry-level is highly recommended. The estimation of the costs of such an initiative requires detailed study given the various scales and different production processes of the industries operating in the study area.

474. Different (pre-)treatment technologies could apply and that would match the profile of the manufacturing processes in operation in the area of study. (Pre-)treatment plants use the same technologies as wastewater treatment plants to achieve the requirements. The (pre-)treatment technologies to be adopted depend on the concentration and characteristics of the generated wastewater. Table 5-9 shows the recommended (pre-)treatment measures corresponding to major manufacturing processes present in the study area.

Table 5-9. (Pre-)treatment Technologies Corresponding to Different Manufacturing Processes Present

Manufacturing Process	Pollutants in Wastewater	(Pre-)treatment Measures
Agro food		
Dairy	pH, BOD, COD, oil and grease, TSS	Screening, Equalisation and neutralisation, Dissolved Air Flotation, followed by biological treatment (aerobic or anaerobic) and sludge dewatering
Bakeries and sweets	Wash waters high in BOD, oil and grease, TDS	Screening, Equalisation and neutralisation, Flocculation, Dissolved Air Flotation
Olive pressing	BOD, COD, oil and grease, TSS	Screening, Equalisation and neutralisation, lime pre-treatment followed by biological treatment and sludge dewatering Evaporation ponds where land is available can also be adopted, but due to the nature of the terrains, this solution was not considered
Stone and marble cutting	TSS, Turbidity	Screening, Gravity thickener, Filter press

475. Following the categorization and prioritization of industries within the study area, the volume of wastewater discharged by the wastewater-generating industries that belong to Priority Groups 1 and 2 were determined. In the absence of primary data, available data from previous audits or site surveys to other similar industries were used to estimate the flows. Data were mainly available from the following studies/reports:

- Business Plan for Combatting Pollution of the Qaraaoun Lake (ELARD, 2011),
- Industrial sector reports for the improvement of solid and liquid waste management (MSC-IPP, 2005),
- Hazardous Waste Management Report (ERM, 2002),
- Olive oil pressing industries survey (UNDP, 2007),
- Personal communication with LEPAP project personnel and review of LEPAP developed guidelines for specific industrial sectors.

476. Once the volumes of industrial effluents were estimated, the characteristics of the effluents were evaluated and a (pre-)treatment measure was proposed for each type of industry. In some cases, as in the case of olive mills and rock cutting industries, grouping of the effluents in one (pre-)treatment unit in one of the existing industries is recommended as more economically feasible, due to the short distance between these industries. The other industries will need to transport their waste to such a (pre-)treatment facility when needed and have to share investment and operation and maintenance costs for such facilities.

477. The investment costs for the suggested (pre-)treatment were estimated based on updated cost data from the Business Plan for Combatting Pollution of the Qaraaoun lake (2011).

478. Table 5-10 and Table 5-11 show the results of the cost for the (pre-)treatment of industrial effluents for Priority Groups 1 & 2. The cost estimates apply to the Priority industries which apply wet manufacturing processes, and comprise (pre-)treatment costs, annual O&M costs and costs of studies to guide the technical implementation of (pre-)treatment options.

Table 5-10. Cost Estimate for the (Pre-)treatment of Effluents from Priority 1 Industries

Zone	Priority 1 industries	Wet processes (discharging wastewater effluents)	(Pre-)treatment Cost (US$)	O&M cost (US$)	Studies' cost (US$)
Zone 1	7	Olive Mill (6), Stone Cutting (1)	330,000	49,500	30,000
Zone 2	1	Dairy industry (1)	60,000	9,000	5,000
Zone 3	3	Olive Mill (3)	155,000	23,250	12,000
Zone 4	1	Olive Mill (1)	65,000	9,750	5,000
Zone 5	9	Olive Mill (6), Stone cutting (3)	520,000	78,000	47,000
Total	**21**		**1,130,000**	**169,500**	**99,000**

Table 5-11. Cost Estimate for the (Pre-)treatment of Effluents from Priority 2 Industries

Zone	Priority 2 industries	Wet processes (discharging wastewater effluents)	(Pre-)treatment Cost (US$)	O&M cost (US$)	Studies' cost (US$)
Zone 1	4	Olive Mill (3), Stone cutting (1)	270,000	40,500	27,000
Zone 2	0	None	0	0	0
Zone 3	8	Olive Mill (8)	365,000	54,750	30,000
Zone 4	8	Olive Mill (6), Stone cutting (1), Dairy industry (1)	450,000	67,500	36,000
Zone 5	5	Olive Mill (3), Stone cutting (1), Chocolate industry (1)	285,000	42,750	25,000
Total	**25**		**1,370,000**	**205,500**	**118,000**

479. An initial investment of US$2.5 Million would be needed for the (pre-)treatment of effluents from Priority Groups' industries. In some cases where industries of similar types (such as olive mills and stone cutting) are close to each other, it was possible to account for a single (pre-) treatment facility for the combined effluents in order to save on the initial investment needed.

480. With respect to Operation and Maintenance of such facilities, an annual budget equivalent to 10-15% of initial investment costs would be needed. All of these costs are to be borne by the industries themselves. A one-time cost of studies of US$217,000 would also accrue and was estimated based on the size of the industries.

481. The detailed cost estimation analysis for Priority Groups' industries including industry ID, location, type of products, size category, estimated WW flow, effluent characteristics, pre-

treatment process and costs are presented in Appendix J, Table J-33, Table J-34, Table J-35, Table J-36, and Table J-37.

482. **After pre-treatment**, industries can discharge their diluted wastewater effluents in the sewer network where a combined effluent is generated after mixing with domestic effluent from the same region. The combined effluent is proposed to be treated in the municipal wastewater treatment plants that are planned for the region thereby offering the following advantages:

- Highly-concentrated industrial wastewaters are diluted;
- Microorganisms are continuously seeded;
- Better control over treatment plant is possible than if sewage is treated in a separate plant; and
- Sewage provides nitrogen and phosphorus as nutrients to the microorganisms which treat industrial wastewaters that are deficient in these elements.

(Pre-)treatment of healthcare wastewater

483. The basic underlying principle of effective healthcare wastewater management is to strictly limit the discharge of hazardous liquids to sewers (WHO, 2014). It is important to apply segregation, waste minimization and safe storage to liquid waste as it would be applied to solid waste.

484. The preferred method is to connect the healthcare sewage system to the municipal sewage system and to discharge healthcare wastewater after adequate pre-treatment to the municipal sewer if the municipal sewage treatment plant meets the following minimum requirements (WHO, 2014):

- Use of primary, secondary and tertiary treatment
- Removal of >95% of bacteria
- Treatment of sewage sludge by anaerobic digestion to destroy helminth eggs to <1 egg per litre
- Compliance with local regulatory requirements for discharge of treated effluent into surface water

485. The healthcare establishment should ensure that its waste management effectively prevents the discharge of significant quantities of toxic chemicals, pharmaceuticals, radionuclides, cytotoxic drugs and antibiotics in the drains, whereby (UNDP/GEF):

- Chemical and pharmaceutical wastes such as photographic chemicals, aldehydes, colorants and antibiotics should not be discharged directly into the sewer drain
- Hazardous liquids originating from the medical laboratory should undergo acid-base neutralization, filtration and sedimentation or autoclaving
- Excreta during an outbreak should undergo decontamination with lime milk (hydrated calcium oxide or calcium hydroxide)
- In the dental department, installing amalgam separators in sinks is required, and the separated mercury waste must be safely stored

- Wastewater from the radiotherapy department should involve separate collection of radioactive wastewater and storage for their decay in a secured die-away basin until background concentrations have decreased, then after the required storage time would have passed, the wastewater can be disposed of in the sewer system
- A grease trap to remove grease, oil, and other floating materials from the kitchen

486. Where healthcare establishments are not connected to any municipal wastewater treatment plant, on-site treatment of wastewater shall be applied as follows (WHO, 2014):
    - Primary treatment
    - Secondary biological purification
    - Tertiary treatment, e.g. lagooning or rapid sand filtration to reduce the concentration of suspended organic matter to less than 10 mg/L
    - Chlorine disinfection, using chlorine dioxide, sodium hypochlorite or chlorine gas, or UV light disinfection, where disinfection of the effluents is particularly important if the discharge is being done to shellfish habitats
    - Sludge treatment can be achieved through anaerobic digestion to ensure thermal elimination of most pathogens. On-site treatment of hospital sewage will produce a sludge that contains high concentration of helminths and other pathogens. Sludges from hospital cesspools should be dehydrated on natural drying beds and disinfected chemically, e.g. with sodium hypochlorite, chlorine gas, or preferably chlorine dioxide. Alternative treatment could be natural drying beds then incineration with solid infectious healthcare waste.
    - In the event of reuse of wastewater and sludge in agriculture and aquaculture, the treated wastewater should contain no more than 1 helminth egg per litre and no more than 1000 faecal coliforms per 100 mL if it is to be used for unrestricted irrigation. Treated sludge should contain no more than 1 helminth egg per kilogram and no more than 1000 faecal coliforms per 100 g. Sludge should be applied to fields in trenches and then covered with soil.

487. Sewage from healthcare establishments should never be used for agricultural or aquaculture purposes. Sewage should not be discharged into natural water bodies that are used to irrigate fruit or vegetable crops, to produce drinking water, or for recreational purposes

488. Non-hazardous chemicals such as syrups, vitamins or eye drops and small quantities of blood and rinsing liquids from surgical theaters can be discharged in the sewer system without pre-treatment. Blood can be discharged in the sewer as long as the organic loading does not require its pretreatment. The UK National Guidance for Healthcare Wastewater Discharges (2014) provides a detailed guidance on the wastewater streams that can be acceptable to discharge into the sewer drain. The decision however ultimately rests with the regulator and wastewater treatment provider based on the capacity of the treatment system to adequately treat the wastewater loads from hospitals.

489. Common parameters for monitoring effluent quality are temperature, pH, TSS, BOD5, COD, Nitrate, Total phosphorus, and E. coli (WHO, 2014).

5.3 CLASSIFIED AND NON-CLASSIFIED ESTABLISHMENTS

490. The major pressures from classified and non-classified non-industrial establishments are a result of their poor observance of common and obvious minimum standards of public hygiene, including pre-treatment of their effluents and segregation of hazardous from non-hazardous wastes. As summarized in the legal section, environmental guidelines for non-classified establishments are available, however poor enforcement and supervision from local authorities for the compliance with rules, regulations and permit conditions have led to widespread infringements, non-compliance and negligence.

491. As it is the responsibility of local authorities to ensure these establishments are observing the environmental guidelines for operation, capacity building to inform and train local officials and police is needed on environmental regulations.

492. Other measures include trade-focused media events and targeted technical assistance by trade/industry sector in order to raise awareness of small businesses on simple public hygiene and resource conservation measures that could help reduce the pollution load from these establishments.

5.4 QUARRIES

493. Numerous measures and legal action were taken to circumvent the damages of quarrying activities and sand washing especially as the flows from quarrying sites have repeatedly caused interruption to water supply from the downstream water pumping and treatment plants.

494. The activation of environmental prosecutors has spurred the litigation of cases related to environmental damages, and working by the principle of polluter pays. It is imperative however to ensure that economic activities of private agents are not suspended indefinitely if the documents and procedures for extraction are carried out as per the text of the law and numerous guidelines issued by the MoE.

495. In the matter of quarrying, the only proposed measure is the application of the law, to ensure quarrying activities do not cause undue harm to third parties, and to the river ecology.

5.5 RECREATIONAL ESTABLISHMENTS

496. Recreational establishments, including restaurants, swimming pools and resorts, are a key activity in the Lower Litani. Yet, it is their poor regulation, in terms of number, encroachments on the river course through built structures or disposal practices that can create the pressure on the quality and flow regime of the river water.

497. It is important to raise the point that the river has a public domain, however its exact delineation or width in the case of the Lower Litani requires clarification among the DGUP, MoEW and LRA, to determine whether recreational establishments are infringing public property rights through built structures and appropriating the river embankments.

498. Through various warnings and regulatory enforcement campaigns, several resorts and riverside recreational facilities installed wastewater treatment systems and septic tanks.

499. Building on field observations and stakeholder communications, it is proposed that the following additional measures be followed:

1- Establish guidelines and operational parameters for recreational facilities of various sizes and activities to follow in the management of wastewater and solid waste

2- Observe implementation of these measures through a discharges custody process whereby facilities are required to contract waste and wastewater collection services to transport their waste and wastewater to the nearest processing facilities, with records maintained and compliance enforced by municipalities

3- Implement a strict no discharge policy of solid waste, anti-littering and wastewater into river water, and apply a penalty system

500. On the planning level, it is imperative that:

1- The public domain on river embankments be defined through topographic surveying and correct interpretation of legal texts on a case-by-case basis

2- Application of rules for setback distances where these apply by requesting and then enforcing demolition of built structures that are encroaching on the public domain and river/tributary courses, especially where these change the river flow regime.

5.6 INFORMAL TENTED SETTLEMENTS

501. Although the pressure level from ITS in the LLB Study Area is considered low, it is imperative that the sanitation and waste management conditions of these ITS are checked to ensure that waste and wastewater discharges are properly directed to the formal and existing collection and treatment systems.

502. Reports about ITS infringing on the property rights of irrigation water canals in the South and directly discharging wastes into the canals have led to wide complaints and conflicts among public administrations and with donor organizations. It is the responsibility of relief agencies to ensure that ITS are abiding by the national and local legislation and to coordinate the efforts with local authorities and governmental agencies to avoid creating a burden of waste cleanup and property rights infringements.

5.7 AGRICULTURE SECTOR

5.7.1 Existing Programs and Projects

503. Several current projects in the agriculture sector that are related to integrated pest management (IPM) and sustainable agriculture were identified. These are:

Lebanon Country Programming Framework (CPF) by FAO

504. Lebanon Country Programming Framework (CPF) 2016-2019 addresses particularly the priorities identified under the Ministry of Agriculture (MoA) Strategy 2015-2019 as well as the LCRP/Food Security Strategic Response Plan 2016. The CPF is organized around two major government priority areas: Government priority one "Expand economic and livelihood opportunities benefiting local economies and the most vulnerable communities", and Government Priority two "Improve performance of the agricultural

sector contributing to the economic, social, environmental and sustainable rural development".

505. Lebanon Country Programming Framework 2016-2019 focuses on seven areas.

Area 1. Food security and resilience of the agricultural sector

Area 2. Sanitary, phytosanitary and food safety

Area 3. Food security and nutrition information

Area 4. Sustainable agricultural production

Area 5. Sustainable natural resources management

Area 6. Data and policy support in agriculture including strengthening of social protection systems

Area 7. Agricultural value chains development

506. This CPF-Lebanon 2016–2019 identifies the total resource requirements for its implementation to around US$48.5 million of which US$6.5 million are currently available. An additional amount of US$0.8 million could be made available under the Technical Cooperation Programme (TCP) and TCP facility resources. Thus, the estimated requirements of voluntary contributions amount to a total of around US$41.2 million over the next four years. FAO is actively engaging with all resource partners in supporting its programme implementation through bilateral and multilateral channels and trust funds especially with the European Union (EU), the Global Environment Facility (GEF), IFAD, the World Bank (WB), Belgium, Canada, Germany, Ireland, Italy, Japan, Norway, Sweden, Switzerland, and the United Kingdom.

Promotion of Good Agricultural Practices, including Integrated Pest Management, to reduce agrochemical pollution in Upper Litani Basin

507. The Food and Agriculture Organization of the United Nations (FAO) is currently implementing a unilateral trust fund project entitled "Promotion of Good Agricultural Practices, including Integrated Pest Management, to reduce agrochemical pollution in Upper Litani Basin". The Project is implemented by FAO in close collaboration with the Ministry of Agriculture and the CDR. The project responds to the increased pollution of the Qaraaoun Lake. It addresses the negative impact caused by the excessive use of agro-chemicals, especially fertilizers in the Upper Litani Basin on the pollution of the Qaraaoun Lake.

508. The project aims at reducing the Litani River and Qaraaoun lake water pollution from agrochemicals by adopting sustainable crop production systems in the Upper Litani basin through introduction and promotion of Good Agricultural Practices (GAP) including IPM in the project area.

509. The main objectives of the proposed project are to:

a) Reduce the total amount of agro-chemicals used by farmers in the Upper Litani Basin and Qaraaoun Lake area,

b) Assess and analyze the current agricultural practices and farmers' (men and women) roles and knowledge in the project area, and develop GAP, including IPM, programmes,

c) Build the capacity of the MoA professionals/facilitators, other stakeholders and farmers in GAP and IPM, and

d) Test and implement GAP practices including IPM programmes at the farm-level.

510. The project started in 2018 and will extend for four years with a budget of US$1.5 Million.

IPM-4-Citrus, Citrus disease Integrated Pest Management: from Research to Market

511. IPM-4-Citrus aims to strengthen collaboration between academic and non-academic partners based in three European Member States (France, Germany and Italy), two Associated Countries (Turkey and Tunisia) and 1 Third Country (Lebanon), in order to develop a new bio-pesticide active against citrus pests and scale it up from lab to market. The project's research and innovation activities are based on a multidisciplinary approach, which aims at understanding and sensitizing stakeholders about the health risk factors related to citrus pests and their treatment by chemical pesticides and developing an alternative IPM approach based on biological control. *Bacillus thuringiensis* (Bt) based bio pesticides occupy almost 97% of the world's bio pesticide market and their use was estimated to exceed 30,000 tons. Despite this widespread use, the originality of Citrus-IPM is to focus on two promising, newly identified strains (Bt kurstaki BLB1 and LIP), which were shown to be more efficient than the commercial (Bt kurstaki HD1). In conjunction with validation through field tests, the project will pave the way for future commercial exploitation of a new bio-pesticide product by drawing up a feasibility study for future spin-off activities and/or new production lines in partner SMEs. Staff secondments and inter-sector and international mobilities between complementary partners will represent a unique opportunity to optimize bio-production processes and obtain high added-value citrus bio-products, such as limonene as solvent; orange peel bio-colorant; flavonoids; pectin, fermentable sugars, etc. while building up the partners' skills and reinforcing the training of early-stage researchers through knowledge sharing and networking. Inter-sectors mobility will bring SMEs and researchers to work jointly on conditioning procedures for field tests, impact evaluation and product maturation/exploitation. The project will also adopt a concrete RRI approach by favoring public engagement and informal education through the different outreach activities aimed at a variety of target groups.

512. This project is in collaboration with Saint Joseph University (USJ) in Lebanon and extends from 2017 till 2021 with a budget of 801,000 euros.

ENPARD SOUTH – European Neighborhood Programme for Agriculture and Rural Development

513. ENPARD is a political initiative launched by the European Union in 2011 aiming to strengthen the partnership between the EU and the neighborhood countries concerning agricultural and rural policies. This mutual commitment affirms the socio-economics of agriculture and rural areas in ensuring a balanced and sustainable development of these countries and stability in the region.

514. The CIHEAM-IAMM was called in 2012 by the European Commission to support the implementation of the initiative in the EU Mediterranean neighborhood and pilot the ENPARD South support program. The first phase of three years involved six pilot countries: Algeria, Egypt, Jordan, Lebanon, Morocco and Tunisia. A new contract was signed to continue this support program for a period of two and a half years in July 2015. This second phase extends the initiative to all the Mediterranean countries and focuses on regional activities. The purpose is to promote the exchange of experience around the challenges of Mediterranean agriculture and rural areas development and policies to be implemented under a common issue: «What are the policies needed to support farmers and rural populations?».

515. The project extends from 2012 till 2018 with a budget of 4 Million euros.

516. The ENPARD South support program team organized a workshop on the good use of pesticides and integrated agricultural production in Lebanon on 21 and 22 October 2017 in Beirut in cooperation with the Ministry of Agriculture. This event is a continuation of the activities and work conducted in Lebanon on the good agricultural practices and its application.

5.7.2 Prospective Projects

517. Canal 800 is planned to provide water from the Qaraaoun Lake to irrigate the agricultural highlands between 250 to 800 m a.s.l. in Southern Lebanon in addition to providing drinking water for about 100 villages. Phase 1 of this project is currently under development and will be completed in 2-3 years. It consists of 73 km of canals and 20 terminal reservoirs with a total storage of 160,000 m^3. Phase 2 will follow to develop an irrigation network system serving around 14,700 ha.

518. The project is financed through two available loans, the first provided by the Arab Fund for Economic and Social Development (AFESD) and the second by the Kuwait Fund for Arab Economic Development (KFAED).

519. In November 2017, a TOR was prepared for the development of an executable plan of Phase 2. Canal 800 will be under the authority of LRA.

520. The CDR signed a contract with the UNDP to execute the Hydro Agricultural Development Project for Marjaayoun area funded by the Spanish government through the Lebanese Recovery Fund (LRF). The project will lay down the infrastructure for the irrigation water distribution network which will link the Canal 800 Litani water conveyor with the Marjaayoun area, one of 12 areas benefiting from the construction of the Canal 800. The project will also provide technical assistance in modern irrigation techniques and agriculture.

5.7.3 Proposed Responses to Pressures from Agriculture

521. Proposed responses to tackle pollution from agricultural practices are general and apply to all zones. Two types of responses are proposed: farm-level and central planning-level for pesticides and fertilizers separately. In addition, measures to assess land degradation (forests, rangeland, quarries, agricultural land, etc.) are proposed as a pre-requisite to their rehabilitation.

5.7.3.1 Pesticides

5.7.3.1.1 Proposed Responses at Farm level to Reduce Pollution from Pesticides

522. The proposed solutions fall under the general title of Good Agricultural Practices. Such practices need to be introduced to farmers through targeted training programs, which are proposed to address the following:

1- Use of non-chemical practices such as introducing biological agents that help in the prevention of pests and diseases.

2- Promotion of organic control practices where and when applicable.

3- Application of pest and disease monitoring techniques where available (e.g. Pheromones, sticky traps...).

4- Storage and use of agrochemicals according to legal requirements of registration for individual crops, rates, timings, and pre-harvest intervals.

5- Prevention of spreading of harmful organisms using field sanitation and hygiene measures and through removal of affected plants or plant parts and regular cleansing of machinery and equipment.

6- Application of pesticides only when threshold values indicate that pesticide use is justified.

7- Keeping of a field book at the level of the farm in which accurate records of agrochemicals used and time of application are logged.

8- Practicing crop rotation and inter-cropping.

9- Use of hand-weeding and trap crops where possible.

10- Use of resistant cultivars and varieties.

5.7.3.1.2 Proposed Responses at the Central Planner's Level

523. Monitoring and control of pesticide use at the central level is also required. Such measures necessitate the mobilization of research capacities to better inform the decision makers on specific actions required. In broad terms, the proposed responses from the central planner's part could involve the following:

1- Promotion of Integrated Pest Management on a national level by developing national IPM policies and improved IPM concepts and practices. These should be based on scientific and other strategies that promote increased participation of farmers, extension agents and on-farm researchers. This should be done in the presence of stakeholders, including farmers and farmer associations, IPM researchers, extension agents, food industry representatives, environmentalists and representatives of consumer groups.

2- Pesticide risk reduction awareness through regulatory control of the distribution and use of pesticides. This implies restricted availability of products of hazardous nature. A re-registration procedure to ensure the periodic review of pesticides would ensure that prompt and effective measures can be taken if new information or data on the performance or risks indicate that regulatory action is needed. A well-functioning pesticide registration scheme by the MoA would be of major help.

3- Pesticide traders should pay special attention to the choice of pesticide formulations and to presentation, packaging and labelling in order to reduce risks to users and minimize adverse effects on the environment.

4- Updating of data collected and proper analysis to determine the fate of pesticides and environmental effects under field conditions. This is done through periodic review of the pesticides used in the catchment, the updated acceptable uses and their availability in retailing stores. The collection and recording data on the import, export, manufacture, formulation, quality, quantity and use of pesticides are required to inform future assessments of any possible effects on human health or the environment from pesticide use.

5- Create incentives in favor of IPM and organic products through removal of direct or indirect subsidies for pesticide use, tax exemption for environmentally friendly pesticides.

6- Creation of market demand for agricultural produce that is less likely to contain pesticide residues.

7- Extension and promotion of farmers' education on proper pesticide uses which include, reading, understanding and following label instructions, selection, calibration and maintenance of application equipment to prevent overuse due to inefficient application techniques, respecting pre-harvest intervals or re-entry intervals, proper pesticide storage and disposal of empty containers and leftover products.

8- Monitoring water quality for irrigation, as well as periodic soil testing for pollutant accumulation (pesticides and fertilizers)

9- Setting up demostration plots in several areas of the LLB for capacity building and training on GAP including IPM

10- Setting up a pilot project for "Empty Pesticide Containers Management System" in order to collect and properly dispose of pesticide containers as well as obsolete stocks in order to reduce pollution of water and soil.

5.7.3.2 Fertilizers

524. The following measures fall under best management practices for water and fertilizers hence reducing the risk of negative impact of on-farm practices on the environment.

5.7.3.2.1 Proposed Responses at Farm level to Reduce Pollution from Fertilizers

1- Application of irrigation water quantities and scheduling of irrigation based on crop water requirement, soil water holding capacity and irrigation water quality.

2- Guidance to the farmers on the application of recommended doses of fertilizers at appropriate and regular times suited to the nutrient requirements of the crop at various growth stages and in the desired manner, coupled with improved agronomic practices tailored to meet the specific agro–soil–climate situation.

3- Promotion of soil and plant tissue testing as a useful tool for assessing plant nutrient needs.

4- Guidance on proper fertilizer selection.

5- Introduction of nitrification inhibitors which are compounds that modify the rate at which N transformations occur in the soil, thus giving plants more chance to absorb the nutrients. Urease inhibitors slow the conversion of urea to ammonium nitrogen, and nitrification inhibitors slow the conversion of ammonium nitrogen to nitrates that can be leached easily.

6- Introduction of fertigation whereby a fertilizer injector is installed with the sprinkler or drip irrigation system thus allowing for fertilizer introduction in 10–15 split applications during the growing season.

7- Spraying of foliar fertilizers as supplementary nutrient sources, mainly to supply micronutrients.

8- Use of sources of organic materials that are available (manure, composted plant residues, etc.) to improve soil structure, water and nutrient holding capacity and soil fertility.

5.7.3.2.2 Proposed Responses at the Central Planner's Level

1-Awareness raising on the negative environmental impacts of traditional fertilization (Overuse of fertilizers and impacts, suggested alternatives to traditional practices).

2- Extension and promotion of farmers' education on proper fertilizer uses and plant nutrition.

3- Creation of conservation buffer zones to manage soil, water and nutrients for sustainable agricultural production, while minimizing environmental impact.

4- Creation of Nitrate Vulnerable Zones (NVZs) along river embankments and imposing limits on fertilizers use to reduce the harmful effects of pollution from nitrate. This is primarily necessary from an environmental impact perspective, but can also be beneficial for the farmer where measured nitrogen input may result in economic gains. Fertilizer is a valuable resource and wastage will have direct financial implications, particularly where additional purchases of fertilizer will need to be made. Through increasing the precision of applications of nitrogen, particularly with regard to better accounting for the nutrient value in applied fertilizers, it is possible to lower overall fertilizer costs for individual farm businesses, whilst simultaneously limiting environmental impact." (Stiles, 2016; DEFRA, 2016; Macgregor *et al.*, 2016; UKEA, 2017)

5.7.3.3 Assessment of Degraded Land for Rehabilitation Purposes

525. Poor land management and the lack of land use master plans covering all areas are the cause behind land degradation in many areas and the over-exploitation of natural resources in Lebanon and partuclarly in the Lower Litani Basin. The influx of refugees since 2011 has increased the pressure on land and natural resources. Hence the need for an assessment of land degradation in the LLB for the purpose of rehabilitating and restoring land, habitats and ecosystems. Such an assessment should start with the following:

1- Estimation of land use – land cover changes between two base maps or satellite images (e.g., 2005 and 2020); net primary productivity (NPP) and soil organic Carbon (SOC). These would allow for the prioritization of areas requiring restoration (reforestation or other), and could include the delineation of the ecological corridors serving as a basis for identifying these locations.

2- Ecological assessment based on tactical sampling (core and edge quadrates and transects) aiming to identify species for ecological restoration; such an assessment must be multiseasonal (spring and autumn) and must be carried out over up to 3 years.

3- Land degradation assessment including establishment of a corridor

4- Topographic surveys of quarries and engineering studies to determine rehabilitation requirements of quarries using construction and demolition waste, and related Environmental Impact Assessments (EIAs).

526. Based on these studies, rehabilitation plans can be developed covering forest management planning, reforestation, rangeland rehabilitation (using seeds collected locally and/or purchased), rangeland management planning, rehabilitation of abandoned terraces and other agricultural land that are publicly owned, simultaneous rehabilitation of construction – demolition waste dumps and quarries with the ultimate creation of vegetated terraces/ public gardens or other depending on each case. In this context, the CoM issued Decision 45 on March 21, 2019 approving MoE's policy for the integrated management of the quarrying sector. As per the policy, the CoM requested the MoF to instruct the Lebanese Armed Forces (LAF), Directorate of Geographic Affairs to survey all quarries, crushers and sand mining sites whether active or inactive, and document all the collected information pertaining to these investments (including materials quality, quantities extracted and inventory levels, topographic surveys, etc.) for taxation and finepurposes. The policy emphasized the importance of allocating to recycling of materials resulting from demolition works and others the weight it deserves due to its importance in the conservation of natural resources; and considering specifically its possible applications in this sector and the required legal reforms, and reconciling between recycling and reuse in order to rehabilitate degraded sites. The policy stipulates the launching of the rehabilitation process of quarries where work has been stopped, based on the mechanisms set forth in the decision of the Ministry of Environment No. 48/1 of 2010 for exploitations operating before 2002 and according to the provisions of decree No. 8803/2002 and its decisions for exploitations operating since 2002.

A pre-requisite to the simultaneous rehabilitation of quarries and C&D dumps is the filtration of quarries based on land ownership (exclusion of privately owned land). The next step lies in grouping of quarries and dumps based on their proximity for feasibility purposes. One of the determinants of the final cover/ land use of the rehabilitated quarry shall be the surrounding land use. Thus, quarries located on public land shall be georeferenced and overlaid on a map with land use and C&D dumps in order to develop a proper rehabilitation plan.

527. Costing of such plans and actions shall be made on a case by case basis building on the proposed assessments. Funding for quarries rehabilitation shall be provided from the following source:

- Confiscated bank guarantees and fines incurred from excesses in the extracted quantities;
- Judicial rulings;
- Draft Law Programme for the rehabilitation of abandoned public quarry sites; and
- The National Environment Fund upon issuing its application decree.

5.7.4 Screening of Proposed Responses to Pressures from Agriculture

528. Based on the analysis laid out in the previous sections, two responses for each identified agricultural pressure were studied for implementation. Specific measures or activities are proposed in light of the current and planned measures being implemented or marked for

implementation by actors in the agricultural sector. For each proposed measure, the parties responsible for its implementation, the cost, timeframe and potential funding sources were outlined as per Table 5-12. A detailed cost breakdown per measure is shown in Appendix J, Table J-38

Table 5-12. Screening of the Proposed Responses to Agricultural Pollution Pressures

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
The use of agrochemicals	1- Build and strengthen capacity on IPM	Technical	Promotion of Good Agricultural Practices, Including Integrated Pest Management, to reduce agrochemical pollution in Lower Litani Basin		1- Development of IPM curricula of important crops in the region (e.g. Olives, Tobacco, Wheat, Grapes) with the help of extension agents and local experts	MoA/LARI	201,500	6 Months	MoA Budget / FAO / International Organizations
					2- Collection of preliminary baseline information on current practices for the selected crops (proper pruning, fertilization, pest control...)	MoA/LARI		6 Months	
					3- Introduction of new varieties/cultivars that are resistant to diseases and pathogens	MoA		6 Months	
					4- Surveying of present pests and natural enemies of selected crops	MoA/LARI		6 Months	
					5- Setting up a collection and disposal system for empty containers and obsolete/unused pesticide stocks: training of farmers. Collection of used containers, and disposal through recycling	MoA/ MoE/ LARI/ FAO	180,500	24 months	MoA/ MoE /LRA / FAO / International Organizations

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
		Training & Capacity Building			1- Training on proper agrochemical handling, application and storage	MoA	13,500	1 Month	FAO/Global GAP Organization
					2- Creation of farmer discussion groups through equipping demonstration plots in 3-4 regions to solve their problems individually and collectively whenever applicable based on their experience and expert consultation.	MoA/Municipalities	206,000	6 Months	MoA Budget / International Organizations / Research Institutes and Universities
					3- Establishment of liaisons between farmers, extension service agents and experts in research stations and universities for the identification of proper IPM techniques and their dissemination	MoA/LARI		6 Months	
					4- Familiarization of farmers with the different techniques and tools used in IPM (insects' attractants, traps, natural enemies, use of climatic parameters)	MoA	80,500	4 Months	
					5- Setting up demostration plots in several areas of the LLB and providing training on GAP including IPM	MoA / MoE /LRA/ LARI	219,000	12 months	MoA Budget / LRA / FAO / International Organizations
		Legal			1-Mandating and enforcing the use of buffer zones for	MoA/MoE	-	18 Months	Law No. 63/2016

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
					maximum pesticide trapping efficiency				
					2- Create incentives in favour of IPM and organic products through removal of direct or indirect subsidies for pesticide use, and tax exemption for environmentally friendly pesticides	MoA/MoF/MoET	-	6 Months	
	2- Identify technical problems and constraints of production and export of selected crops	Technical			1- Promotion of produce cultivated using IPM techniques (agricultural trade fairs, TV awareness, international exhibitions…)	MoA / MoET /CCIA	-	6 Months	Law No. 63/2016
		Training & Capacity Building			1- Training sessions on traceability and certification: Protocol of production following the characteristics of the agricultural products (varieties, form, colour, etc.), region of production, localization of the field where crops are cultivated (name/ producer/ certificates), cultural techniques used	MoET / CCIA / Exporting bodies (IDAL)	22, 500	4 Months	MoET Budget / IDAL Budget / NGOs
					2- Training sessions on labelling, packaging, storage, current safety standards and quality, crop specific quarantine requirements in the targeted markets, and proper storage and/or disposal of pesticides	MoET / CCIA / Exporting bodies (IDAL)/ Certifying bodies/ MoA/ MoE	22,500	4 Months	

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
					containers and obsolete pesticides				
		Monitorin g			1- Performance of regular pesticide residue tests on certified IPM products throughout the production season	MoA / MoE /LARI	153,000	12 Months	MoA Budget / MoET Budget / CCIA
	3- Monitor Water and Soil Quality	Training & Capacity Building			1- Training Sessions on water quality for irrigation	MoA / LRA/ LARI	36,000	4 Months	MoA Budget / FAO / International Organizations
					2- Training Sessions on water analysis for irrigation				
					3- Training Sessions on agricultural soil pollutants				
					4- Training Sessions on soil sampling and analysis for pollutant accumulation				
		Monitorin g			1- Estimation of pollution loads by frequent soil sampling and analysis	MoA / LRA/ LARI	84,500	12 Months	Budgets of Responsible Institutions / International Donors
					2- Estimation of pollution loads by frequent sampling of water to determine if the irrigation water quality standards are met for fertilizers and pesticides	MoA / MoE /LRA/ LARI	99,500	12 Months	Budgets of Responsible Institutions / International Donors

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
Agricultural water mismanagement leading to nutrient losses, erosion, runoff and leaching of fertilizers and pesticides into surface and groundwater	1- Support the installation and use of efficient Irrigation methods and technologies to avoid excessive leaching and salinization	Training & Capacity Building			1- Field training on drip irrigation: Existing and new equipment features and benefits	FAO / International NGOs	22,500	2 Months	FAO / International Organizations
					2- Field training on water management, water budgeting and scheduling, and use of agro-meteorological data	FAO / International NGOs	22,500	2 Months	
					3- Field training on methods to enhance the use of filtration techniques (improve water quality, impact on irrigation systems, use of sand, screen, disc, etc.)	FAO / International NGOs	22,500	2 Months	
					4- Field training on methods in field drainage (planning of drainage improvements, operation & maintenance of drainage system)	FAO / International NGOs	151,500	6 Months	
	2- Support integrated Plant nutrition systems and soil conservation at farming community level	Training & Capacity Building			1- Educate farmers on the use of soil organic matter and appropriate mechanical and conservation tillage practices	MoA / NGOs	36,000	2 Months	MoA Budget / FAO / NGOs
					2- Awareness raising on the negative environmental impacts of traditional fertilization (Overuse of fertilisers and impacts, suggested alternatives to traditional practices)	MoA / NGOs	-	12 Months	

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
					3 Training to improve understanding of basic plant nutrient requirements (crops' needs for production)	MoA / NGOs	36,000	2 Months	
					4- Training on proper fertilization and fertigation (Basics of fertilization and techniques of fertigation)	MoA / NGOs	36,000	2 Months	
	3- Creation of Nitrate Vulnerable Zones (NVZs)	Technical			1- Identification of potentially susceptible areas known as Nitrate Vulnerable Zones (NVZs)	MoA / LRA	108,000	6 Months	FAO / LRA
		Legal			1- Restricting farms within an NVZ with regard to how much nitrogen fertilizer can be applied to the land	MoA / LRA / DGUP / Municipalities	80,000	12 Months	FAO / LRA
	4- Ecological and Land Rehabilitation	Technical			1- Estimation of land use – land cover changes between two base maps or satellite images (e.g., 2005 and 2020); net primary productivity (NPP) and soil organic Carbon (SOC).	MoE/ CDR/ NCSR/ MoA	69,000	6 months	Budgets of Responsible Institutions, International Donors
		Technical			2- Multiseasonal ecological assessment based on tactical sampling (core and edge quadrates and transects) over up to 3 years	MoE	35,000	36 months	International Donors
		Technical			3- Land degradation assessment including establishment of a corridor	MoE	57,000	18 months	International Donors

Pressure or Source	Responses	Nature of Measures	Current measures being undertaken	Planned Measures	Proposed Measures	Responsible Parties for Proposed Measures	Total Cost (USD)	Timeframe	Potential Funding Source
		Technical			4- Topographic surveys of quarries and engineering studies to determine rehabilitation requirements of quarries using construction and demolition waste, and related Environmental Impact Assessments (EIAs).	LAF/ MoE	575,000	12 months	Budgets of Responsible Institutions, International Donors

5.8 CROSS-SECTORAL MEASURES

529. Five cross-sectoral measures stand out:

1. Strengthening the governance and law enforcement procedures to ensure that technical measures are effectively carried out.
2. Systemizing and standardizing data management to effectively measure, document and understand how and where mitigation actions are leading to improvements.
3. Improvement of public administration management and inter-agency coordination to carry out the proposed measures. As the Litani River Authority (LRA) transforms into a river basin authority in accordance with Law No. 77/2018, its monitoring, technical and managerial capacities should be updated and upgraded to allow for better governance on environmental pressures that are depleting its resource base, which is the Litani River.
4. Physical and chemical monitoring systems for water quality, water balance, and river ecology baseline; this would allow (among others) to carry out an in-depth study of one section of the Lower Litani to validate pollution levels, sources and the cost of response measures needed.
5. Masterplan for the LL Basin and creation/updating of land zoning that will determine river and tributary course boundaries, and permissible land uses (all economic activities) that can ensure river course integrity (setback distances) and protection from encroachments.
6. Monitoring and evaluation of proposed sectoral interventions for the Upper Litani basin to build on lessons learned.

5.9 COST SUMMARY OF PROPOSED RESPONSES

530. The cost summary tables below summarize the costs of infrastructure measures, what can be called the capital cost. However, there is large cost that could not be estimated in this study and which is the human capital and social capital cost which are largely depleted. Investments in building the capacity of institutions and their personnel to deal with the pollution of the Litani River basin are a must. No infrastructure can operate effectively if no investments are made into building the institutions that will manage these investments, starting with governance structures, technical capacity, managerial capacity, targeted, consistent and informed awareness raising to the general public and to specific interest groups, and capacity for fair law enforcement that rebuilds public trust.

Table 5-13. Summary Costs of Proposed Measures for Solid Waste Pollution Curbing

Zone	Intervention	Cost estimate
1	Ain El Tine Dump – D22	US$ 19,400-36,000
1	Sohmor Dump – D10	US$ 5,600-13,100
1	Majdel Balhis dump - D3	US$ 8,200-13,800
2	Rihane Jezzine – D34	US$ 8,800-17,200

Zone	Intervention	Cost estimate
1&2	Enforcement of anti-littering, education and awareness	US$ 44,000
3&4	Nabatiye Sanitary Landfill	€ 2,177,000 eq. to US$ 2,525,400
3&4	Sorting and composting facility for Bent Jbayl and Marjaayoun	€ 2,135,000 eq. to US$ 2,476,600
3&4	Bent Jbayl Sanitary Landfill	€ 2,471,100 eq. to US$ 2,866,500
3&4	Sorting and composting facility for Sahel El Zahrani	€ 1,890,000 eq. to US$ 2,192,400
3	Yohmor (Nabatiye) – D48	US$ 8,200-13,800
4	Aadchit El Qoussair Dump – D67	US$ 19,400-20,200
4	Bany Haiyane dump – D61	US$ 2,100-4,000
4	Kounine Dump – D75	US$ 14,300-26,600
4	Deir Siriane Dump – D52	US$ 15,300-19,800
4	Houla Dump – D44	US$ 14,300-26,600
4	Rabb Et-Talatine Dump – D50	US$ 19,400-36,500
3&4	Enforcement of anti-littering, education and awareness	US$ 44,000
5	Ras El Ain rehabilitation and closure	US$ 5,462,100
5	Tyre Sanitary Landfill	US$ 3,474,750
5	Sorting and composting facility for Sahel El Zahrani	US$ 2,192,400
5	Sahel El Zahrani Sanitary Landfill	US$ 2,525,400
5	Borj Rahhal Dump – D126	US$ 22,500-22,700
5	Bedias dump – D116	US$ 2,100-4,000
5	Deir Qanoun En-Nahr Dump – D113	US$ 51,700-58,400
5	Maaroub dump – D108	US$ 9,200-15,700
5	Hmairi Sour dump – D107	US$ 9,200
5	Sir El Gharbiyeh Dump – D106	US$ 14,300-26,600
5	Srifa Dump – D94	US$ 9,500-15,000
5	Enforcement of anti-littering, education and awareness	US$ 22,000
	TOTAL	**US$ 24,079,050 – 24,204,250**

1 € = 1.16 US$

Totals that are reported in Appendix J are rounded up to the nearest 100.

Table 5-14. Summary Costs of Proposed Measures for Domestic Wastewater Infrastructure Investment

Zone	Capital Investment in WW Network & Treatment Systems (US$)
1	US$ 8,573,000
2	US$ 16,013,000
3	US$ 1,890,000
4	US$ 4,040,000
5	US$ 2,800,000
TOTAL	**US$ 34,341,000**

Table 5-15. Summary Costs of Proposed Measures for Industrial Wastewater (Pre-)treatment

Zone	Priority 1 Industries		Priority 2 Industries	
	Capital Investment & Studies' Costs (US$)	Annual O&M costs (US$)	Capital Investment & Studies' Costs (US$)	Annual O&M costs (US$)
1	167,000	23,250	395,000	54,750
2	65,000	9,000	-	-
3	167,000	23,250	395,000	54,750
4	70,000	9,750	486,000	67,500
5	567,000	78,000	310,000	42,750

Capital Investment & Studies' Costs	**US$ 2,622,000**
Annual O&M Costs	**US$ 363,000**

531. The total costs of the proposed measures to address pollution from pesticides were estimated at US$ 770,000 to be carried over a period of 1-2 years. The total costs of the proposed measures to addressing pollution from fertilizers were estimated at US$ 395,000 to be carried over a period of 1-2 years.

532. The proposed responses were grouped under six responses for the identified agricultural pressure and were studied for implementation. Specific measures or activities are proposed in light of the current measures being implemented. For each proposed measure, the parties responsible for its implementation, the cost, timeframe and potential funding sources were outlined as per Appendix J, Table J-38. A summary cost of the proposed measures is shown in Table 5-16 below.

Table 5-16. Summary Costs of Proposed Measures for Agricultural Improvement Projects across all Zones

Proposed Response	Total Cost (US$)
Build and strengthen capacity on IPM	901,000
Identify technical problems and constraints of production and export of selected crops	198,000
Monitor water and soil quality	220,000
Support the installation and use of efficient irrigation methods and technologies to avoid excessive leaching and salinization	219,000
Support integrated Plant nutrition systems and soil conservation at farming community level	108,000
Creation of Nitrate Vulnerable Zones (NVZs)	188,000
Ecological and Land Rehabilitation (assessment studies)	736,000
Total (US$)	**2,570,000**

Table 5-17. Summary Costs of Proposed Measures across all Zones

Sector	Total Cost (US$)
Municipal Solid Waste	24,204,250
Municipal Wastewater	34,341,000
Industrial Wastewater	2,622,000
Agricultural Improvement	2,570,000
Cross-sectoral and Governance	12,300,000
Total (US$)	**76,037,250**

5.10 RESPONSE PRIORITIZATION STRATEGY

5.10.1 Solid Waste Sector

533. The priority for solid waste is to address the largest dumping sites which are located in Zone 5. All dumpsites that are near water courses and where plastic and other waste are finding their way to the river should be first addressed. The priorities should be ordered based on size of dumping sites, and taking into consideration the programming of operation of planned or newly built SWM facilities and sanitary landfills.

Table 5-18. Solid Waste Responses by Priority

Solid Waste Responses Listed by Priority
Construction and commissioning of operations in the - Tyre Sanitary Landfill - Bent Jbayl / Marjaayoun Facility and Sanitary Landfill - Nabatiye Sanitary Landfill - Sahel El Zahrani Sanitary Landfill
Closure and rehabilitation of: - Ras El Ain Dumpsite - Maaroub Dumpsite - Sir El Gharbiyeh Dumpsite - Borj Rahhal Dumpsite - Deir Qanoun En-Nahr Dumpsite - Houla Dumpsite - Youhmor En Nabatiye Dumpsite - Srifa Dumpsite - Kounine Dumpsite - Hmairi Dumpsite - Bedias Dumpsite - Rihane Dumpsite - Ain Et Tineh Dumpsite - Aadchit El Qoussair - Sohmor Dumpsite - Majdel Balhis Dumpsite - Rabb Et Talatine Dumpsite - Bani Haiyane Dumpsite - Deir Siriane Dumpsite

5.10.2 Wastewater Sector

534. The largest wastewater pressures are identified by crossing the population pressure with the presence of water supply sources, whether for drinking, irrigation or recreational purposes. Following this reasoning, the prioritized responses are shown in Table 5-19.

535. As for industrial wastewater, the pressures are seasonal, yet not to be underestimated in their acute and long-term impact, especially that olive mill wastewater contains high levels of COD and phenols that can be detrimental to aquatic fauna, and to water supply structures downstream of the points of discharge.

536. Nonetheless, the top priority for response is indeed the municipal wastewater infrastructure investments.

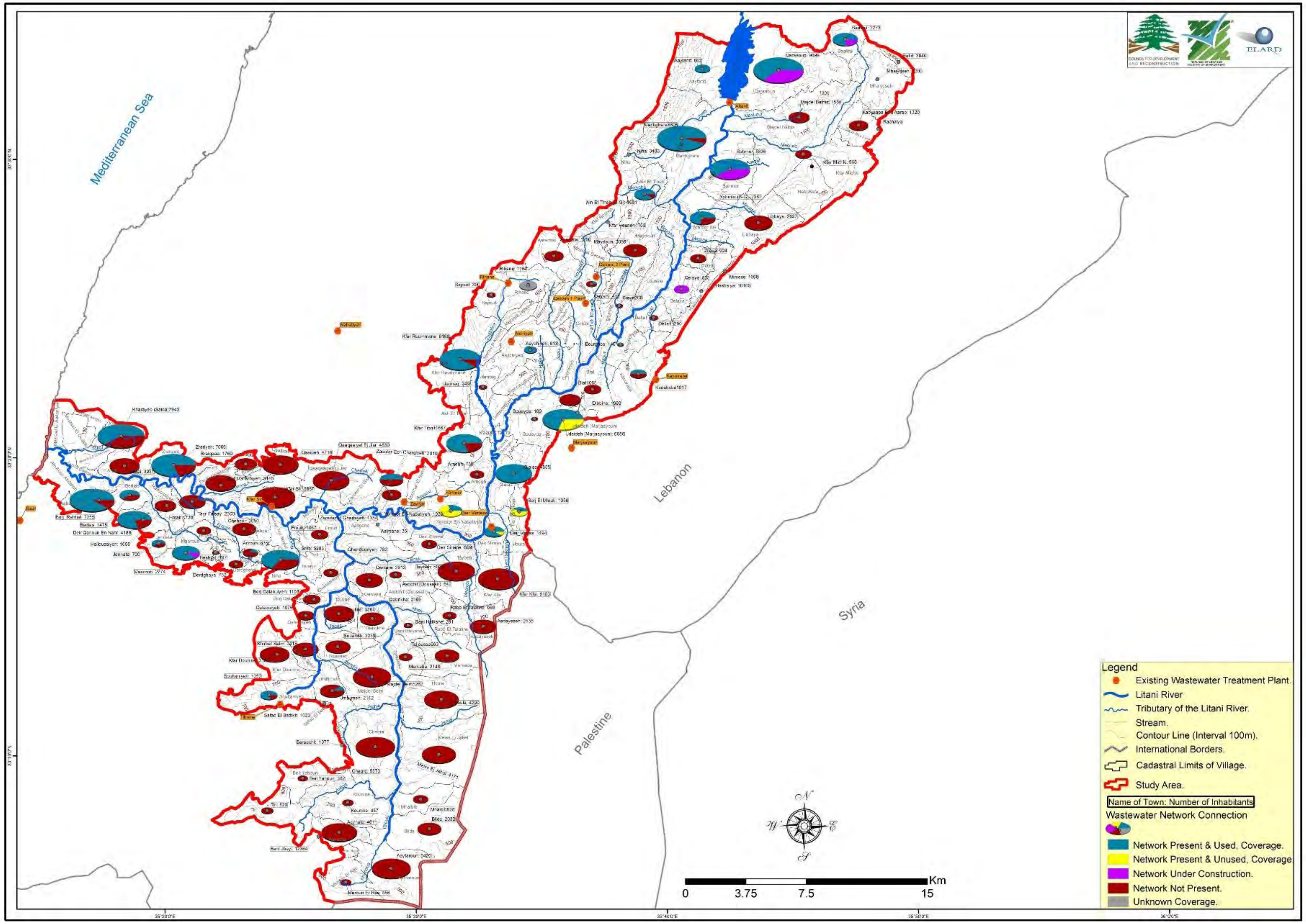


Figure 5-9. Status of Wastewater Network Coverage and Existing Treatment Systems

Table 5-19. Prioritization of Responses to Wastewater Pollution Pressures

Response	Programming Status	Description of Measures	Population Estimate (2018)	Estimated Total Flow (m^3/d)	Priority
Establishment of the Zilaya Plant and wastewater collection networks for Zone 1	Allocated as part of Law No. 63/2016 – US$ 15.4 Million	Carrying out the feasibility study and design of the Zilaya Treatment Plant. Completion of the networks in Ain Et Tineh, Yohmor (B-G), and Sohmor. Establishing networks in Zilaya and Maydoun & Loussia	16,927	2,539	1
Establishment of the Sarafand Plant and collection networks for parts of Zone 5	Allocated as part of Law No. 63/2016 – US$ 15.4 Million (Nabaa El Tasseh Plant US$ 27.7 Million)	Carrying out the feasibility study and design of the Sarafand Treatment Plant. Completion of the networks in Kharayeb (with Yahoudiyeh, Mazraat El Ouasta and Mazraat Jamjim) and in Zrariyeh Establishment of collection networks in Kfar Houneh and Aaramta.	18,047	2,707	2
Completion of collection networks as part of Sour-2 Wastewater treatment system in Zone 5 and parts of Zone 4	Allocated as part of Law No. 63/2016 – US$ 89.1 Million (Srifa US$ 11.9 Million; Halloussiyeh US$ 7.4 Million)	Completion of networks in Maaroub, Borj Rahhal & Ain Abou Abdallah, Deir Qanoun En-Nahr, Jennata, Bedias & Arzoun Establishing networks in Arzai (with Jazira and Matariyet Ech Choumar), Kfar Dounine, Sir El Gharbiyeh, Chehour, Derdaghaiya, and Bestiyat Completion of the network in Srifa, with Marnaba, Mazraat Tayr Semhat, Niha (Sour), and Touayri Establishment of the network in Tayr Falsay, Halloussiyeh, and Hmairi.	40,209	6,033	3
Wastewater collection networks for Zone 4 (Bent Jbayl and Marjaayoun), parts of Zone 3 and 5, including establishment of Qaaqaaiyet Ej Jisr Treatment Plant	Allocated as part of Law No. 63/2016 – US$ 87.1 Million	Updating the Master plan and feasibility study for the collection and treatment systems of Bent Jbayl and Marjaayoun (Zone 4 and parts of Zone 3 and Zone 5) Establishing collection networks in Chaqra, Aaytaroun, Majdel Selm, Taybeh, Qaaqaaiyet Ej Jisr, Qsaibeh, Aaynata, Houla, Meiss Ej Jabal, Touline, Qantara, Adaysseh, Khirbet Selm, Souaneh, Qabrikha, Markaba, Jmaijmeh, Blida, Braiqeaa, Borj Qalaouiyeh, Qalaouiyeh,	76,514	11,478	3

Response	Programming Status	Description of Measures	Population Estimate (2018)	Estimated Total Flow (m^3/d)	Priority
		Froun, Deir Siriane, Mhaibib, Ghandouriyeh, Rabb Et Talatine, Talloussa, Aadchit (Qoussair), Kounine, Maroun Er Ras, Beit Yahoun and Bani Haiyane			
Assessment of the Marjaayoun Plant, and collection networks for villages in Zones 2 and 3	Unallocated US$ 3,170,000	Assess the operations and treatment effectiveness at the existing Marjaayoun Plant. Upgrading of the Plant, if necessary. Completion of the network coverage in Borj El Mlouk. Establishing the networks in Dibbine, Blat and Bouayda.	8,805	1,320	3
Completion of collection networks as part of Nabatiye-2 Wastewater treatment system in Zone 5 and parts of Zone 4	Allocated as part of Law No. 63/2016 – US$ 47.5 Million	Completion of the network coverage in Kfar Roummane and Kfar Tibnit and linking with the Nabatiye Treatment Plant. Establishing networks in Arnoun and Aali Et Taher.	11,570	1,735	4
Assessment of the Deir Mimas Plant, and network connections for villages in Zone 3	Allocated as part of Law No. 63/2016 – US$ 7.9 Million	Assess the operations and treatment effectiveness at the existing Deir Mimas Plant. Upgrading of the Plant, if necessary. Completion of the network coverage in Deir Mimas, along with Houra and Mazraat Doumiat. Establishing networks in Kfar Kila.	7,597	1,140	5
Kfar Sir Plant and network connections (Zone 5)	Unallocated US$ 2,800,000	Assess the operations at Kfar Sir Plant. Establish network connections in Kfar Sir	5,887	883	6
Establishment of the Majdel Balhis Treatment Plant and collection networks for villages in Zone 1	Unallocated US$ 4,323,000	Carrying out the feasibility study and design of the Majdel Balhis Treatment Plant, and sewer collection network Establishment of the network in Majdel Balhis, Kaoukaba Bou Arab, Kfar Michki and Nabi Safa.	3,848	578	7
Completion of the collection network in Zaoutar (Zone 3)	Unallocated US$ 1,025,000	Completion of the collection network in Zaoutar Ech-Charqiyeh & Mazraat El Hamra. Establishment of a collection network in Zaoutar El Gharbiyeh and linking to Zaoutar Plant or to Sarafand.	3,373	506	8

Response	Programming Status	Description of Measures	Population Estimate (2018)	Estimated Total Flow (m^3/d)	Priority
Completion of the collection network in Yohmor and connection to the existing Yohmor Treatment Plant (Zone 3)	Unallocated US$ 1,890,000	Completion of the collection networks in Yohmor.	1,923	289	9
Assessment of the Rihane and Aaychiyeh treatment plants, and completion of networks for villages in Zone 2	Allocated as per of Law No. 63/2016 – US$ 5.9 Million	Assess the operations and connections at Aaychiyeh and Rihane. Completion of the collection networks to connect the localities of Mazraat Zighrine, Mahmoudiyeh, Mazraat Khallet Khazen, Mazraat Louayziyeh, Mazraat Qrouh, Ouardiyeh, Chbail, Mazraat Daraya, and Sejoud.	2,077	312	10
Completion of network in Soultaniyeh and Jmaijmeh to connect to existing Tibnine Plant (Zone 4)	Unallocated US$ 540,000	Completion of the collection network in Soultaniyeh and Jmaijmeh	1,052	158	11
Assessment of the Kaoukaba Plant and completion of connections (Zone 2)	Unallocated US$ 275,000	Assess the operations at the existing Kaoukaba Plant and complete the connections in the village of Kaoukaba (Hasbaiya).	1,017	153	12
Establishment of networks in Aaynata and Tiri and connection to Bent Jbayl Treatment Plant (Zone 4)	Unallocated US$ 3,500,000	Establishment of the collection network in Tiri.	520	78	13
Establishment of a treatment system in Wadi El Jarmaq and collection network (Zone 2)	Unallocated US$ 2,000,000	Establishment of a wastewater treatment system for Jarmaq, including Demachqiyeh, Mazraat El Aarqoub, Mazraat Ouazaaiyeh and Mazraat Tamra	249	37	14
Establishment of a treatment plant in Srayri and collection network (Zones 1 and 2)	Unallocated US$ 10,068,000	Establishment of a wastewater treatment system for Srayri, including Dellafi, Bourghos and Qelaya	1,471	309	15

5.10.3 Agriculture Sector

537. The analysis has shown that agriculture does not constitute a major pressure on the River pollution in the LLB. However, the overuse of pesticides and fertilizers was noted for all crops and eventually agricultural return flows will contribute to the river pollution as well as groundwater and soil pollution.

538. Addressing pollution from agriculture would serve to improve surface water quality over time, which would have positive implications on improving irrigation water quality as well as contributing to the gradual improvement in overall surface water quality.

539. Ecological and land rehabilitation (forests, rangeland, quarries, dumps, agricultural land) would also reduce soil erosion and surface runoff, which would indirectly reduce contamination of surface water with contaminated runoff. Hence the need for the assessments listed in Table 5-12.

5.10.4 Touristic Sector

540. Prioritization of the measures to apply to recreational establishments are guided by the concentration and number of establishments in a certain area and professional judgment on the potential impact on river flow regime from these activities.

541. The priority is to examine the area with the largest concentration of recreational activities which is Zone 5, where Tayr Falsay, Sir El Gharbiyeh, Qaaqaaiyet Ej Jsir, Bedias and Jazira are the priority areas to be looked into to determine encroachment and regulate river use at these recreational establishments in order to allow for sustainable operations.

542. The next in line is Zone 1, namely the areas of Yohmor and Qelaya, downstream of Ain ez Zarqa, followed by Zone 3 with facilities in Khardali area (Mazraat Tamra) and in Zaoutar. Zones 2 and 4 are less urgent due to the small number of facilities. Regulating how these facilities use or burden their local and river environment is intended to sustain the river environment to continue to deliver recreational value to all users.

6. ROADMAP TO THE IMPLEMENTATION OF THE BUSINESS PLAN

I – Cross-sectoral and Governance

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
CG01	Strengthening the governance and law enforcement procedures to ensure that technical measures are effectively carried out.	LRA & Courts (All Stakeholders)	$2,000,000	Implementing roadmap for Upper Litani Environmental Prosecutors Environmental Police Training of municipal police	ST: 2018-2021
CG02	Systemizing and standardizing data management to effectively measure, document and understand how and where mitigation actions are leading to improvements. Establishing a unified common data room/system on all pollution pressures in the basin	LRA (All stakeholders)	$2,000,000	None	ST & MT: 2018-2024
CG03	Improvement of public administration management and inter-agency coordination to carry out the proposed measures, through capacity building.	Council of Ministers (All Stakeholders)	$2,000,000	None	ST: 2018-2020
CG04	Physical and chemical monitoring systems for water quality, water balance, and river ecology baseline	LRA (MoEW & MoE)	$1,000,000	None	ST & MT: 2018-2024
CG05	Masterplan for the LL Basin and creation/updating of land zoning that will determine river and tributary course boundaries, and permissible land uses (all economic activities) that can ensure river course integrity	DGUP (Local authorities, LRA and Line Ministries)	$5,000,000	Master plan for Upper Litani Basin	ST & MT: 2019-2025

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
	(setback distances) and protection from encroachments				
CG06	Monitoring and evaluation of proposed sectoral interventions for the Upper Litani basin to build on lessons learned;	Litani Committee (all stakeholders)	$300,000	Evaluation of progress of implementation of the road map for the Upper Litani Basin	ST &MT: 2020-2024

II – Municipal Solid Waste

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
SW01	Operate the solid waste management facility in Joub Jannine (Sorting and Composting Facility - capacity 100 t/d)	OMSAR & Union of Municipalities of Lake Qaraaoun (Ministry of Environment & UNDP)	US$ 1,200,000	Administrative, operational and contract implementation oversight and monitoring	ST: 2018-2021
SW02	Construction of Nabatiye 75 t/d sanitary landfill, procure equipment and award O&M services	OMSAR & Union of Municipalities of Chqif	US$2,525,400	Sorting and composting facility completed Construction of Sanitary Landfill was programmed under SWAM II*, encompassing construction tender and construction of landfill. Awarding O&M contract Administrative, operational and contract implementation oversight and monitoring	ST: 2019-2020 MT: 2020-2023
SW03	Construction of Bent Jbayl /Marjaayoun SWM complex (sorting, composting and landfilling – S&C-250 t/d & SL-100 t/d), procure equipment and award O&M services	OMSAR & Unions of Municipalities of Jabal Aamel, Bent Jbayl and Qalaa	US$5,343,100	Prepare design and EIA studies, and land allocation Construction of Sanitary Landfill was programmed under SWAM II*, encompassing construction tender and construction of landfill	ST: 2019-2020 MT: 2020-2023

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
				Awarding O&M contract Administrative, operational and contract implementation oversight and monitoring	
SW04	Construction of Sahel El Zahrani sorting and composting facility and sanitary landfill (75 t/d)	OMSAR & Union of Municipalities of Sahel El Zahrani	US$ 4,717,800	Prepare design and EIA studies, and land allocation under PROMARE project. Construction of Sanitary Landfill was programmed under SWAM II*, encompassing construction tender and construction of landfill Awarding O&M contract Administrative, operational and contract implementation oversight and monitoring	ST: 2019-2020
SW05	Closure and rehabilitation of dumpsites in Ain Et Tineh, Sohmor and Majdel Balhis, and their rehabilitation	Municipalities of Ain Et Tineh, Sohmor and Majdel Balhis (Union of Municipalities of Lake Qaraaoun)	US$ 33,200-62,900	Sanitary landfill in Joub Jannine	ST: 2019-2020
SW06	Closure and rehabilitation of dumpsite in Rihane	Municipality of Rihane	US$ 8,800-17,200		ST: 2019-2020
SW07	Closure and rehabilitation of dumpsites in Yohmor (Nabatiye), Aadchit El Qoussair, Bani Haiyane, Kounine, Deir Siriane, Houla, Rabb Et Talatine	Municipalities of Yohmor (Nabatiye), Aadchit El Qoussair, Bani Haiyane, Kounine, Deir Siriane, Houla, Rabb Et Talatine (Unions of Municipalities of Jabal	US$ 93,000-147,500	Sanitary landfills in Nabatiye & in Bent Jbayl /Marjaayoun	ST: 2019-2020

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
		Aamel, Bent Jbayl and Qalaa)			
SW08	Closure and rehabilitation of dumpsite in Ras El Ain and building of a sanitary landfill	OMSAR and Union of Tyre Municipalities	US$ 9,000,000		ST: 2019-2020
SW09	Closure and rehabilitation of dumpsites in Borj Rahhal, Bedias, Deir Qanoun En-Nahr, Maaroub, Hmairi, Sir El Gharbiyeh and Srifa	Municipalities of Borj Rahhal, Bedias, Deir Qanoun En-Nahr, Maaroub, Hmairi, Sir El Gharbiyeh and Srifa (Unions of Municipalities of Tyre and Sahel El Zahrani)	US$ 118,500-151,600	SWM facilities in Tyre (Ain Baal) and Sahel El Zahrani	ST: 2020-2021
SW10	Equip municipal solid waste collection services with materials, bins and vehicles that allow for separate collection of different waste streams	OMSAR, Unions of Municipalities of Lake Qaraaoun, Chqif, Jabal Aamel, Bent Jbayl, Qalaa and Sahel El Zahrani & Municipalities (Ministry of Environment & UNDP)	US$ 508,500		ST: 2019-2021
SW11	Training and capacity building of Unions of Municipalities to oversee the operation of sorting and composting facilities and sanitary landfills, and monitoring of performance and contract delivery for Joub Jannine, Nabatiye, Bent Jbayl /Marjaayoun, Ras El Ain and Sahel El Zahrani	OMSAR & Ministry of Environment (UNDP)			ST: 2019-2020

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
SW12	Implement social marketing and awareness campaigns to encourage sorting at the source	Unions of Municipalities of Lake Qaraaoun, Chqif, Jabal Aamel, Bent Jbayl I, Qalaa and Sahel El Zahrani and Municipalities (Ministry of Environment & UNDP)			ST: 2019-2020
SW13	Enforce anti-littering and waste disposal penalties on municipalities within their jurisdiction	Municipalities / Municipal Police (Unions of Municipalities)	US$ 110,000		ST: 2019-2020

* The SWAM II Program has been cancelled; alternative sources of funding are to be found

III- Municipal Wastewater Discharges

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
MW01	Establishment of the Zilaya Plant and wastewater collection networks: Completion of the networks in Ain Et Tineh, Yohmor (B-G), and Sohmor. Establishing networks in Zilaya Maydoun and Loussia.	MoEW (CDR)	Funding allocated (Law No. 63/2016)	Carrying out the feasibility study and design of the Zilaya Treatment Plant.	ST: 2018-2021
MW02	Establishment of the Sarafand Plant and collection networks: Completion of the networks in Kharayeb (with Yahoudiyeh, Mazraat El Ouasta and Mazraat Jamjim) and in Zrariyeh. Establishment of collection networks in Kfar Houneh and Aaramta.	MoEW (CDR)	Funding allocated (Law No. 63/2016)	Carrying out the feasibility study and design of the Sarafand Treatment Plant.	MT: 2021-2023
MW03	Completion of collection networks as part of Sour-2 Wastewater treatment system: Completion of networks in Maaroub, Borj Rahhal & Ain Abou Abdallah, Deir Qanoun En-Nahr, Jennata, Bedias & Arzoun Establishing networks in Arzai (with Jazira and Matariyet Ech Choumar), Kfar Dounine, Sir El Gharbiyeh, Chehour, Derdaghaiya, and Bestiyat Completion of the network in Srifa, with Marnaba, Mazraat Tayr Semhat, Niha (Sour), and Touayri Establishment of the network in Tayr Falsay, Halloussiyeh, and Hmairi.	MoEW (CDR)	Funding allocated (Law No. 63/2016)	Construction works, and design of village-level collectors and lines	ST: 2018-2020
MW04	Wastewater collection networks for Bent Jbayl and Marjaayoun, including establishment of Qaaqaaiyet Ej Jisr Treatment Plant: Establishing collection networks in Chaqra, Aaytaroun, Majdel Selm, Taybeh, Qaaqaaiyet Ej Jisr, Qsaibeh, Aaynata, Houla, Meiss Ej Jabal, Touline, Qantara, Adaysseh, Khirbet Selm, Souaneh, Qabrikha, Markaba, Jmaijmeh, Blida, Braiqeaa, Borj Qalaouiyeh, Qalaouiyeh, Froun, Deir Siriane, Mhaibib, Ghandouriyeh, Rabb Et Talatine, Talloussa, Aadchit (Qoussair), Kounine, Maroun Er Ras, Beit Yahoun and Bani Haiyane	MoEW (CDR)	Funding allocated (Law No. 63/2016)	Update of the feasibility study	ST: 2019-2021

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
MW05	Assessment of the Marjaayoun Plant, and collection networks: Assess the operations and treatment effectiveness at the existing Marjaayoun Plant. Upgrading of the Plant, if necessary. Completion of the network coverage in Borj El Mlouk. Establishing the networks in Dibbine, Blat and Bouayda.	MoEW (CDR)	US$ 3,170,000	*Note: No allocated funding as per Law No. 63/2016*	MT: 2021-2023
MW06	Completion of collection networks as part of Nabatiye-2 Wastewater treatment system: Completion of the network coverage in Kfar Roummane and Kfar Tibnit, and linking with the Nabatiye Treatment Plant. Establishing networks in Arnoun and Aali Et Taher.	MoEW (CDR)	Funding allocated (Law No. 63/2016)		ST: 2019-2021
MW07	Assessment of the Deir Mimas Plant, and network connections: Assess the operations and treatment effectiveness at the existing Deir Mimas Plant. Upgrading of the Plant, if necessary. Completion of the network coverage in Deir Mimas, along with Houra and Mazraat Doumiat. Establishing networks in Kfar Kila.	MoEW (CDR)	Funding allocated (Law No. 63/2016)		ST: 2019-2021
MW08	Kfar Sir Plant and network connections: Assess the operations at Kfar Sir Plant. Establish network connections in Kfar Sir	MoEW (CDR)	US$ 2,800,000	*Note: No allocated funding as per Law No. 63/2016*	ST: 2019-2020
MW09	Establishment of the Majdel Balhis Treatment Plant and collection networks: Carrying out the feasibility study and design of the Majdel Balhis Treatment Plant. Establishment of the network in Majdel Balhis, Kaoukaba Bou Arab, Kfar Michki and Nabi Safa.	MoEW (CDR)	US$ 4,323,000	*Note: No allocated funding as per Law No. 63/2016*	MT: 2021-2023
MW10	Completion of the collection network in Zaoutar: Completion of the collection network in Zaoutar Ech-Charqiyeh & Mazraat El Hamra. Establishment of a collection network in Zaoutar El Gharbiyeh and linking to Zaoutar Plant or to Sarafand.	MoEW (CDR)	US$ 1,025,000	*Note: No allocated funding as per Law No. 63/2016*	ST: 2019-2020

Ref.	Description of the Proposed Measure	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities	Timeframe
MW11	Completion of the collection network in Yohmor and connection to the existing Yohmor Treatment Plant	MoEW (CDR)	US$ 1,890,000	*Note: No allocated funding as per Law No. 63/2016*	ST: 2019-2021
MW12	Assessment of the Rihane and Aaychiyeh treatment plants, and completion of networks for villages: Assess the operations and connections at Aaychiyeh and Rihane. Completion of the collection networks to connect the localities of Mazraat Zighrine, Mahmoudiyeh, Mazraat Khallet Khazen, Mazraat Louayziyeh, Mazraat Qrouh, Ouardiyeh, Chbail, Mazraat Daraya, and Sejoud.	MoEW (CDR)	Funding allocated (Law No. 63/2016)		ST: 2019-2021
MW13	Completion of network in Soultaniyeh and Jmaijmeh to connect to existing Tibnine Plant	MoEW (CDR)	US$ 540,000	*Note: No allocated funding as per Law No. 63/2016*	MT: 2021-2023
MW14	Assessment of the Koukaba Plant and completion of connections in the village of Kaoukaba (Hasbaiya)	MoEW (CDR)	US$ 275,000	*Note: No allocated funding as per Law No. 63/2016*	MT: 2021-2023
MW15	Establishment of a network in Tiri and connection to Bent Jbayl Treatment Plant	MoEW (CDR)	US$ 3,500,000	*Note: No allocated funding as per Law No. 63/2016*	MT: 2021-2023
MW16	Establishment of a treatment system in Wadi El Jarmaq and collection network: Establishment of a wastewater treatment system for Jarmaq, including Demachqiyeh, Mazraat El Aarqoub, Mazraat Ouazaaiyeh and Mazraat Tamra	MoEW (CDR)	US$ 2,000,000	*Note: No allocated funding as per Law No. 63/2016*	ST: 2019-2021
MW17	Establishment of a treatment system in Srayri: Establishment of a wastewater treatment system for Srayri, including Dellafi, Bourghos and Qelaya	MoEW (CDR)	US$ 10,068,000	*Note: No allocated funding as per Law No. 63/2016*	ST: 2019-2021

IV – Non-Municipal Discharges

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
Industrial Establishments					
IW01	Establish a regional pre-treatment facility for olive mills wastewater treatment to receive olive mill wastewater by tankers, from at least 37 olive mills within the Basin	ST & MT: 2019-2023	MoE (MoI & Agricultural Cooperatives)	US$ 2,192,000	None
IW02	Support priority stone cutting facilities, numbered 7, and licensed quarry and sand washing sites, to establish their own pre-treatment units, consisting of screening, gravity thickeners and filter presses to reduce loads of suspended solids in effluents.	ST: 2019-2021	MoE (MoI / Governorate)	US$ 600,000	LEPAP
IW03	Support two dairy industries, and one chocolate industry to install pre-treatment systems and comply with standards of discharge into sewer systems or surface water bodies	ST: 2019-2021	MoE (MoI / Governorate)	US$ 300,000	LEPAP
Healthcare Establishments					
HC01	Support healthcare establishments (starting with governmental hospitals) in establishing separate waste and wastewater collection systems. Advise HC establishments on pre-treatment systems if not connected to municipal WW network. Establish routine effluent monitoring programs at HC establishments.	ST: 2019-2021	MoE (MoPH)	US$ 100,000	
Classified and Non-Classified Non-Industrial Establishments					
CI01	Training of local government bodies on environmental requirements for various establishments	ST: 2019-2021	MoE (Local government)	US$ 100,000	
CI02	Awareness raising on environmental measures for trade entities and small businesses	ST: 2019-2021	MoE (Regional trade associations)	US$ 75,000	

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
CI03	Inspection spot-checks for regional MoE departments, environmental police and municipal police	ST: 2019-2021	MoE (Local government)	US$ 75,000	
Quarries					
QU01	Enforce environmental legislation through Environmental Prosecutors	ST: 2019-2021	MoE (MoJ)	--	
Recreational Establishments					
RE01	Establish guidelines and operational parameters for recreational facilities of various sizes and activities to follow in the management of wastewater and solid waste	ST: 2019-2020	MoE (MoT)	US$ 30,000	
RE02	Observe implementation of these measures through a discharges custody process whereby facilities are required to contract waste and wastewater collection services to transport their waste and wastewater to the nearest processing facilities, with records maintained and compliance enforced by municipalities	ST: 2019-2020	MoE (Municipalities)	--	
RE03	Implement a strict no discharge policy of solid waste, anti-littering and wastewater into river water, and apply a penalty system	ST, MT & LT	Municipalities	--	
RE04	The public domain on river embankments be defined through topographic surveying and correct interpretation of legal texts on a case-by-case basis	ST & MT: 2019-2024	LRA & MoEW, with DGUP	US$ 500,000	
RE05	Application of rules for setback distances where these apply by requesting and then enforcing demolition of built structures that are encroaching on the public domain and river/tributary courses, especially where these change the river flow regime	ST, MT & LT: 2019-2029	LRA, MoEW & Municipalities	TBD based on the outcomes of RE04	
Informal Tented Settlements					
IS01	Inspection of sanitation and waste management conditions of ITS to ensure that waste and wastewater discharges are	ST: 2019-2020	Municipalities with UNHCR	--	

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
	properly directed to the formal and existing collection and treatment systems				

V – Agricultural Pollution

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
AG01	Build and strengthen capacity on IPM through: - Development of IPM curricula of important crops in the region (e.g. Olives, Tobacco, Wheat, Grapes) with the help of extension agents and local experts - Collection of preliminary baseline information on current practices for the selected crops (proper pruning, fertilization, pest control...) - Introduction of new varieties/cultivars that are resistant to diseases and pathogens - Surveying of present pests and natural enemies of selected crops - Setting up a collection and disposal system for empty containers and obsolete/unused pesticide stocks: training of farmers. Collection of used containers, and disposal through recycling - Training on proper agrochemical handling, application and storage - Creation of farmer discussion groups through equipping demonstration plots in 3-4 regions to solve their problems individually and collectively whenever applicable based on their experience and expert consultation	ST-LT: 2019-2029	MoA (FAO/ LARI / LRA/ MoE)	US$ 901,000	IPM programmes with FAO

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
	- Establishment of liaisons between farmers, extension service agents and experts in research stations and universities for the identification of proper IPM techniques and their dissemination - Familiarization of farmers with the different techniques and tools used in IPM (insects' attractants, traps, natural enemies, use of climatic parameters) - Setting up demostration plots in several areas of the LLB and providing training on GAP including IPM - Mandating and enforcing the use of buffer zones for maximum pesticide trapping efficiency - Creating incentives in favour of IPM and organic products through removal of direct or indirect subsidies for pesticide use, and tax exemption for environmentally friendly pesticides				
AG02	Identification of technical problems and constraints of production and export of selected crops, through: - Identifying technical problems and constraints of production and export of selected crops - Training sessions on traceability and certification: Protocol of production following the characteristics of the agricultural products (varieties, form, colour, etc.), region of production, localization of the field where crops are cultivated (name/ producer/ certificates), cultural techniques used - Training sessions on labelling, packaging, storage, current safety standards and quality, crop specific quarantine requirements in the targeted markets - Performance of regular pesticide residue tests on certified IPM products throughout the production season	ST-MT: 2019-2024	MoA (MoET / CCIA / LARI)	US$ 198,000	

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
AG03	Monitoring of Water and Soil Quality: - Training Sessions on water quality for irrigation - Training Sessions on water analysis for irrigation - Training Sessions on agricultural soil pollutants - Training Sessions on soil sampling and analysis for pollutant accumulation - Estimation of pollution loads by frequent soil sampling and analysis - Estimation of pollution loads by frequent sampling of water to determine if the irrigation water quality standards are met for fertilizers and pesticides	ST: 2019-2021	MoE / MoA (LRA / LARI)	US$ 220,000	
AG04	Supporting the installation and use of efficient irrigation methods and technologies to avoid excessive leaching and salinization, through: - Field training on drip irrigation: Existing and new equipment features and benefits - Field training on water management, water budgeting and scheduling, and use of agro-meteorological data - Field training on methods to enhance the use of filtration techniques (improve water quality, impact on irrigation systems, use of sand, screen, disc, etc.) - Field training on methods in field drainage (planning of drainage improvements, operation & maintenance of drainage system)	ST-MT: 2019-2024	MoA (FAO / LARI / LRA)	US$ 219,000	
AG05	Support integrated Plant nutrition systems and soil conservation at farming community level: - Educate farmers on the use of soil organic matter and appropriate mechanical and conservation tillage practices - Awareness raising on the negative environmental impacts of traditional fertilization (Overuse of fertilisers	ST-MT: 2019-2024	MoA (FAO / LARI)	US$ 108,000	

Ref.	Description of the Proposed Measure	Timeframe	Responsible Entity (Coordinating Entity)	Estimated Budget	Current & Planned Activities
	and impacts, suggested alternatives to traditional practices) - Training to improve understanding of basic plant nutrient requirements (crops' needs for production) - Training on proper fertilization and fertigation (Basics of fertilization and techniques of fertigation)				
AG06	Creation of Nitrate Vulnerable Zones (NVZs): - Identification of potentially susceptible areas known as Nitrate Vulnerable Zones (NVZs) - Restricting farms within an NVZ with regard to how much nitrogen fertilizer can be applied to the land	LT: 2025-2029	MoA / LRA (MoEW / Municipalities / Land owners / Directorate General of Urban Planning)	US$ 188,000	
AG07	Ecological and Land Rehabilitation: - Estimation of land use – land cover changes between two base maps or satellite images (e.g., 2005 and 2020); net primary productivity (NPP) and soil organic Carbon (SOC) - Multiseasonal ecological assessment based on tactical sampling (core and edge quadrates and transects) over up to 3 years - Land degradation assessment including establishment of a corridor - Topographic surveys of quarries and engineering studies to determine rehabilitation requirements of quarries using construction and demolition waste, and related Environmental Impact Assessments (EIAs).	ST-MT: 2019-2024	MoE (CDR/ NCS/ MoA/ MoE/ LAF)	US$ 736;000	

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Reviewed Studies

	Publication Title	Author	- Theme/Topic	Year	Publication Type
1	Environment Pollution and Climate Change / Assessment of the efficiency of a pilot constructed wetland on the remediation of water quality; case study of Litani river, Lebanon	Amacha et al. / Department of Life and Earth Science, Faculty of Sciences, Lebanese University. / Litani River Basin Management Support (LRBMS) Program/	- Constructed Wetland - Litani River - Water Quality - Remediation - Aquatic Macrophytes	2017	Academic Publication
2	Reservoir sediments: a sink or source of chemicals at the surface water-groundwater interface	Ammar et al.	- Biological and physicochemical parameters - Anthropogenic impact - Water quality - Environmental isotopic ratios - Sediment analysis - Litani River Basin	2015	Academic Publication
3	Litani Water Quality Management Project / Canal 900 Algae Control: Testing and validation	BAMAS	- Canal 900 - Litani River - Algae Control - Agriculture	2005	Report
4	Lead, cadmium and arsenic in human milk, their socio-demographic and lifestyle determinants in Lebanon	Bassil et al.	- Lower Litani River Basin - Heavy metal concentrations - Toxic metals - Socio-demographic impacts	2017	Academic Publication
5	Observations on geomorphology, transportation and distribution of sediment in western Lebanon and its continental shelf and slope regions	Beydoun Z.R. / Department of Geology, American University of Beirut	- Geomorphology - Drainage - Water discharge - East Mediterranean	1976	Academic Publication
6	‘Assessing Lebanon’s water balance’ in Water balances in the Eastern Mediterranean	Brooks et al.	- Hydrogeographics of Lebanon - Water management - Litani River Basin - Water consumption	2000	Book Chapter

	Publication Title	Author	- Theme/Topic	Year	Publication Type
7	Restructuring water sector in Lebanon: Litani river authority facing the challenges of good water governance	Catafago S.	- Legal - Water management - LRA - Water policy - Litani River	2005	Academic Publication
8	Solid Waste Progress Report	CDR	- Solid waste - Policies - Dumpsites	2016a	Report
9	Agriculture and Irrigation Progress Report	CDR	- Current Situation of the Agricultural Sector - Past, Present, Future Projects	2016b	Report
10	Social and Economic Development Progress Report	CDR	- Social Infrastructure - Past, Present, Future Projects	2016c	Report
11	Land Use and Environment Progress Report	CDR	- Past, Present, Future Projects - Current Urbanization Situation	2016d	Report
12	Wastewater Progress Report	CDR	- Insufficiency of Lebanese Wastewater Service - Past, Present, Future Projects	2016e	Report
13	Equity for an integrated water resources management of irrigation systems in the Mediterranean: the case study of South Lebanon	Chami et al.	- Litani River System - Irrigation/ Water distribution - Farmer Equity	2014	Academic Publication
14	Water Sector in Lebanon an operational Framework for Undertaking Legislative and Institutional Reforms	Comair, Fadi / United Nations Economic and Social Commission for Western Asia	- Water Resources Management in Lebanon - Water Sector Legislation - IWRM	2007	Report
15	Modelling water quality in time and space: case study the Litani river Lebanon	Dandan et al.	- Water quality - Litani River - Pollution monitoring	2001	Thesis (MSc)

	Publication Title	Author	- Theme/Topic	Year	Publication Type
16	Eighth International Conference on Material Sciences / Study of physicochemical properties of colloidal sediments of Litani river in Lebanon	Diab et al. / Laboratory of Materials, Catalysis, Environment and Analytical Methods, Faculty of Sciences, Lebanese University.	- Physicochemical properties of sediments - Litani River - Seasonal Variations - Anthropogenic effects - Sediments	2014	Academic Publication
17	Optimal water resources management: case of Lower Litani River, Lebanon	Doummar et al.	- Lower Litani watershed - Water supply/demand - Water quality - Legislation - Hydrogeology - River management	2009	Journal Article
18	Optimisation for sustainable water resources management. Case Study: Lower Litani Basin – Lebanon	ELARD	- Lower Litani watershed - Water supply/demand - Water quality - Legislation - Hydrogeology - River management	2006	Report
19	ACF / Technical consultancy for project design and contract follow up – swim quality control program in South Lebanon	ELARD	- Water quality - Litani River basin - Wells - WWTP - Turbidity - Mitigation and Management - Upper Litani mixing with Lower Litani - Contamination	2013	Report
20	Updated Master Plan for the Closure and Rehabilitation of Open Dumpsites Throughout the Country of Lebanon	ELARD	- Solid waste - Soil and Sediment Quality - Water Quality	2017a	Report

	Publication Title	Author	- Theme/Topic	Year	Publication Type
21	DAI – Lebanon Water Project / Assessment of River Gauging Stations in Lebanon / Litani Lower Watershed	ELARD	- Lower Litani Watershed - Performance efficiency - Monitoring	2017b	Report
22	Dynamics of the toxin *Cylindrospermopsin* and the cyanobacterium *Chrysoporum (Aphanizomenon) ovalisporum* in a Mediterranean eutrophic reservoir	Fadel et al.	- *Chrysosporum ovalisporum* - Cyanobacteria - Qaraaoun reservoir - Nutrients	2014	Academic Publication
23	First Assessment of the ecological status of the Karaoun reservoir, Lebanon	Fadel et al.	- Eutrophication - Litani River Basin - Phytoplankton diversity - Water Quality - Water Level`	2018	Academic Publication
24	Environmental factors associated with phytoplankton succession in a Mediterranean reservoir with a highly fluctuating water level	Fadel et al.	- Eutrophication - Qaraaoun Reservoir - Phytoplankton - Thermal Stratification	2015	Academic Publication
25	Water Quality for Agriculture	FAO	- Water Quality evaluation - Contamination - Livestock and Poultry WQ - Wastewater Irrigation	1989	Report
26	Guide to efficient plant nutrition management	FAO	- Sources of plant nutrients - Nutrients management - Policy	1996	Report
27	International Code of Conduct on the Distribution and Use of Pesticides	FAO	- Legislation - Pesticide management - Health and environmental risks	2002	Report

	Publication Title	Author	- Theme/Topic	Year	Publication Type
28	FAO / Control of water pollution from agriculture – FAO Irrigation and Drainage Paper	FAO - Ongley Edwin	- Agricultural water pollution - Sediment pollution - Fertilizers/Pesticides	1996	Report
29	Effect of environmental conditions on bio uptake of Cu and Pb from natural freshwaters by Chlamydomonas reinhardtii: a case study, Litani River, Lebanon	Flouty Roula	- Algae: *Chlamydomonas reinhardtii* - Metal contamination - Litani River - Water quality - Biosorption	2016	Academic Publication
30	Groundwater conditions in South Lebanon between the Awali and Litani rivers	Hamzeh M	- South Lebanon - Groundwater conditions - Aquifers - Pollution/contamination	2000	Thesis (MSc)
31	Eighth International Conference on Material Sciences / Water quality of the Upper Litani river basin, Lebanon	Haydar et al. / Faculty of Sciences, Lebanese University / LEM / Industrial Research Institute (IRI)	- Litani River - Physiochemical characteristics - Water quality - Anthropogenic waste water	2014	Academic Publication
32	Eighth International Conference on Material Sciences / Assessing contamination level of heavy metals in the lake of Qaraaoun. Lebanon	Haydar et al. / Lebanese University / Laboratoires Environnement et Mineralugie (LEM) /	- Lake Qaraaoun - Heavy metal concentration - Sediment analysis - pollution	2014	Academic Publication
33	Towards an ecosystem approach to the sustainable management of the Litani watershed	IDRC	- Litani Watershed - Hydrogeology - Water quality - Sediment analysis - Lower Litani - Socio-economic attributes	2007	Report
34	Investigation on macrophyte development in Litani River subjected to human disturbances	Ismail et al.	- Macrophytes - Litani River - Antropic disturbance - Qaraaoun Lake	2009	Academic Publication

	Publication Title	Author	- Theme/Topic	Year	Publication Type
35	Comparative analysis of results obtained from 3 indexes (SEQ-Eau, IBD, IPS) used to assess water quality of the Berdawni, a Mediterranean stream at the Beqaa Region – Lebanon	Ismail et al.	- Trophic quality - Biological index - Chemical index - Litani River - Water quality	2015	Academic publication
36	Metal binding in soil cores and sediments in the vicinity of a dammed agricultural and industrial watershed	Kanbar et al.	- Qaraaoun Reservoir - Soil vs. Sediment analysis - Physicochemical parameters - Metal content	2014	Academic Publication
37	The environmental impacts of humans on groundwater in Lebanon	Khair et al.	- Private wells - Precipitation - Water quality - River discharge	1993	Academic Publication
38	Litani River Pollution from Qaraaoun to Qasmiyeh	Kodeih	- Water quality - Litani river basin - Waste disposal	2016	Report
39	Spatial and temporal assessment of metal pollution in the sediments of the Qaraaoun reservoir, Lebanon	Korfali et al.	- Metal contamination - Qaraaoun reservoir - Economic/industrial development	2016	Academic Publication
40	Occurrence of pesticide residues in Lebanon's water resources	Kouzhaya et al.	- Pesticides - Contamination - Lebanese waters - Water quality	2013	Academic Publication
41	Anaerobic digestion of pesticide plant wastewater	Lin C.	- Water contamination - Pesticides - Wastewater - Anaerobic digestion	1990	Academic Publication
42	Investigating the temporal variability of the standardized precipitation index in Lebanon	Mahfouz et al.	- Drought - Standardized Precipitation Index - Lebanon	2016	Academic Publication

	Publication Title	Author	- Theme/Topic	Year	Publication Type
43	Temporal Changes in the Lebanese Litani river: hydrological assessment and recommended actions to handle the human and global change impacts	Nassif et al. / Faculty of Agricultural Engineering and Veterinary Sciences, Lebanese University, Dekwane, El Maten, Lebanon. / National Council for Scientific Research in Lebanon	- Climatic/hydrologic trends - Litani river basin - Rainfall/river discharge - Anthropogenic impact - Water shortage	2015	Academic Publication
44	Evaluation of the physicochemical characteristics of water in the Lower Litani Basin, Lebanon	Nehme et al	- Physicochemical properties - Lower Litani basin - Pollution - Heavy metals	2013	Academic Publication
45	Eighth International Conference on Material Sciences / Study of the correlation of the physicochemical characteristics of the Litani lower river basin	Nehme et al.	- Contamination - Physicochemical parameters - Agricultural/Irrigation - WWTP - Lower Litani basin	2014a	Academic Publication
46	Eighth International Conference on Material Sciences / The distribution of heavy metals in the Lower River Basin, Lebanon	Nehme et al. / Faculty of Sciences, Lebanese University / LEM / School of Mechanical and Materials Engineering, Washington State University.	- Lower Litani River Basin - Heavy metal concentration - Sediment analysis - Seasonal variation	2014b	Academic Publication
47	Metal Concentrations in river water and bed sediments of the lower Litani river basin, Lebanon	Nehme et al. / MCEMA Laboratory, Lebanese University, Beirut, Lebanon.	- Contamination - Agricultural/Industrial - Wastewater - Sediment Analysis - Lower Litani river	2014c	Academic Publication
48	Evaluation de la qualité de l’eau du basin inférieur de la rivière du Litani, Liban: approche environnementale	Nehme Nada / Université du Lorraine	- Hydrogeology Lower Litani River Basin - Physico-Chemical parameters - Water Quality Analysis - Heavy Metal Contamination - Socio economic parameters	2014	Thesis (PhD)

	Publication Title	Author	- Theme/Topic	Year	Publication Type
49	Correlation between teleconnection patterns and temporal climate variation in the Litani Basin – Lebanon	Ramadan et al	- Litani river basin - Precipitation - Annual and seasonal variance - Hydro-climatology	2013	Conference
50	Temperature and Precipitation Trends in Lebanon's Largest River: The Litani Basin	Ramadan et al.	- Litani River Basin - Watershed - Precipitation Trends - Temperature variations - Runoff	2013	Academic Publication
51	Inter-annual temperature and precipitation variations over the Litani basin in response to atmospheric circulation patterns	Ramadan et al.	- Climatology - Litani River Basin - Precipitation	2011	Academic Publication
52	Modelling streamflow trends for a watershed with limited data: case of the Litani basin, Lebanon	Ramadan et al. / Department of Transportation, California / Structural Hazards and Response Research, FM Global / Department of Civil and Environmental Engineering, Concordia University	- Litani River Basin - Streamflow and Runoff	2012	Academic Publication
53	Climate effects on the Litani basin watershed in Lebanon	Ramadan H.	- Litani River Basin - Precipitation - Climatology - Runoff	2012	Thesis (PhD)
54	Physicochemical Evaluation of the Upper Litani River Watershed, Lebanon	Saadeh et al.	- Litani River Basin - Surface/Subsurface water quality - Eutrophication - Climate Change	2012	Academic Publication
55	Preliminary flood frequency estimates for Lebanon	Sene et al.	- Flood estimation - Lebanon	2001	Academic Publication

	Publication Title	Author	- Theme/Topic	Year	Publication Type
56	Indicators and aspects of Hydrological drought in Lebanon	Shaban A.	- Climate change - Hydrologic drought - Surface/subsurface water - Litani River	2009	Academic Publication
57	Analysis of long-term fluctuations in stream flow time series: an application to Litani River, Lebanon	Shaban et al.	- Litani River - Run-off - Stream flow	2014	Academic Publication
58	Litani River Basin Management Support Program: Groundwater Modelling Within the Upper Litani Basin Report	USAID	- Hydrogeology - Litani River Basin - Groundwater data - Wells analysis	2013	Report
59	Republic of Lebanon Country Environmental Analysis	World Bank	- Lebanese Environmental Spending - Solid Waste and Waste Water Strategy - Policies and Legislation	2011	Report
60	Occurrence and levels of pesticides in South Lebanon waters	Youssef et al.	- Pesticides - Surface/groundwater - South Litani region	2015	Academic Publication
61	Use of GIS and Remote Sensing for Mapping the Violations on Lower Litani River Public Domain	A. Kalout and M. Asaad, IUL	- Litani River Basin - South Litani region - GIS - Riverine Public Domain Encroachment	2017	Academic Publication

8. APPENDICES

APPENDIX A – GEOLOGICAL AND HYDROGEOLOGICAL MAPS OF THE LOWER LITANI RIVER BASIN


Legend
Lower Litani Basin
Villages
Springs
Public Wells
Syncline
Anticline
Cross Section
Streams
Mediterranean Sea
Faults
Litani River
Elevation Contour Lines (50 m)
Geological Formations
Quaternary Deposits (Q)
Pliocene Basalts (βP)
Middle to Upper Miocene Formation (mcg)
Upper Eocene Formation (e2b)
Lower Eocene Formation (e2a)
Chekka Formation (C6)
Sannine-Maameltain Formation (C4-C5)
Hammana Formation (C3)
Mdairej Formation (C2b)
Abieh Formation (C2a)
Chouf Basalts (βC1)
Chouf Sandstone (C1)
Salima Formation (J7)
Bikfaya Formation (J6)
Bhannes Formation (J5)
Kesrouane Formation (J4)
International Border
N
Occupied Palestine
Syria
0
10
20
Km
A
A'
B
B'
C
C'
Yammouneh Fault


Legend
Lower Litani Basin
Villages
Springs
Public Wells
Syncline
Anticline
Mediterranean Sea
Streams
Groundwater Flow Direction
Faults
Litani River
Elevation Contour Lines (50 m)
International Border
Groundwater Basins (UNDP, 2014)
Cretaceous Basins (C4-C5)
20a C4-C5, Jarmaq Cretaceous Basin
20b C4-C5, Jezzine Basin
19a C4-C5, Naqoura-Sarafand Cretaceous Basin
6 C4-C5, Qaraoun Cretaceous Basin
Chouf Sandstone Basins (C1)
27a C1, Jezzine-Chouf Sandstone Basin
Eocene Basins
10 Eocene, Eastern Bekaa Eocene Basin
24a Eocene, Nabatiye-Bent Jbeil Eocene Basin
4 Eocene, Southern Bekaa Eocene Basin
24b Eocene, Sour-Sarafand Eocene Basin
Jurassic Basins (J4-J7)
1a J4-J7, Eastern Barouk-Niha Jurassic Basin
1b J4-J7, Southern Barouk-Niha Jurassic Basin
17a J4-J7, West Barouk-Niha Jurassic Basin
Quaternary Basins
26a Quaternary, Southern Quaternary Basin
Unproductive Basins
12 BP, Unproductive
28/12 C2-C3, Unproductive
30/12 C6, Unproductive
30 e2a, Unproductive
30 m, Unproductive
N
Occupied Palestine
Syria
0 10 20 Km

APPENDIX B – SURVEY QUESTIONNAIRES

Municipal Survey Questionnaire

استمارة مسح المنطقة

البيانات الجغرافية والتعريفية	
اسم المحلة	
اسم المنطقة (المناطق) الملحقة	
السلطة المسؤولة	
عضوية في اتحاد بلديات	☐ كلا ☐ نعم، حدّد: ________________________
اسم المجيب وصفته المهنية	
رقم للإتصال (للتأكد من المعلومات)	

الأراضي ووجهة استعمالها			ملاحظات (املأ أسماء المحال)
المساحة الإجمالية للمنطقة: ________________ (حدّد الوحدة: م٢ او كم٢)			
وجهة استعمال الأراضي أو تصنيفها	زراعة: _____% سكن: ______% صناعة: _______% مناطق غير المبنيّة (مثلاً: مناطق طبيعية أو أخرى غير محدّدة): _____%		
هل يوجد مخطط توجيهي للمنطقة؟	☐ نعم، رقم المرسوم وسنة إصداره: ________________________________ ☐ كلا		
هل يوجد....	☐ مراكز تربوية؟	☐ جامعات ومعاهد، عددها: __، مجموع عدد الطلاب: _________ ☐ حضانات ومدارس، عددها: __، مجموع عدد الطلاب: _________ ☐ غيرها: ____________، عددها: __، مجموع عدد مستخدِميها: ______	

الأراضي ووجهة استعمالها			ملاحظات (املأ أسماء المحال)
	☐ مراكز خدمات اجتماعية	☐ دور العجزة، عددها: __، مجموع عدد قاطنيها: ___________ ☐ دور الأيتام، عددها: __، مجموع عدد قاطنيها: ____________ ☐ غيرها: _________، عددها: __، مجموع عدد مستخدِميها: ________	
	☐ مراكز حكومية أو عسكرية	☐ إدارات رسمية، عددها: __، مجموع عدد مستخدِميها: _____________ ☐ مخافر، عددها: __، مجموع عدد مستخدِميها: ________________ ☐ ثكنات عسكرية/قوات اليونيفيل، عددها: __، مجموع عدد مستخدِميها: ____ ☐ غيرها: ___________، عددها: __، مجموع عدد مستخدِميها: ______	
	☐ مستشفيات	☐ حكومية، عددها: __، مجموع عدد الأسرّة: ______________ ☐ خاصة، عددها: __، مجموع عدد الأسرّة: ______________	
	☐ مستوصفات	☐ عددها: _____	
	☐ عيادات طبية وأسنان	☐ عددها: _____	
	☐ مختبرات	☐ عددها: _____	
	☐ مزارع لتربية الدواجن أو المواشي	☐ مزارع الدواجن، عددها: __، مجموع عدد الطيور فيها: __________ ☐ مزارع الأبقار، عددها: __، مجموع عدد الأبقار فيها: _________ ☐ مزارع الأغنام والماعز، عددها: __، مجموع عدد المواشي: ________	
	☐ ملاحم	☐ ملاحم الأبقار، الأغنام والماعز، عددها: ______ ☐ ملاحم الدجاج، عددها: ______	
	☐ مسالخ	هل تضم المحلة مسلخ موحّد يتم اعتماده للذبح اليومي؟ ☐ كلا ☐ نعم	

<table dir="rtl">
<tr><th colspan="3">الأراضي ووجهة استعمالها</th><th>ملاحظات (املأ أسماء المحال)</th></tr>
<tr><td rowspan="4"></td><td></td><td>اجمالي عدد الرؤوس التي تذبح: ______</td><td></td></tr>
<tr><td>☐ معاصر الزيتون</td><td>هل تضم المحلة معاصر زيتون قائمة؟ ☐ كلا ☐ نعم، عددها: ____
ما هي وضعها الحالي؟ ☐ تعمل ☐ متوقفة عن العمل ☐ قيد الانشاء
اجمالي طاقتها الانتاجية (من الزيت): ____ م٣ أو طن</td><td></td></tr>
<tr><td>☐مقالع الرمال والكسارات</td><td>هل تضم المحلة مقالع الرمال و/أو كسارات؟ ☐ كلا ☐ نعم، عددها: ____
ما هي وضعها الحالي؟ ☐ تعمل ☐ متوقفة عن العمل ☐ قيد التأهيل ☐ قيد الانشاء
هل هي مرخّصة: ☐ كلا، عددها: ___ ☐ نعم، عددها: ___
اجمالي طاقتها الاستخراجية: ____ م٣ أو طن
ما هو دور البلدية الحالي في تنظيم عملها: ______________________________
______________________________</td><td></td></tr>
<tr><td>☐ محطات للوقود وغسيل السيارات؟</td><td>☐ محطات الوقود، عددها: __، مساحات الإشغال: _______ م٢
☐ كاراجات تصليح السيارات، عددها: __، مساحات الإشغال: _______ م٢
☐ مغاسل السيارات، عددها: __، مساحات الإشغال: _______ م٢</td><td></td></tr>
<tr><td></td><td>☐ منتجعات سياحية (مقاهي واستراحات)</td><td>عددها: _______
هل هي مرخّصة: ☐ كلا، عددها: ___ ☐ نعم، عددها: ___</td><td></td></tr>
<tr><td colspan="4">ملاحظات:</td></tr>
</table>

<table dir="rtl">
<tr><th colspan="4">السكان، المساكن والأبنية</th><th>ملاحظات (مثلاً مصدر المعلومات)</th></tr>
<tr><td>اجمالي عدد السكان القاطنين (للعام الماضي (٢٠١٧))</td><td colspan="3">__________ نسمة
من بينهم، دائمون: __________ نسمة
موسميون: __________ نسمة
لاجئون سوريون: __________ نسمة
لاجئون فلسطينيون: __________ نسمة
عمال أجانب: __________ نسمة</td><td></td></tr>
<tr><td>عدد المباني
عدد الوحدات السكنية</td><td colspan="3">__________ مبنى
__________ وحدة</td><td></td></tr>
<tr><td>متوسط عدد أفراد الأسرة لكل وحدة سكنية</td><td colspan="3">__________ فرد/ الوحدة السكنية</td><td></td></tr>
<tr><td rowspan="2">عدد رخص البناء الممنوحة خلال السنوات الثلاث الماضية</td><td>٢٠١٥</td><td>٢٠١٦</td><td>٢٠١٧</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">نسبة إشغال الوحدات السكنية: _______ %</td><td></td></tr>
<tr><td colspan="4">عدد المشاريع السكنية قيد الإنجاز أو الترخيص (٢٠١٨): ______________</td><td></td></tr>
<tr><td colspan="4">الوحدات السكنية التي يشغلها اللاجئون السوريون:☐ شقق سكنية، عددها:______ ☐ خيم مؤقتة، عددها: ______</td><td></td></tr>
<tr><td colspan="4">ملاحظات:</td><td></td></tr>
</table>

<table dir="rtl">
<tr><th colspan="2">النشاط الصناعي (مؤسسات صناعية مصنفة بحسب المرسوم ٢٠٠١/٥٢٤٣ ومؤسسات غير مصنفة بحسب المرسوم ١٩٩٤/٤٩١٧)</th><th>ملاحظات</th></tr>
<tr><td>هل تضم المحلة مصانع تعمل حالياً؟</td><td>☐ كلا☐ نعم، عددها: ______________
اجمالي عدد المصانع العاملة في نطاق المحلة: ______________
أنواع الصناعات: ______________________________
______________________________</td><td></td></tr>
<tr><td>تراخيص الانشاء والاستثمار الصناعي</td><td>اجمالي عدد المصانع المرخّص لها: ____________
نشاطها الصناعي:______________________________
اجمالي عدد المصانع غير المرخّص لها: ____________
نشاطها الصناعي:______________________________</td><td></td></tr>
</table>

<table>
<tr><th colspan="2">النشاط الصناعي (مؤسسات صناعية مصنفة بحسب المرسوم ٢٠٠١/٥٢٤٣ ومؤسسات غير مصنفة بحسب المرسوم ١٩٩٤/٤٩١٧)</th><th>ملاحظات</th></tr>
<tr><td>معلومات عن المؤسسات الصناعية العاملة في نطاق المحلة
الرجاء العودة الى الملحق ١ من هذه الاستمارة
Categorical Information: Industrial Activity</td><td>
<table>
<tr><th>الفئة</th><th>اسم المؤسسة الصناعية</th><th>نشاطها الصناعي</th><th>ملاحظات</th></tr>
<tr><td>١</td><td></td><td></td><td></td></tr>
<tr><td>٢</td><td></td><td></td><td></td></tr>
<tr><td>٣</td><td></td><td></td><td></td></tr>
<tr><td>٤</td><td></td><td></td><td></td></tr>
<tr><td>٥</td><td></td><td></td><td></td></tr>
</table>
</td><td></td></tr>
<tr><td colspan="2">هل يوجد مناطق مصنفة صناعياً وفق مخطط توجيهي للمحلة؟ ☐ كلا ☐ نعم
نسبة المؤسسات الصناعية الواقعة في مناطق مصنفة: _____% (من اجمالي المؤسسات الصناعية)
هل يوجد مناطق تجمع صناعية محددة؟ ☐ كلا ☐ نعم، أين تقع؟ ____</td><td></td></tr>
<tr><td colspan="3">ملاحظات:</td></tr>
</table>

مصادر مياه الشرب والخدمة			ملاحظات
ما هو (هي) مصدر (مصادر) مياه الشرب والإستعمال المنزلي المستخدمة من قبل السكان؟ *الرجاء تحديد تفاصيل المصدر، خصائصه والنسبة المئوية من السكان الذين يستعملونه(ا).*	☐ **بئر (آبار) عام(ة) في النطاق البلدي**، النسبة: ____%		
	١	وضعه الحالي: ☐ مستمر☐ غير مستمر☐ قيد الانشاء/الحفر العمق: ______م، الإحداثيات (أو العنوان) لموقعه: ______________________________ من يديره؟ ☐ البلدية ☐ الأهالي ☐ مصلحة مياه ______________ مصدر الطاقة المستهلكة في مضخة البئر (شركة الكهرباء/مولّد احتياطي/...): ________________ الإستطاعة الكهربائية: ________ (kVA)، قطر أنابيب الضخ: _________ هل مياه البئر موزّعة على المنازل؟ ☐ كلا ☐ نعم، النسبة: _____% هل يتم تحليل نوعية مياه البئر دورياً؟ ☐ كلا ☐ نعم، النتائج: __________________________	
	٢	وضعه الحالي: ☐ مستمر☐ غير مستمر☐ قيد الانشاء/الحفر العمق: ______م، الإحداثيات (أو العنوان) لموقعه: من يديره؟ ☐ البلدية ☐ الأهالي ☐ مصلحة مياه ______________ مصدر الطاقة المستهلكة في مضخة البئر (شركة الكهرباء/مولّد احتياطي/...): ________________ الطاقة الإنتاجية: ________ (كيلوواط)، قطر أنابيب الضخ: _________ هل مياه البئر موزّعة على المنازل؟ ☐ كلا ☐ نعم، النسبة: _____% هل يتم تحليل نوعية مياه البئر دورياً؟ ☐ كلا ☐ نعم، النتائج: __________________________	
	٣	وضعه الحالي: ☐ مستمر☐ غير مستمر☐ قيد الانشاء/الحفر العمق: ______م، الإحداثيات (أو العنوان) لموقعه:____________________- من يديره؟ ☐ البلدية ☐ الأهالي ☐ مصلحة مياه ______________ مصدر الطاقة المستهلكة في مضخة البئر (شركة الكهرباء/مولّد احتياطي/...): ________________ الطاقة الإنتاجية: ________ (كيلوواط)، قطر أنابيب الضخ: _________ هل مياه البئر موزّعة على المنازل؟ ☐ كلا ☐ نعم، النسبة: _____% هل يتم تحليل نوعية مياه البئر دورياً؟ ☐ كلا ☐ نعم، النتائج: __________________________	
	☐ **نبع (ينابيع) في النطاق البلدي**، النسبة: ____%		
	١	اسم النبع: ________ احداثيات (أو عنوان) موقع النبع: ____________________ وضعه الحالي: ☐ مستمر☐ غير مستمر من يديره؟ ☐ البلدية ☐ الأهالي ☐ مصلحة مياه ______________ كمية تدفّق المياه: __________ م^3 هل مياه النبع موزّعة على المنازل؟ ☐ كلا ☐ نعم، النسبة: _____% هل يتم تحليل نوعية مياه النبع دورياً؟ ☐ كلا ☐ نعم، النتائج: __________________________	
	٢	اسم النبع: ________ احداثيات (أو عنوان) موقع النبع: ____________________	

مصادر مياه الشرب والخدمة	ملاحظات
وضعه الحالي: ☐ مستمر☐ غير مستمر من يديره؟ ☐ البلدية ☐ الأهالي ☐ مصلحة مياه __________________ كمية تدفّق المياه: ____________ م٣ هل مياه النبع موزّعة على المنازل؟ ☐ كلا ☐ نعم، النسبة: _____% هل يتم تحليل نوعية مياه النبع دورياً؟ ☐ كلا ☐ نعم، النتائج: __________________________________	
☐ **بئر (آبار) خاص(ة) يديره(ا) السكان**، النسبة: ____%	
معدل عمق البئر (الآبار): _______م	
كمية تدفّق المياه: ___________ م٣	
عدد الآبار الخاصة المرخّصة: _______________	
عدد الآبار الخاصة غير المرخّصة: ________________	
☐ **مياه معبأة / مباعة**، النسبة: ____%	
مصادر مياه التعبأة: __________________________________	
☐ **مياه سطحية**، النسبة: ____%	
المصادر (نهر/برك تجميع مياه الشتاء/...): ____	
☐ **مياه الشبكة**، النسبة: ____%	
الحالة: ☐ جيدة ☐ وسط ☐سيئة ☐لا يوجد	
تاريخ الإنشاء: _________الجهة المموّلة/المنفّذة: ___________________	
أحدث تاريخ لأعمال التأهيل: ☐ جزئي، السنة ☐_______ كامل، السنة ________	

ملاحظات:

<table dir="rtl">
<tr><th colspan="3">خدمات الصرف الصحي</th><th>ملاحظات</th></tr>
<tr><td rowspan="9">كيف يتم تصريف المياه المبتذلة؟
الرجاء اعطاء التفاصيل كتابةً.</td><td colspan="2">☐ **شبكة الصرف الصحي**</td><td></td></tr>
<tr><td colspan="2">الحالة: ☐ جيدة ☐ وسط ☐سيئة ☐لا يوجد</td><td></td></tr>
<tr><td colspan="2">تاريخ الإنشاء: ________الجهة المموّلة/المنفّذة: __________________</td><td></td></tr>
<tr><td colspan="2">أحدث تاريخ لأعمال التأهيل: ☐ جزئي، السنة ☐_______ كامل، السنة ________</td><td></td></tr>
<tr><td colspan="2">نسبة الوحدات السكنية الموصولة بالشبكة: _____%
نسبة المؤسسات الصناعية الموصولة بالشبكة: _____%
إذا لم تكن نسبة الوحدات/ المؤسسات الموصولة بالشبكة ١٠٠%، حدّد الأسباب أو العوائق لعدم وصلها بالشبكة:
____
____</td><td></td></tr>
<tr><td colspan="2">طريقة الصرف النهائي:
☐ تضخ او تجر بالجاذبية للتصريف في اقرب مجرى مياه سطحية: __________
☐ تضخ او تجر بالجاذبية للتصريف في اقرب معمل لمعالجة مياه الصرف الصحي
موقع محطة المعالجة: _____________، القدرة التصميمية: _______________م٣ يومياً، الحالة التشغيلية: _____________%، التقنية المستخدمة في المعالجة: _______________________
☐ طرق أخرى، حدّد: ____</td><td></td></tr>
<tr><td>☐ **حفر تسريب**، نسبة ______%</td><td>☐ **خزانات صرف صحي**، نسبة _____%</td><td></td></tr>
<tr><td>حجم الإستيعاب: ___ - __ م٣
الصيانة الدورية: _________</td><td>حجم الإستيعاب: ___ - ___ م٣
الصيانة الدورية: ___________</td><td></td></tr>
<tr><td>طريقة الصرف النهائي:
☐ تُفرّغ عبر شاحنات تابعة لِـ أو متعاقدة مع البلدية
حدّد الكميات المنقولة سنوياً: ______________ م٣
أين تُفَرّغ؟ ___________________________
☐ تُفرّغ عبر شاحنات خاصة مُستأجرَة من قِبَل السكان
☐ تترك للمعالجة الطبيعية/تسريب الى الأرض
☐ طُرق أخرى، حدّد:_________________________</td><td>طريقة الصرف النهائي:
☐ تضخ او تجر بالجاذبية للتصريف في اقرب مجرى مياه سطحية: __________
☐ تضخ او تجر بالجاذبية للتصريف في اقرب معمل لمعالجة مياه الصرف الصحي: ______________
☐ تُفرّغ عبر شاحنات تابعة لِـ أو متعاقدة مع البلدية
حدّد الكميات المنقولة سنوياً: ____________ م٣
أين تُفَرّغ؟ ___________________________
☐ تُفرّغ عبر شاحنات خاصة مُستأجرَة من قِبَل السكان</td><td></td></tr>
</table>

خدمات الصرف الصحي			ملاحظات
		☐ تترك للمعالجة الطبيعية/تسريب الى الأرض ☐ طُرق أخرى، حدّد: ______________________	
هل لدى البلدية أية خطط مستقبلية أو حالية لإنشاء محطة لمعالجة مياه الصرف الصحي أو المشاركة مع البلديات المجاورة في إنشاء محطة لمعالجة مياه الصرف الصحي؟ ☐ كلا ☐ نعم، حدّد البلديات المشاركة ومصادر التمويل إذا كانت متوفّرة: _________________ ____			

خدمات النفايات الصلبة		ملاحظات
ما هي كمية النفايات الصلبة المُنتجة في نطاق المحلة؟ ________ طن/اليوم		
كيف تتوزّع أنواعها؟	☐ نفايات منزلية صلبة، نسبة: _____% ☐ نفايات صناعية صلبة، نسبة: _____% ☐ نفايات صلبة ناتجة عن مؤسسات تجارية وحرفية، نسبة: _____% ☐ نفايات صلبة ناتجة عن معاصر الزيتون، نسبة: _____% ☐ نفايات المراكز الصحية، نسبة: _____% ☐ غيرها، حدّد: __________________، نسبة: _____% __________________، نسبة: _____% __________________، نسبة: _____% __________________، نسبة: _____%	
كيف يتم جمع النفايات الصلبة؟ ______________________________________ ____ ما هي البنى التحتية الخاصة بالنفايات التي تملكها البلدية؟ ☐ براميل، حدّد نوعها وسعتها ______________________________ ☐ آليات جمع، حدّد نوعها ______________________________ ☐ عقار مخصص للتخلص من النفايات ☐ غيرها، حدّد: ______________________________		
كيف يتم التخلّص من النفايات الصلبة؟ ______________________________ هل تختلف طريقة التخلّص بحسب الأنواع المحدّدة أعلاه؟ ☐ كلا ☐ نعم، حدّد: ____________________ موقع أقرب مركز معالجة/مكب/مطمر: ______________________________ متى تمّ استحداث مركز المعالجة/المكب/المطمر؟ سنة __________ حدّد المسافة التي تفصله عن مجرى نهر الليطاني: ________ كم هل تمّ بناء حواجز تفصل مركز المعالجة/المكب/المطمر عن النهر؟ ☐ كلا ☐ نعم، حدّد: __________________		

<table dir="rtl">
<tr><th colspan="4">خدمات النفايات الصلبة</th><th>ملاحظات</th></tr>
<tr><td colspan="4">______________________________
هل من تأثير مباشر على تلوّث النهر من مركز المعالجة/المكب/المطمر؟ ☐ كلا ☐ نعم، حدّد: ______________________</td><td></td></tr>
<tr><td colspan="4">من يدير مركز المعالجة/المكب/المطمر (متعهد خاص/بلدية/ ...)؟ الرجاء التحديد. ______________________
______________________________</td><td></td></tr>
<tr><td colspan="4">ما هي الميزانية التي تدفعها البلدية سنوياً للتخلّص من النفايات؟ حدّد المبالغ المدفوعة عن السنوات الثلاث الماضية.</td><td></td></tr>
<tr><td></td><td>٢٠١٥</td><td>٢٠١٦</td><td>٢٠١٧</td><td></td></tr>
<tr><td>المبلغ</td><td></td><td></td><td></td><td></td></tr>
<tr><td>النسبة من ميزانية البلدية</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">هل لدى البلدية أية خطط مستقبلية أو حالية لإنشاء معمل/مطمر لمعالجة النفايات أو المشاركة مع البلديات المجاورة في إنشاء معمل/مطمر لمعالجة النفايات الصلبة؟ ☐ كلا ☐ نعم، حدّد البلديات المشاركة ومصادر التمويل إذا كانت متوفّرة:______________________
______________________________</td><td></td></tr>
</table>

النشاطات الحالية والمستقبلية
ما هي النشاطات الحالية والمستقبلية للبلدية المتعلقة **بنفايات المصانع والمستشفيات ومعاصر الزيتون (صلبة وسائلة)**؟

Annex 1: Categorical Information on Industries

Categorical Information: Industrial Activity
O Animal Production ☐ Raising of cattle and buffaloes ☐ Raising of sheep and goats ☐ Raising of poultry
O Manufacture of basic metals ☐ Basic iron & steel ☐ Basic precious & other non-ferrous metals ☐ Casting of iron & steel ☐ Casting of non-ferrous metals
O Manufacture of beverages ☐ Distilling, rectifying & blending of spirits ☐ Wines ☐ Soft drinks; production of mineral waters & other bottled waters
O Manufacture of chemicals and chemical products ☐ Basic chemicals ☐ Fertilizers & nitrogen compounds ☐ Plastics & synthetic rubber in primary forms ☐ Pesticides & other agrochemical products ☐ Paints, varnishes & similar coatings, printing ink & mastics ☐ Soap & detergents, cleaning & polishing preparations, perfumes & toilet preparations ☐ Other chemical products
O Manufacture of electrical equipment ☐ Electric motors, generators, transformers & electricity distribution & control apparatus ☐ Batteries & accumulators ☐ Domestic appliances

Categorical Information: Industrial Activity
O Manufacture of fabricated metal products, except machinery & equipment ☐ Structural metal products ☐ Tanks, reservoirs & containers of metal ☐ Steam generators, except central heating hot water boilers ☐ Forging, pressing, stamping & roll-forming of metal; powder metallurgy ☐ Treatment & coating of metals; machining ☐ Cutlery, hand tools & general hardware ☐ Other fabricated metal products not elsewhere classified
O Manufacture of food products ☐ Processing & preserving of meat (incl. poultry) ☐ Processing & preserving of fruit & vegetables ☐ Vegetable & animal oils & fats ☐ Dairy products ☐ Grain mill products ☐ Starches & starch products ☐ Bakery products ☐ Sugar ☐ Cocoa, chocolate & sugar confectionary ☐ Macaroni, noodles, couscous & similar farinaceous products ☐ Other food products (e.g. honey, mustard, mayonnaise, vinegar, spices, tea…)
O Manufacture of furniture
O Manufacture of machinery & equipment not elsewhere classified ☐ Lifting & handling equipment ☐ Engines & turbines ☐ Other general-purpose machinery ☐ Agricultural & forestry machinery ☐ Metal-forming machinery & machine tools

Categorical Information: Industrial Activity
☐ Machinery for metallurgy ☐ Machinery for mining, quarrying & construction ☐ Machinery for food, beverage & tobacco processing ☐ Other special-purpose machinery
O Manufacture of non-metallic mineral products ☐ Clay building materials ☐ Articles of concrete, cement and plaster ☐ Cutting, shaping & finishing of stone
O Manufacture of paper & paper products ☐ Pulp, paper & paperboard ☐ Corrugated paper & paperboard & of containers of paper & paperboard ☐ Other articles of paper & paperboard
O Manufacture of rubber & plastics products ☐ Plastics products
O Mining and Quarrying ☐ Quarrying of stone, sand & clay
O Waste collection, treatment & disposal activities; materials recovery ☐ Collection of non-hazardous waste ☐ Collection of hazardous waste ☐ Treatment & disposal of non-hazardous waste ☐ Treatment & disposal of hazardous waste ☐ Materials recovery
O Water collection, treatment & supply ☐ Water collection, treatment & supply ☐ Sewerage
O Wholesale & retail trade & repair of motor vehicles & motorcycles ☐ Maintenance & repair of motor vehicles

Farmer's Survey Questionnaire

عن ..... حتى .....

إسم المزارع:	المنطقة:	التاريخ: ...../...../٢٠١٨	إسم مالىء الإستمارة: ....
المساحة الكاملة المستصلحة من قبل المزارع:		☐ ايجار ......%، منذ سنة ...... ولمدة ....☐ ملك ....%، منذ سنة	
مساحة الأراضي المزروعة:		مساحة الأراضي المروية:	
مساحة الأراضي غير المزروعة:		الإحداثيات: E .... N	

١- استعمال مبيدات الحشرات والأعشاب

المحصول والمساحة المزروعة	تاريخ الزرع	مصدر مياه الري / طريقة الري	المبيدات المستخدمة ومكوّناتها	معدّل الإستخدام (كلغ أو ليتر) لكل دنم	السعر (حدّد الوحدة)	المزوّد	تاريخ الرش الأوّل:			تاريخ الرش الثاني:			تاريخ الرش الثالث:		
							مرحلة المحصول	الكمية المستخدمة / دنم	طريقة الرش	مرحلة المحصول	الكمية المستخدمة / دنم	طريقة الرش	مرحلة المحصول	الكمية المستخدمة / دنم	طريقة الرش

٢- استعمال الأسمدة الكيميائية والعضوية

المحصول والمساحة المزروعة	تاريخ الزرع	مصدر مياه الري / طريقة الري	الأسمدة المستخدمة ومكوّناتها	معدّل الإستخدام (كلغ أو ليتر) لكل دنم	السعر (حدّد الوحدة)	المزوّد	تاريخ الرش الأوّل:			تاريخ الرش الثاني:			تاريخ الرش الثالث:		
							مرحلة المحصول	الكمية المستخدمة / دنم	طريقة الرش*	مرحلة المحصول	الكمية المستخدمة / دنم	طريقة الرش*	مرحلة المحصول	الكمية المستخدمة / دنم	طريقة الرش*

* طريقة الرش: (١) يدوي(٢) آلي (جرّار أو تراكتور)(٣) خلّاط(٤) فينتوري (بخّاخ)

٣- الرجاء ابداء الأي حول المواضيع التالية:

	لا أوافق مطلقاً	لا أوافق	لست متأكد / لا أدري	أوافق	أوافق تماماً
(أ) مياه نهر الليطاني ملوثّة	١	٢	٣	٤	٥
(ب) الأسمدة والمبيدات يؤثران سلبياً في نوعية مياه النهر	١	٢	٣	٤	٥
(ج) الري بمياه النهر المشبّعة بالنيترات تفيد الأرض والمحاصيل	١	٢	٣	٤	٥
(د) الإفراط في استعمال الأسمدة والمبيدات يؤثّر سلباً على نوعية التربة	١	٢	٣	٤	٥

٤- برأيك، ما هي أهم مصادر تلوّث النهر؟ ....
....
....

٥- ما المشاكل التي تعاني منها في زراعة الأرض؟

(أ) مشاكل تقنية: ....
(ب)مشاكل في تأمين المياه / نوعية المياه: ....
(ج) مشاكل في تصريف مياه الري: ....
(د) مشاكل تتعلق بتلوّث التربة: ....
(ه) مشاكل تتعلق بانجراف التربة: ....
(و) مشاكل تتعلق بتملّح التربة: ....
(ز) مشاكل تتعلق بخصوبة التربة: ....
(ح) غيرها من المشاكل: ....

٦- هل تدخل المبيدات والأسمدة مع مياه الري؟ ☐ كلا ☐ نعم، إشرح. ....
....

٧- هل تفحص التربة دورياً؟ ☐ كلا ☐ نعم، أين ومتى؟ أعطِ لمحة عن النتائج: ....
....
....

٨- كيف تختار نوعيات الأسمدة والمبيدات التي تستخدمها والكميات التي تضعها على المحصول؟
....
....

٩- ما هو الانتاج المتوقع لكل محصول (كغ/دنم أو طن/دنم)؟...
....

Agricultural Input Suppliers' Survey Questionnaire

Please provide information on the pesticides, herbicides and fertilisers your company has sold / distributed in the last year (January – December 2017), in the Lower Litani River Basin or Bekaa (West Bekaa, Rachaya), Nabatiye (Nabatiye, Marjaayoun, Bent Jbayl, Hasbaiya), South (Saida, Tyre, Jezzine) as per the following:

A. Pesticides and Herbicides:

Pesticide / Herbicide Type (include Active Ingredient Nomenclature)	Quantity sold (specify unit)	Region where produce is sold (Farmers' location)	Type(s) of Crop(s)	Period of planting	Application criteria and recommended dosage	Method of application

B. Chemical and Organic Fertilisers:

Fertiliser Type (include Formulations)	Quantity sold (specify unit)	Region where produce is sold (Farmers' location)	Type(s) of Crop(s)	Period of planting	Application criteria and recommended dosage	Method of application

Please use a separate sheet if needed

Dealer Name:					
Crop:					
Fertilisers					
Common Name	**Concentration & Formulation (NPK)**	**Type (Granular (G), Soluble (S))**	**Application Rate (used by farmer)**	**Application Rate (recommended)**	**Number of Applications**

Dealer Name:

Pesticides

Pesticide Trade Name	Common Name	Concentration & Formulation	Type* (I, A, F, H)	Crop/Pest	Application Rate (used by farmer)	Application Rate (recommended)	Number of Applications

* I (Insecticide), A (Acaricide), F (Fungicide), H (Herbicide)

APPENDIX C – SOCIO-ECONOMIC AND ENVIRONMENTAL PROFILES OF THE FIVE ZONES

Zone 1		Villages' Names	**Baaloul, Hasbaiya, Dellafi, Rachaiya, Rafid, Zilaya, Sohmor, Aaytanit, Ain Et Tineh, Qaraaoun, Qelaya, Kfar Houneh, Kfar Michki** – Nabi Safa, **Kaoukaba Bou Aarab, Libbaya, Majdel Balhis, Mhaiydseh, Machghara**, **Maydoun + Loussia**, **Mimess, Niha, Yohmor B-G**
Geo-political		Altitude Range (m)	530-1820
		Tot. land area (m^2)	203,326,755
		Tot. population (range)	39,975 (835-8,805)
	Source: 2018 Municipal Survey	Resident population (%)	58%
		Seasonal population (%)	23.5%
		Refugee population (%)	17.5%
		Tot. nb. of HHs (range)	8,143 (120-2,500)
		Av. HH size (range)	5.08 (4-7)
Land Cover *(Source: 2013 Land Use/Land Cover Map)*		Agricultural land (%)	20.67%
		Grassland (%)	29.61%
		Wooded Land (%)	16.01%
		Natural Land (%)	25.38%
		Built-up Area (%)	4.3%
Land Use *(Source: 2018 Municipal Survey)*		Nb. of nurseries, schools, institutes & universities; Tot. nb. of students (range)	3 universities and institutes, 326 students (151-175), 25 nurseries and schools, 7,757 students (9-2,588)
		Nb. of community & social service centres; Tot. nb. of users (range)	2 community & social service centres
		Nb. of governmental & military centres; Tot. nb. of users (range)	1 official department, 3 users, 3 police stations, 15 users, 2 barracks, 2 other, 7 users
		Nb. of hospitals; names; Tot. nb. of beds	1 hospital: West Bekaa Hospital – 151 beds
		Nb. of dispensaries; names	3 dispensaries: Al Hajj Mehdi Aydi Amel Health Center – Machghara Machghara Primary Healthcare Center The Lebanese Association for Health and Social Care - Sohmor
		Poultry farms; Tot. nb. of birds	22 poultry farms, 186,200 birds
		Cattle farms; Tot. nb. of heads	60 cattle farms, 527 heads
		Sheep & Goats' farms; Tot. nb. of heads	57 Sheep & Goats' farms, 37,400 heads
		Gas stations; Tot. nb.	22 gas stations
		Garages; Tot. nb.	72 garages
		Vehicle wash centres; Tot. nb.	22 vehicle wash centres
Drinking water		Public Wells	17 wells
		Springs	18 springs
		Private wells	115 private wells
		Vended/Bottled water; Av. % use (range)	45%
		Surface water; Av. % use (range)	0%
Wastewater		Nb. of HHs connected to a WW network	4,929 households
		Nb. of HHs using cesspools	3,214 households
		Nb. of villages with entire network coverage	1 village
		Nb. of villages with partial network coverage, average coverage %	5 villages, 68%
		Nb. of villages with no network coverage	7 villages
		Nb. of existing WWTPs & names of villages served	**1 existing WWTP**. Villages served: **Aaytanit:** Aaytanit, Baaloul, Machghara, Qaraaoun, Sohmor[*]
		Nb. of planned WWTPs & names of villages to be served	**8 planned WWTPs**. Villages to be served: **Ain Et Tineh:** Ain Et Tineh. **Beit Lahya:** Rachaiya. **Jal el Tout:** Mimess. **Libbaya:** Libbaya. **Majdel Balhis:** Nabi Safa, Kaoukaba Bou Arab, Kfar Michki, Majdel Balhis. **Mhaiydseh:** Mhaiydseh, Rafid. **Srifa:** Niha. **Zilaya:** Yohmor, Loussia, Maydoun, Qelaya, Zilaya.
Solid waste		Tot. generated waste per day	34.5 t/day
		Operational dumpsites & names of villages served	**17 dumpsites**. Villages served: **Ain Et Tineh:** Ain Et Tineh, **Aaytanit:** Aaytanit, **Hasbaiya**: Qelaya, **Kaoukaba Bou Arab:** Kaoukaba Bou Arab, **Sohmor:** Sohmor, **Kfar Michki:** Kfar Michki**, Libbaya:** Libbaya**,**

[*] Planned Connection

		Machghara: Machghara**, Majdel Balhis:** Majdel Balhis, **Maydoun:** Maydoun, **Qaraaoun:** Qaraaoun**, Yohmor B-G:** Yohmor B-G, **Zilaya:** Zilaya
Industries	Industrial products	**Categories:** Manufacture of bakery products (2) Manufacture of plastics products (2) Manufacture of articles of concrete, cement and plaster (16) Cutting, shaping and finishing of stone (9) Manufacture of other non-metallic mineral products n.e.c. (1) Manufacture of structural metal products (2) Manufacture of vegetable and animal oils and fats (14) Water collection, treatment and supply (1)
Recreational establishments	Recreational establishments bordering river	15 recreational establishments
Quarries	Tot. nb. & types	**22 quarries:** Rock (21); Sand (1)

Zone 2		Villages' Names	**Bourghos, Blat, Jarmaq** – Demachqiyeh, Mazraat El-Aarqoub, Mazraat Ouazaiye, Mazraat Tamra, **Dibbine, Rihane** – Mazraat Khallet Khazen, Mazraat Qrouh, Mazraat Louzid (Louayziyeh), Ouardiyeh, **Sejoud, Srayri, Chbail, Aaramta, Aaychiyeh** – Mahmoudiyeh, Mazraat Zighrine, **Qatrani, Kfar Roummane, Kaoukaba, Mazraat Daraya, Dellafi, Bouayda, Maydoun + Loussia,** Aali Et Taher**, Kfar Tibnit, Kfar Houneh, Qelaya, Jdaideh (Marjaayoun), Hasbaiya**
Geo-political		Altitude Range (m)	250-1350
		Tot. land area (m²)	144,068,157
		Tot. population (range)	20,828 (146-6,168)
	Source: 2018 Municipal Survey	Resident population (%)	48%
		Seasonal population (%)	37%
		Refugee population (%)	15%
		Tot. nb. of HHs (range)	6,499 (12-3,000)
		Av. HH size (range)	4.8 (4-6)
Land Cover *(Source: 2013 Land Use/Land Cover Map)*		Agricultural land (%)	15.68%
		Grassland (%)	26.46%
		Wooded Land (%)	39.44%
		Natural Land (%)	12.29%
		Built-up Area (%)	6.1%
Land Use *(Source: 2018 Municipal Survey)*		Nb. of nurseries, schools, institutes & universities; Tot. nb. of students (range)	2 universities and institutes, 750 students (50-700), 11 nurseries and schools, 3,700 students (80-2,000)
		Nb. of community & social service centres; Tot. nb. of users (range)	3 community & social service centres
		Nb. of governmental & military centres; Tot. nb. of users (range)	6 official department, 1 police station, 2 barracks
		Nb. of hospitals; names; Tot. nb. of beds	1 hospital: Marjaayoun Governmental Hospital – 49 beds
		Nb. of dispensaries	10 dispensaries
		Poultry farms; Tot. nb. of birds	11 poultry farms, 232,800 birds
		Cattle farms; Tot. nb. of heads	10 cattle farms, 257 heads
		Sheep & Goats' farms; Tot. nb. of heads	19 Sheep & Goats' farms, 6,330 heads
		Gas stations; Tot. nb.	16 gas stations
		Garages; Tot. nb.	45 garages
		Vehicle wash centres; Tot. nb.	14 vehicle wash centres
Drinking water		Public Wells	14 wells
		Springs	12 springs
		Private wells	31 private wells
Wastewater		Nb. of HHs connected to a WW network	4,116households
		Nb. of HHs using cesspools	2,379 households
		Nb. of villages with entire network coverage	0 villages
		Nb. of villages with partial network coverage, average coverage %	7 villages, 58%
		Nb. of villages with no network coverage	6 villages
		Nb. of existing WWTPs & names of villages served	**3 existing WWTPs**. Villages served: **Aaychiyeh:** Aaychiyeh, Dellafi*, Mazraat Zighrine*. **Marjaayoun:** Jdeideh (Marjaayoun), Blat, Bouayda*, Dibbine*. **Kaoukaba:** Kaoukaba. **Qatrani:** Qatrani*. **Rihane:** Mazraat Khallet Khazen*, Mazraat Qrouh*, Ouardiyeh*, Chbail*, Mazraat Daraya*, Rihane*, Sejoud*.
		Nb. of planned WWTPs & names of villages to be served	**6 planned WWTPs**. Villages to be served: **Hasbaiya:** Hasbaiya. **Nabaa el Tasseh:** Kfar Houneh, Aaramta. **Wadi El Jarmaq:** Demachqiyeh, Mazraat el Aarqoub, Mazraat Ouazaiye, Mazraat Tamra, Jarmaq. **Wadi el Kfour:** Kfar Roummane.
Solid waste		Tot. generated waste per day	23.8 t/day
		Operational dumpsites & names of villages served	**10 dumpsites**. Villages served: **Aaychiyeh:** Aaychiyeh, **Aaramta:** Aaramta, **Bouayda (Marjaayoun), Dellafi:** Dellafi, **Hasbaiya:** Qelaya, **Kaoukaba:** Kaoukaba, **Kfar Roummane:** Kfar Roummane, Jarmaq, **Kfar Tibnit:** Kfar Tibnit, **Arnoun:** Arnoun, **Rihane**

* Planned Connection

Industries	Industrial products	**Categories:** Manufacture of articles of concrete, cement and plaster (1) Cutting, shaping and finishing of stone (1) Manufacture of cocoa, chocolate and sugar confectionery (1) Manufacture of dairy products (2) Manufacture of furniture (2) Manufacture of structural metal products (1) Manufacture of vegetable and animal oils and fats (10) Manufacture of grain mill products (1) Sawmilling and planning of wood (2)
Recreational establishments	Recreational establishments bordering river	2 recreational establishments
Quarries	Tot. nb. & types	**34 quarries:** Rock (19); Sand (15)

Zone 3		Villages' Names	**Arnoun, Deir Mimas** – Mazraat Doumiat, Houra, **Zaoutar Ech-Charqiyeh, Aadaysseh, Kfar Kila** - Houra, **Yohmor, Aalmane, Kfar Tibnit, Qlaiaa, Deir Siriane, Zaoutar El Gharbiyeh** - Mazraat El Hamra**, Borj El Mlouk, Taybeh, Rabb Et Talatine, Bouayda, Markaba, Houla, Qaaqaaiyet Ej Jisr, Aadchit (Qoussair), Jdaideh (Marjaayoun)**
Geo-political		Altitude Range (m)	110-900
		Tot. land area (m^2)	85,515,942
		Tot. population (range)	28,333 (35-6,103)
	Source: 2018 Municipal Survey	Resident population (%)	66%
		Seasonal population (%)	25%
		Refugee population (%)	9%
		Tot. nb. of HHs (range)	8,506 (6-1,800)
		Av. HH size (range)	4.5 (3-6)
Land Cover *(Source: 2013 Land Use/Land Cover Map)*		Agricultural land (%)	31.5%
		Grassland (%)	32.6%
		Wooded Land (%)	12.7%
		Natural Land (%)	17%
		Built-up Area (%)	5.8%
Land Use *(Source: 2018 Municipal Survey)*		Nb. of nurseries, schools, institutes & universities; Tot. nb. of students (range)	0 universities and institutes, 14 nurseries and schools, 2,283 students (70-900)
		Nb. of community & social service centres; Tot. nb. of users (range)	5 community & social service centres
		Nb. of governmental & military centres; Tot. nb. of users (range)	0 official departments, 4 police stations, 5 barracks
		Nb. of hospitals; names; Tot. nb. of beds	0 hospital
		Nb. of dispensaries	12 dispensaries
		Poultry farms; Tot. nb. of birds	14 poultry farms, 180,000 birds
		Cattle farms; Tot. nb. of heads	13 cattle farms, 1,925 heads
		Sheep & Goats' farms; Tot. nb. of heads	14 Sheep & Goats' farms, 9,575 heads
		Gas stations; Tot. nb.	22 gas stations
		Garages; Tot. nb.	20 garages
		Vehicle wash centres; Tot. nb.	10 vehicle wash centres
Drinking water		Public Wells	10 wells
		Springs	6 springs
		Private wells	34 private wells
Wastewater		Nb. of HHs connected to a WW network	2,880 households
		Nb. of HHs using cesspools	5,476 households
		Nb. of villages with entire network coverage	1 village
		Nb. of villages with partial network coverage, average coverage %	5 villages, 58%
		Nb. of villages with no network coverage	7 villages
		Nb. of existing WWTPs & names of villages served	**4 existing WWTPs**. Villages served: **Deir Mimas:** Deir Mimas, Houra*, Mazraat Doumiat*, Kfar Kila*. **Marjaayoun:** Borj El Mlouk*, Qlaiaa*, Rabb Et Talaltine*. **Yohmor:** Yohmor, Arnoun*. **Zaoutar:** Zaoutar Ech-Charqiye, Zaoutar El Gharbiyeh*, Mazraat El Hamra*.
		Nb. of planned WWTPs & names of villages to be served	**2 planned WWTPs**. Villages to be served: **Nabatiye:** Kfar Tibnit, Deir Siriane. **Wadi Slouki:** Aadaysseh
Solid waste		Tot. generated waste per day	36.8 t/day
		Operational dumpsites & names of villages served	**6 dumpsites**. Villages served: **Aadaysseh:** Aadaysseh, **Deir Mimas, Kfar Kila, Mazraat El Hamra:** Zaoutar Ech-Charqiyeh, **Qlaiaa, Yohmor**
Industries		Industrial products	**Categories:** Manufacture of articles of concrete, cement and plaster (8) Manufacture of other articles of paper and paperboard (1) Manufacture of soft drinks, production of mineral waters and other bottled (1) Manufacture of structural metal products (2) Manufacture of vegetable and animal oils and fats (20)

* Planned Connection

		Manufacture of wearing apparel, except fur apparel (1) Sawmilling and planning of wood (1)
Recreational establishments	Recreational establishments bordering river	10 recreational establishments
Quarries	Tot. nb. & types	**3 quarries:** Rock (1); Sand (2)

Zone 4		Villages' Names	**Aaynata**, **Aaytaroun**, **Bani Haiyane**, **Beit Yahoun**, **Blida**, **Borj Qalaouiyeh**, **Chaqra**, **Jmaijmeh**, **Kfar Dounine**, **Khirbet Selm**, **Kounine**, **Majdel Selm**, **Maroun Er Ras**, **Meiss Ej Jabal**, **Mhaibib**, **Qabrikha**, **Qalaouiyeh**, **Qantara**, **Souaneh**, **Soultaniyeh**, **Talloussa**, **Tiri**, **Touline**, **Aadchit (Qoussair)**, **Houla**, **Markaba**, **Ghandouriyeh**, **Rabb Et Talatine**, **Taybeh**, **Deir Siriane**, **Bent Jbayl**, **Froun**, **Aalmane**, **Baraachit**, **Safad El Battikh**
Geo-political		Altitude Range (m)	110-940
		Tot. land area (m^2)	231,267,704
		Tot. population (range)	63,967 (291-5,420)
	Source: 2018 Municipal Survey	Resident population (%)	42%
		Seasonal population (%)	50%
		Refugee population (%)	8%
		Tot. nb. of HHs (range)	21,513(30-2,050)
		Av. HH size (range)	4.7 (3-8)
Land Cover *(Source: 2013 Land Use/Land Cover Map)*		Agricultural land (%)	39.51%
		Grassland (%)	20.58%
		Wooded Land (%)	13.14%
		Natural Land (%)	20.01%
		Built-up Area (%)	6.75%
Land Use *(Source: 2018 Municipal Survey)*		Nb. of nurseries, schools, institutes & universities; Tot. nb. of students (range)	3 universities and institutes, 120 students, 38 nurseries and schools, 8,057 students (100-1,900)
		Nb. of community & social service centres; Tot. nb. of users (range)	5 community & social service centres
		Nb. of governmental & military centres; Tot. nb. of users (range)	3 official departments, 3 police stations, 13 barracks
		Nb. of hospitals; names; Tot. nb. of beds	2 hospitals: Mays El Jabal Governmental Hospital – 64 beds Bent Jbayl Governmental Hospital
		Nb. of dispensaries	35 dispensaries
		Poultry farms; Tot. nb. of birds	60 poultry farms, 122,900 birds
		Cattle farms; Tot. nb. of heads	65 cattle farms, 805 heads
		Sheep & Goats' farms; Tot. nb. of heads	34 Sheep & Goats' farms, 3,150 heads
		Gas stations; Tot. nb.	45 gas stations
		Garages; Tot. nb.	53 garages
		Vehicle wash centres; Tot. nb.	61 vehicle wash centres
Drinking water		Public Wells	22 wells
		Springs	11 springs
		Private wells	26 private wells
Wastewater		Nb. of HHs connected to a WW network	630 households
		Nb. of HHs using cesspools	23,223 households
		Nb. of villages with entire network coverage	0 villages
		Nb. of villages with partial network coverage, average coverage %	2 villages, 45%
		Nb. of villages with no network coverage	25 villages
		Nb. of existing WWTPs & names of villages served	**2 existing WWTPs**. Villages served: **Tibnine:** Jmaijmeh, Soultaniyeh, Baraachit*, Safad El Battikh*.
		Nb. of planned WWTPs & names of villages to be served	**4 planned WWTPs**. Villages to be served: **Bent Jbayl:** Bent Jbayl, Tiri. **Qaaqaaiyet Ej Jisr**: Aaynata, Aaytaroun, Beit Yahoun, Blida, Chaqra, Houla, Kounine, Maroun Er Ras, Meiss Ej Jabal, Mhaibib. **Sour:** Kfar Dounine.**Wadi Slouki:** Aadchit (Qoussair), Bani Haiyane, Borj Qalaouiyeh, Ghandouriyeh, Khirbet Selm, Majdel Selm, Qabrikha, Qalaouiyeh, Qantara, Souaneh, Talloussa, Taybeh, Touline, Markaba.
Solid waste		Tot. generated waste per day	84.5 t/day
		Operational dumpsites & names of villages served	**25 dumpsites**. Villages served: **Aadchit (Qoussair):** Qantara (Marjaayoun), **Aaytaroun, Bani Haiyane, Beit Yahoun:** Beit Yahoun, **Chaqra:** Chaqra, **Deir Siriane:** Deir Siriane, **Ghandouriyeh:** Ghandouriyeh, **Houla,** Houla, **Aaynata:** Aaynata, **Majdel Selm:** Majdel Selm, **Meiss Ej Jabal:** Meiss Ej Jabal, Mhaibib,

* Planned Connection

		Qabrikha: Qabrikha, **Rabb Et Talatine:** Rabb Et Talatine, **Talloussa:** Talloussa, **Taybeh:** Taybeh, **Tiri:** Tiri, **Touline:** Touline
Industries	Industrial products	**Categories:** Cutting, shaping and finishing stone (9) Manufacture of articles of concrete, cement and plaster (13) Manufacture of clay building materials (1) Manufacture of bakery products (1) Manufacture of dairy products (3) Manufacture of furniture (1) Manufacture of other articles of paper and paperboard (1) Manufacture of other non-metallic mineral products n.e.c. (1) Manufacture of plastic products (1) Manufacture of structural metal products (2) Manufacture of vegetable and animal oils and fats (22) Printing (1) Sawmilling and planning of wood (1) Wholesale of solid, liquid and gaseous fuels and related products (2)
Recreational establishments	Recreational establishments bordering river	3 recreational establishments
Quarries	Tot. nb. & types	**8 quarries:** Rock (8); Sand (0)

Zone 5		Villages' Names	**Aabbassiyeh, Arzai** - Jazira (Saida), Matariyet Ech Choumar**, Arzoun, Bedias, Bestiyat, Borj Rahhal** - Ain Abou Abdallah, **Braiqeaa, Chehour, Deir Qanoun En-Nahr, Derdaghaiya, Froun, Ghandouriyeh, Halloussiyeh, Hmairi, Jennata, Kfar Sir, Kharayeb (Saida) -** Mazraat El Ouasta, Mazraat El Yahoudiye (Aataniye), Mazraat Jamjim, **Maaroub, Qaaqaaiyet Ej Jisr, Qsaibeh, Sir El Gharbiyeh, Srifa** – Marnaba, Mazraat Tayr Semhat, Niha, **Tayr Falsay, Touayri, Zaoutar El Gharbiyeh, Zrariyeh**
Geo-political		Altitude Range (m)	0-490
		Tot. land area (m^2)	127,384,533
		Tot. population (range)	70,347 (187-7,940)
	Source: 2018 Municipal Survey	Resident population (%)	65.5%
		Seasonal population (%)	20%
		Refugee population (%)	14.5%
		Tot. nb. of HHs (range)	22,398 (60-3,700)
		Av. HH size (range)	4.95 (3-6)
Land Cover *(Source: 2013 Land Use/Land Cover Map)*		Agricultural land (%)	37.68%
		Grassland (%)	19.36%
		Wooded Land (%)	17.43%
		Natural Land (%)	16.64%
		Built-up Area (%)	8.86%
Land Use *(Source: 2018 Municipal Survey)*		Nb. of nurseries, schools, institutes & universities; Tot. nb. of students (range)	4 universities and institutes, 670 students,40 nurseries and schools, 11,910 students (180-1,800)
		Nb. of community & social service centres; Tot. nb. of users (range)	5 community & social service centres
		Nb. of governmental & military centres; Tot. nb. of users (range)	0 official departments, 1 police station, 0 barracks
		Nb. of hospitals	0 hospitals
		Nb. of dispensaries	16 dispensaries
		Poultry farms; Tot. nb. of birds	84 poultry farms, 213,000 birds
		Cattle farms; Tot. nb. of heads	21 cattle farms, 330 heads
		Sheep & Goats' farms; Tot. nb. of heads	23 Sheep & Goats' farms, 3,270 heads
		Gas stations; Tot. nb.	41 gas stations
		Garages; Tot. nb.	127 garages
		Vehicle wash centres; Tot. nb.	71 vehicle wash centres
Drinking water		Public Wells	45 wells
		Springs	11 springs
		Private wells	390 private wells
Wastewater		Nb. of HHs connected to a WW network	7,332 households
		Nb. of HHs using cesspools	14,906 households
		Nb. of villages with entire network coverage	0 villages
		Nb. of villages with partial network coverage, average coverage %	9 villages, 67%
		Nb. of villages with no network coverage	13 villages
		Nb. of existing WWTPs & names of villages served	**0 existing WWTP**. Villages served: 0
		Nb. of planned WWTPs & names of villages to be served	**7 planned WWTPs**. Villages to be served: **Braiqeaa-Maifadoun:** Braiqeaa, Qaaqaaiyet Ej Jisr, Qsaibeh, Jazira (Saida), **Hallousiyeh:** Hallousiyeh, Hmairi. **Kfar Sir:** Kfar Sir. **Sarafand:** Kharayeb (Saida), Zrariyeh, Mazraat El-Ouasta, Mazraat Jamjim. **Sour:** Arzoun, Bedias, Borj Rahhal, Deir Qanoun En-Nahr, Jennata, Maaroub, Arzai, Bestiyat, Chehour, Derdaghaiya, Sir El Gharbiyeh, Tayr Falsay, Ain Abou Abdallah, Matariyet Ech Choumar, Touayri, Aabbassiyeh. **Srifa:** Srifa, Marnaba, Mazraat Tayr Semhat, Niha. **Wadi Slouki:** Froun.
Solid waste		Tot. generated waste per day	116.8 t/day
		Operational dumpsites & names of villages served	**20 dumpsites**. Villages served: **Ain Abou Abdallah:** Borj Rahhal, **Arzai:** Arzai, **Bedias:** Bedias, **Bestiyat:** Bestiyat, **Deir Qanoun En-Nahr:** Deir Qanoun En-Nahr, **Derdaghaiya, Froun:** Froun, **Halloussiyeh:** Halloussiyeh, Maaroub, **Hmairi, Jazira (Saida), Jennata:** Jannata, **Kfafr Sir:** Kfar Sir, **Sir El Gharbiyeh:** Sir El Gharbiyeh, **Srifa, Tayr Falsay:** Tayr Falsay, **Zaoutar El Gharbiyeh:** Zaoutar El Gharbiyeh

Industries	Industrial products	**Categories:** Cutting, shaping and finishing stone (9) Manufacture of clay building materials (2) Manufacture of articles of concrete, cement and plaster (15) Manufacture of other non-metallic mineral products n.e.c. (3) Manufacture of bakery products (1) Manufacture of clay building material (1) Manufacture of cocoa, chocolate and sugar confectionary (2) Manufacture of dairy products (2) Manufacture of furniture (1) Manufacture of grain mill products (1) Manufacture of other articles of paper and paperboard (1) Manufacture of plastic products (1) Manufacture of structural metal products (1) Manufacture of sugar / Manufacture of other food products n.e.c. (1) Manufacture of tanks, reservoirs and containers of metal / Manufacture of domestic appliances (2) Manufacture of vegetable and animal oils and fats (23) Manufacture of wearing apparel, except fur apparel (1) Manufacture of wiring devices (1) Packaging activities (1) Printing (1) Wholesale of solid, liquid and gaseous fuels and related products (1)
Recreational establishments	Recreational establishments bordering river	106 recreational establishments
Quarries	Tot. nb. & types	**0 quarries:** Rock (0); Sand (0)

APPENDIX D – MANUFACTURING INDUSTRIES, HEALTHCARE FACILITIES, CLASSIFIED NON-INDUSTRIAL ESTABLISHMENTS AND RECREATIONAL ESTABLISHMENTS IN THE AREA OF STUDY

Table D-1. Manufacturing Industries in the LLB Study Area

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A001	Qaraaoun	1	33.588006	35.720117	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A002	Qaraaoun	1	33.585645	35.718948	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A003	Qaraaoun	1	33.580322	35.722091	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A004	Qaraaoun	1	33.579309	35.721162	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A005	Qaraaoun	1	33.578395	35.731823	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A006	Qaraaoun	1	33.578351	35.723001	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A007	Qaraaoun	1	33.575935	35.713662	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A008	Qaraaoun	1	33.575788	35.723147	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A009	Qaraaoun	1	33.575293	35.714119	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A010	Qaraaoun	1	33.574799	35.716572	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A011	Qaraaoun	1	33.574586	35.717359	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A012	Qaraaoun	1	33.574349	35.715461	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A013	Qaraaoun	1	33.57369	35.719164	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A014	Qaraaoun	1	33.573269	35.717087	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A015	Qaraaoun	1	33.571357	35.720434	Plastic Industry	C-2220	Manufacture of plastics products	Dry process
A016	Qaraaoun	1	33.57118	35.714361	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A017	Qaraaoun	1	33.569961	35.709393	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A018	Qaraaoun	1	33.565931	35.719111	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A019	Qaraaoun	1	33.56358	35.717104	Water Treatment	E-3600	Water collection, treatment and supply	Wet process
A020	Qaraaoun	1	33.55442	35.705495	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A021	Aaytanit	1	33.553317	35.666983	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A022	Machghara	1	33.545861	35.663016	Bakery	C-1071	Manufacture of bakery products	Dry process
A023	Kaoukaba Bou Arab	1	33.545006	35.776663	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A024	Majdel Balhis	1	33.544564	35.663295	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A025	Majdel Balhis	1	33.538919	35.718605	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A026	Majdel Balhis	1	33.534076	35.699414	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A027	Sohmor	1	33.528964	35.691426	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A028	Sohmor	1	33.527665	35.701795	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A029	Sohmor	1	33.526858	35.692183	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A030	Majdel Balhis	1	33.525018	35.75338	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A031	Majdel Balhis	1	33.523767	35.755192	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A032	Sohmor	1	33.520493	35.693768	Bakery	C-1071	Manufacture of bakery products	Dry process
A033	Machghara	1	33.516945	35.667778	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A034	Sohmor	1	33.507553	35.691487	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A035	Machghara	1	33.504983	35.658855	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A036	Yohmor	1	33.489662	35.670766	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A037	Kfar Michki	1	33.489636	35.75398	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A038	Yohmor (B-G)	1	33.483734	35.677774	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A039	Libbaya	1	33.476872	35.717091	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A040	Libbaya	1	33.474308	35.70842	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A041	Libbaya	1	33.473527	35.706928	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A042	Yohmor (B-G)	1	33.472575	35.67451	Plastics	C-2220	Manufacture of plastics products	Dry process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A043	Zilaya	1	33.463345	35.677184	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A044	Aaramta	2	33.45493	35.577939	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A045	Maydoun	1	33.45476	35.638779	Asphalt	C-2399	Manufacture of other non-metallic mineral products n.e.c.	Dry process
A046	Maydoun	1	33.454601	35.638389	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A047	Qelaya	1	33.438193	35.660037	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A048	Dellafi	1	33.43503	35.648608	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A049	Qatrani	2	33.432843	35.599383	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A050	Kaoukaba	2	33.397741	35.652158	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A051	Kfar Roummane	2	33.393591	35.51118	Wood Carpentry	C-1610	Sawmilling and planing of wood	Dry process
A052	Kaoukaba (Hasbaiya)	2	33.393474	35.644058	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A053	Kaoukaba (Hasbaiya)	2	33.393406	35.645229	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A054	Kfar Roummane	2	33.3923	35.5121	Wood Carpentry	C-1610	Sawmilling and planing of wood	Dry process
A055	Kaoukaba (Hasbaiya)	2	33.39039	35.645842	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A056	Kaoukaba (Hasbaiya)	2	33.389934	35.647210	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A057	Kfar Roummane	2	33.388	35.4929	Ice Cream	C-1050	Manufacture of dairy products	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A058	Kfar Roummane	2	33.387342	35.494542	Chocolate	C-1073	Manufacture of cocoa, chocolate and sugar confectionery	Wet process
A059	Kfar Roummane	2	33.387056	35.498118	Furniture	C-3100	Manufacture of furniture	Dry process
A060	Kfar Roummane	2	33.386628	35.497318	Furniture	C-3100	Manufacture of furniture	Dry process
A061	Dibbine	2	33.371853	35.594728	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A062	Dibbine	2	33.37112	35.595245	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A063	Dibbine	2	33.370477	35.597447	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A064	Blat	2	33.368054	35.619128	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A065	Jdaideh (Marjaayoun)	2	33.363564	35.596304	Olive Mill / Grain Mill	C-1040/ C-1061	Manufacture of vegetable and animal oils and fats/ Manufacture of grain mill products	Wet process
A066	Kfar Tibnit	2	33.355701	35.522727	Dairy Products	C-1050	Manufacture of dairy products	Wet process
A067	Kfar Tibnit	2	33.355095	35.524608	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A068	Kharayeb (Saida)	5	33.354776	35.284936	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A069	Kharayeb (Saida)	5	33.350639	35.296757	Nylon Industry	C-2220	Manufacture of plastics products	Dry process
A070	Qlaiaa	3	33.346451	35.571748	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A071	Kharayeb (Saida)	5	33.344778	35.287019	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A072	Kharayeb (Saida)	5	33.343879	35.301756	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A073	Qlaiaa	3	33.343323	35.574845	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A074	Kharayeb (Saida)	5	33.342102	35.290839	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A075	Braiqeaa	5	33.339664	35.376046	Bakery	C-1071	Manufacture of bakery products	
A076	Qsaibeh (Nabatiye)	5	33.337809	35.401701	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A077	Qsaibeh (Nabatiye)	5	33.337724	35.413162	Rock and Marble Cutting	C-2396/ C-2392	Cutting, shaping and finishing of stone/ Manufacture of clay building materials	Wet process
A078	Qsaibeh (Nabatiye)	5	33.335394	35.400964	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A079	Zrariyeh	5	33.3351998	35.3514072	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A080	Qaaqaaiyet Ej Jisr	5	33.334273	35.425918	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A081	Zrariyeh	5	33.3341373	35.3543221	Textiles and Clothing	C-1410	Manufacture of wearing apparel, except fur apparel	Dry process
A082	Zrariyeh	5	33.333621	35.34899	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A083	Arzai	5	33.333618	35.298992	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A084	Arnoun	3	33.330623	35.532069	Water Filling	C-1104	Manufacture of soft drinks; production of mineral waters and other bottled	Wet process
A085	Qlaiaa	3	33.330516	35.560566	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A086	Matariyet Ech Choumar	5	33.330362	35.270382	Concrete Industry / Asphalt	C-2395/ C-2399	Manufacture of articles of concrete, cement and plaster/ Manufacture of other non-metallic mineral products n.e.c.	Dry process
A087	Zrariyeh	5	33.329901	35.336044	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A088	Qlaiaa	3	33.329131	35.565313	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A089	Qsaibeh	5	33.325239	35.38254	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A090	Yohmor (Nabatiye)	3	33.32510959	35.51526267	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A091	Yohmor (Nabatiye)	3	33.324722	35.5125	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A092	Sir El Gharbiyeh	5	33.324269	35.379349	Grain Mill	C-1061	Manufacture of grain mill products	Dry process
A093	Kfar Sir	5	33.32413	35.384207	Packaging	N-8292	Packaging activities	Dry process
A094	Kfar Sir	5	33.32413	35.384207	Chocolate	C-1073	Manufacture of cocoa, chocolate and sugar confectionery	Wet process
A095	Zaoutar el-gharbiyeh	3	33.3241	35.4678	Textiles and Clothing	C-1410	Manufacture of wearing apparel, except fur apparel	Dry process
A096	Sir El-Gharbiyeh	5	33.323561	35.371671	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A097	Zaoutar Ech-Charqiyeh	3	33.323543	35.492984	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A098	Zaoutar Ech-Charqiyeh	3	33.323077	35.482959	Tissue Paper	C-1709	Manufacture of other articles of paper and paperboard	Dry process
A099	Zaoutar Ech-Charqiyeh	3	33.322229	35.494383	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A100	Yohmor	3	33.319813	35.519602	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A101	Tayr falsay	5	33.318524	35.333509	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A102	Tayr falsay	5	33.317176	35.33569	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A103	Kfar Sir	5	33.316802	35.414148	Ice Cream	C-1050	Manufacture of dairy products	Wet process
A104	Bedias	5	33.314794	35.305593	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A105	Bedias	5	33.314328	35.303107	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A106	Tayr falsay	5	33.310344	35.346533	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A107	Kfar Sir	5	33.310086	35.384541	Concrete cinder blocks/ Marble	C-2395/ C-2392	Manufacture of articles of concrete, cement and plaster/ Manufacture of clay building materials	Dry process
A108	Bedias	5	33.310016	35.29597	Water Tanks/ water heaters	C-2512/ C-2750	Manufacture of tanks, reservoirs and containers of metal/ Manufacture of domestic appliances	Dry process
A109	Halloussiyeh	5	33.31001	35.324213	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A110	Borj El Mlouk	3	33.309909	35.553427	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A111	Bedias	5	33.309644	35.295745	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A112	Halloussiyeh	5	33.309523	35.321734	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A113	Yohmor	3	33.309224	35.515641	Wood Carpentry	C-1610	Sawmilling and planing of wood	Dry process
A114	Tayr Falsay	5	33.309	35.3479	Molasses	C-1072 / C-1079	Manufacture of sugar / Manufacture of other food products n.e.c.	Dry process
A115	Halloussiyeh	5	33.307242	35.32642	Dairy Products	C-1050	Manufacture of dairy products	Wet process
A116	Deir Qanoun En-Nahr	5	33.3063	35.3035	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A117	Tayr Falsay	5	33.306062	35.349695	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A118	Deir Mimas	3	33.305676	35.552847	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A119	Deir Mimas	3	33.305606	35.547637	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A120	Deir Qanoun En-Nahr	5	33.3055	35.304	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A121	Halloussiyeh	5	33.304461	35.328039	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A122	Halloussiyeh	5	33.30306	35.328735	Plastic Conduit pipes	C-2733	Manufacture of wiring devices	Dry process
A123	Deir Qanoun En-Nahr	5	33.302102	35.299794	Printing	C-1811	Printing	Dry process
A124	Deir Qanoun En-Nahr	5	33.30147	35.301145	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A125	Borj El Mlouk	3	33.301128	35.562745	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A126	Deir Qanoun En-Nahr	5	33.3011	35.308	Furniture	C-3100	Manufacture of furniture	Dry process
A127	Deir Qanoun En-Nahr	5	33.3008	35.3085	Water Tanks/ water heaters	C-2512/ C-2750	Manufacture of tanks, reservoirs and containers of metal/	Dry process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
							Manufacture of domestic appliances	
A128	Deir Qanoun En-Nahr	5	33.300793	35.305422	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A129	Halloussiyeh	5	33.300285	35.332327	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A130	Deir Qanoun En-Nahr	5	33.300284	35.315661	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A131	Deir Qanoun En-Nahr	5	33.300284	35.315661	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A132	Deir Qanoun En-Nahr	5	33.300283	35.298995	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A133	Deir Qanoun En-Nahr	5	33.300283	35.298995	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A134	Deir Qanoun En-Nahr	5	33.300283	35.298995	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A135	Kfar kila	3	33.296138	35.562645	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A136	Deir Qanoun En-Nahr	5	33.2929	35.3163	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A137	Jennata	5	33.292843	35.321393	Tissue Paper	C-1709	Manufacture of other articles of paper and paperboard	Dry process
A138	Derdaghaiya	5	33.291097	35.36261	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A139	Kfar Kila	3	33.290803	35.566036	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A140	Taybeh (Marjaayoun)	4	33.287645	35.512914	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A141	Froun	4	33.287077	35.429883	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A142	Maaroub	5	33.28662	35.331716	Marble/Granite	C-2392	Manufacture of clay building materials	Dry process
A143	Froun	5	33.286361	35.429834	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A144	Kfar kila	3	33.285714	35.551304	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A145	Kfar kila	3	33.285234	35.553043	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A146	Kfar kila	3	33.283714	35.552454	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A147	Kfar kila	3	33.283225	35.553261	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A148	Kfar kila	3	33.280789	35.551783	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A149	Kfar kila	3	33.280105	35.554731	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A150	Srifa	4	33.279281	35.406549	Tissue Paper	C-1709	Manufacture of other articles of paper and paperboard	Dry process
A151	Srifa	4	33.278863	35.407573	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A152	Derdaghaiya	5	33.278144	35.365054	Gas Storage	G-4661	Wholesale of solid, liquid and gaseous fuels and related products	Dry process
A153	Derdaghaiya	5	33.278134	35.374153	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A154	Derdaghaiya	5	33.277074	35.372054	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A155	Derdaghaiya	5	33.276772	35.375336	Chocolate	C-1073	Manufacture of cocoa, chocolate and sugar confectionery	Wet process
A156	Kfar kila	3	33.276292	35.552952	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A157	Srifa	5	33.275189	35.40208	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A158	Srifa	5	33.274979	35.40273	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A159	Maaroub	5	33.27411	35.334773	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A160	Kfar kila	3	33.273916	35.557189	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A161	Srifa	5	33.27384	35.404278	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A162	Derdaghaiya	5	33.27281	35.371035	Concrete/ Asphalt Industry	C-2395 / C-2399	Manufacture of articles of concrete, cement and plaster / Manufacture of other non-metallic mineral products n.e.c.	Dry process
A163	Derdaghaiya	5	33.267281	35.37413	Concrete/ Asphalt Industry	C-2395 / C-2399	Manufacture of articles of concrete, cement and plaster / Manufacture of other non-metallic mineral products n.e.c.	Dry process
A164	Taybeh (Marjaayoun)	4	33.261409	35.489914	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A165	Aadaysseh (Marjaayoun)	3	33.259244	35.529083	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A166	Taybeh (Marjaayoun)	4	33.258872	35.50861	Rock Cutting / Concrete Industry	C-2396/ C-2395	Cutting, shaping and finishing of stone/ Manufacture of articles of concrete, cement and plaster	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A167	Borj Qalaouiyeh	4	33.258392	35.429522	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A168	Qalaouiyeh	4	33.257028	35.42247	Dairy Products	C-1050	Manufacture of dairy products	
A169	Qalaouiyeh	4	33.256803	35.430515	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A170	Aadaysseh (Marjaayoun)	3	33.256757	35.527877	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A171	Aadaysseh (Marjaayoun)	3	33.256488	35.532453	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A172	Qalaouiyeh	4	33.250288	35.415661	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A173	Qabrikha	4	33.249714	35.467755	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A174	Qabrikha	4	33.248817	35.468961	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A175	Aadaysseh (Marjaayoun)	3	33.247266	35.529083	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A176	Touline	4	33.246988	35.444836	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A177	Qalaouiyeh	4	33.243349	35.421609	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A178	Aadaysseh (Marjaayoun)	3	33.23858	35.528734	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A179	Souaneh (Marjaayoun)	4	33.238428	35.433257	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A180	Markaba	3	33.238344	35.526958	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A181	Aadaysseh (Marjaayoun)	3	33.236726	35.533455	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A182	Khirbet Selm	4	33.233621	35.415663	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A183	Markaba	4	33.232301	35.505425	Plastic Industry	C-2220	Manufacture of plastics products	Dry process
A184	Markaba	4	33.231667	35.525369	Asphalt	C-2399	Manufacture of other non-metallic mineral products n.e.c.	Dry process
A185	Majdel Selm	4	33.230928	35.460742	Furniture	C-3100	Manufacture of furniture	Dry process
A186	Khirbet Selm	4	33.230141	35.412712	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A187	Khirbet Selm	4	33.22611	35.40861	Wood Carpentry	C-1610	Sawmilling and planing of wood	Dry process
A188	Houla	4	33.219625	35.530211	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A189	Khirbet Selm	4	33.219193	35.429057	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A190	Kfar Dounine	4	33.216952	35.398998	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A191	Soultaniyeh bent jbayl	4	33.213341	35.425171	Gas Storage	G-4661	Wholesale of solid, liquid and gaseous fuels and related products	Dry process
A192	Soultaniyeh bent jbayl	4	33.212676	35.406356	Printing	C-1811	Printing	Dry process
A193	Soultaniyeh bent jbayl	4	33.210994	35.417072	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A194	Soultaniyeh bent jbayl	4	33.210905	35.406055	Bakery	C-1071	Manufacture of bakery products	Dry process
A195	Majdel Selm	4	33.209595	35.45358	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A196	Houla	4	33.206642	35.521078	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A197	Houla	4	33.206642	35.521078	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A198	Majdel Selm	4	33.20456	35.461751	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A199	Houla	4	33.20417	35.491402	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A200	Houla	4	33.201613	35.522481	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A201	Jmaijmeh	4	33.200424	35.448119	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A202	Chaqra	4	33.19791991644	35.476672403363	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A203	Safad El battikh	4	33.196918	35.449425	Concrete Industry	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A204	Jmaijmeh	4	33.195805	35.446337	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry Process
A205	Beit Yahoun	4	33.170351	35.418613	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A206	Meiss Ej Jabal	4	33.165649	35.508087	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A207	Meiss Ej Jabal	4	33.165179	35.495879	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process
A208	Meiss Ej Jabal	4	33.16204	35.493922	Concrete cinder blocks/ Marble	C-2395/ C-2392	Manufacture of articles of concrete, cement and plaster/ Manufacture of clay building materials	Dry process
A209	Meiss Ej Jabal	4	33.161727	35.492532	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A210	Meiss Ej Jabal	4	33.161626	35.492067	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process

Industry ID	Village	LLB Zone	Longitude	Latitude	Type of Activity	ISIC Code	ISIC Sector/Sub-sector	Category
A211	Baraachit	4	33.158291	35.475568	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A212	Beit Yahoun	4	33.157528	35.425855	Rock Cutting	C-2396	Cutting, shaping and finishing of stone	Wet process
A213	Kounine	4	33.1405939	35.4275836	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A214	Tiri	4	33.139848	35.407408	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A215	Tiri	4	33.133616	35.399005	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A216	Tiri	4	33.131456	35.417636	Gas Storage	G-4661	Wholesale of solid, liquid and gaseous fuels and related products	Dry process
A217	Aaytaroun	4	33.130011	35.485037	Steel Fabrication	C-2511	Manufacture of structural metal products	Dry process
A218	Aaytaroun	4	33.129069	35.480906	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A219	Aaytaroun	4	33.129011	35.460468	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A220	Aaytaroun	4	33.122112	35.472761	Dairy Products	C-1050	Manufacture of dairy products	Wet process
A221	Aaytaroun	4	33.12211	35.489695	Dairy Products	C-1050	Manufacture of dairy products	Wet process
A222	Aaytaroun	4	33.116952	35.465671	Olive Mill	C-1040	Manufacture of vegetable and animal oils and fats	Wet process
A223	Aaytaroun	4	33.116293	35.491186	Concrete cinder blocks	C-2395	Manufacture of articles of concrete, cement and plaster	Dry process

Table D-2. Healthcare Facilities in the LLB Study Area

HC Est. #	Healthcare Institution Name	Village	LLB Zone	Healthcare Establishment Type	Longitude	Latitude	Nearest Linear Distance from LR or LT (m)	LR or LR Tributary	Notes
H01	West Bekaa Hospital	Sohmor	1	Secondary	33.51582	35.70173	534	Aassaf	151 beds. MoPH database
PHC01	Al Hajj Mehdi Aydi Amel Health Center - Machghara	Machghara	1	Primary	33.53401	35.65729	340	Jbatb	MoPH Database
PHC02	Machghara Primary Healthcare Center	Machghara	1	Primary	33.52924	35.65012	515	Jbatb	MoPH Database
PHC03	The Lebanese Association for Health and Social Care - Sohmor	Sohmor	1	Primary	33.51744	35.68241	33	Litani River	MoPH Database
H02	Marjaayoun Governmental Hospital	Jdaideh (Marjaayoun)	2	Secondary	33.36391	35.58703	1,741	Litani River	49 beds. MoPH database.
PHC08	Al Zahraa Charity Center - Marjaayoun	Kfar Kila	3	Primary	33.27593	35.55119	395	Jall ed Dekhene	MoPH Database
H03	Mays El Jabal Governmental Hospital	Meiss Ej Jabal	4	Secondary	33.18691	35.52151	799	Jamal	64 beds. MoPH database
H04	Bent Jbayl Governmental Hospital	Bent Jbayl	4	Secondary	33.12748	35.43524	1,161	Aaliqa	MoPH Database
PHC06	Imam Al Sader Foundation -	Deir Siriane	4	Primary	33.29024	35.50529	476	Braik	MoPH Database

HC Est. #	Healthcare Institution Name	Village	LLB Zone	Healthcare Establishment Type	Longitude	Latitude	Nearest Linear Distance from LR or LT (m)	LR or LR Tributary	Notes
	Deir Siriane PHC Center								
PHC09	Borj Qalaouiyeh Health Center	Borj Qalaouiyeh	4	Primary	33.26313	35.42216	888	Nqaai	MoPH Database
PHC10	Al Mustapha Ocio Medical	Qabrikha	4	Primary	33.24991	35.46333	861	Litani River	MoPH Database
PHC11	Sayed Abdel Mohsen Fadlallah Health Center	Khirbet Selm	4	Primary	33.22905	35.42426	233	Litani River	MoPH Database
PHC12	Rajeh Taher Institution Charity Center	Houla	4	Primary	33.20836	35.51469	1,220	Jamal	MoPH Database
PHC13	Imam Al Sadr Center	Chaqra	4	Primary	33.19336	35.46447	652	Nahle	MoPH Database
PHC14	Alnour Specialized Medical Center	Baraachit	4	Primary	33.19229	35.44258	597	Nahle	MoPH Database
PHC04	Lebanese Red Cross - Zrariyeh	Zrariyeh	5	Primary	33.34174	35.33104	1,666	Litani River	MoPH Database
PHC05	Qaaqaaiyet Ej Jisr Governmental Center	Qaaqaaiyet Ej Jisr	5	Primary	33.32796	35.42279	922	Chemali	MoPH Database
PHC07	Srifa Municipality Center	Srifa	5	Primary	33.28196	35.39578	849	Arzoun	MoPH Database

Table D-3. Geographical Coordinates of some Farms and Slaughterhouses in the LLB Study Area

Poultry Farms	Latitude	Longitude	Cattle Farms	Latitude	Longitude	Sheep/Goat Farms	Latitude	Longitude	Slaughterhouses	Latitude	Longitude
PF1-001	33.58503	35.71744	CF1-001	33.58866	35.72014	SG1-001	33.5797	35.7204	SH1-01	33.49023	35.68657
PF1-002	33.57048	35.71418	CF1-002	33.57477	35.7202	SG1-002	33.5764	35.7137	SH1-02	33.48512	35.6663
PF1-003	33.52931	35.70198	CF1-003	33.54977	35.72142	SG1-003	33.55891	35.73158			
PF1-004	33.51828	35.70618	CF1-004	33.51723	35.70644	SG1-004	33.55169	35.77	SH3-03	33.25052	35.51898
PF1-005	33.47225	35.64205	CF1-005	33.51301	35.76071	SG1-005	33.55097	35.71765			
PF1-006	33.47215	35.6416	CF1-006	33.49129	35.71135	SG1-006	33.54646	35.70794	SH4-04	33.27552	35.43524
			CF1-007	33.476	35.64408	SG1-007	33.54432	35.70187	SH4-05	33.2515	35.51564
PF2-007	33.43947	35.60579				SG1-008	33.54266	35.69952	SH4-06	33.23595	35.48935
PF2-008	33.43861	35.59626	CF2-008	33.43112	35.64311	SG1-009	33.53532	35.7114			
PF2-009	33.40979	35.55004	CF2-009	33.43088	35.62614	SG1-010	33.5307	35.7549	SH5-07	33.31906	35.32803
PF2-010	33.40134	35.54668	CF2-010	33.3861	35.52491	SG1-011	33.52796	35.73478	SH5-08	33.28057	35.35529
PF2-011	33.39614	35.54542	CF2-011	33.38101	35.53679	SG1-012	33.52577	35.75429	SH5-09	33.27454	35.42968
PF2-012	33.39444	35.54814				SG1-013	33.51508	35.73474			
PF2-013	33.37349	35.58957	CF3-012	33.3517	35.53386	SG1-014	33.51444	35.73812			
PF2-014	33.3618	35.56197	CF3-013	33.32079	35.5126	SG1-015	33.51059	35.76668			
			CF3-014	33.31815	35.51393	SG1-016	33.5099	35.7669			
PF3-015	33.35092	35.53486	CF3-015	33.30694	35.52655	SG1-017	33.50714	35.74017			
PF3-016	33.34369	35.53573	CF3-016	33.25575	35.52312	SG1-018	33.49519	35.7459			
PF3-017	33.34242	35.53822				SG1-019	33.48034	35.70752			
PF3-018	33.3295	35.5145	CF4-017	33.22567	35.45028	SG1-020	33.47731	35.70638			
PF3-019	33.31544	35.51153	CF4-018	33.17036	35.47239	SG1-021	33.46901	35.64213			
PF3-020	33.30823	35.48963	CF4-019	33.11224	35.45259	SG1-022	33.46863	35.64182			
PF3-021	33.29557	35.48795	CF4-020	33.09965	35.46563	SG1-023	33.46407	35.67429			
PF3-022	33.28955	35.47897				SG1-024	33.45825	35.63752			
PF3-023	33.25546	35.51928	CF5-021	33.33994	35.40839	SG1-025	33.45781	35.63746			
			CF5-022	33.33757	35.4611	SG1-026	33.44948	35.67142			
PF4-024	33.28565	35.51073	CF5-023	33.32569	35.46244	SG1-027	33.4464	35.66698			
PF4-025	33.25725	35.44864	CF5-024	33.31092	35.33053						

Poultry Farms	Latitude	Longitude	Cattle Farms	Latitude	Longitude	Sheep/Goat Farms	Latitude	Longitude	Slaughterhouses	Latitude	Longitude
PF4-026	33.24411	35.4238	CF5-025	33.30906	35.31791	SG2-028	33.45445	35.63006			
PF4-027	33.21692	35.47718	CF5-026	33.3058	35.33099	SG2-029	33.43633	35.60258			
PF4-028	33.21334	35.41893	CF5-027	33.30157	35.33076	SG2-030	33.43131	35.64781			
PF4-029	33.18381	35.46759	CF5-028	33.2899	35.42417	SG2-031	33.426	35.66035			
PF4-030	33.18073	35.47701				SG2-032	33.42566	35.66089			
PF4-031	33.17947	35.47607				SG2-033	33.42172	35.60182			
PF4-032	33.16992	35.43166				SG2-034	33.41428	35.56918			
PF4-033	33.16975	35.47902				SG2-035	33.41375	35.57185			
PF4-034	33.16675	35.50629				SG2-036	33.40134	35.54668			
PF4-035	33.16512	35.49586				SG2-037	33.39702	35.56707			
PF4-036	33.14013	35.3939				SG2-038	33.38869	35.55513			
PF4-037	33.13319	35.52111				SG2-039	33.38035	35.53442			
PF4-038	33.13162	35.52076				SG2-040	33.38033	35.5211			
PF4-039	33.13115	35.52077									
PF4-040	33.12926	35.52452				SG3-041	33.35148	35.53351			
PF4-041	33.12753	35.52135				SG3-042	33.32377	35.51391			
PF4-042	33.12639	35.51851				SG3-043	33.32236	35.45761			
PF5-043	33.3189	35.32491				SG3-044	33.31895	35.47251			
						SG3-045	33.30655	35.49162			
PF5-044	33.31804	35.31623				SG3-046	33.30288	35.47168			
PF5-045	33.31712	35.31717				SG3-047	33.30269	35.47037			
PF5-046	33.31053	35.32891				SG3-048	33.30241	35.4691			
PF5-047	33.31019	35.33241									
PF5-048	33.30699	35.31486				SG4-049	33.29757	35.43131			
PF5-049	33.28933	35.36816				SG4-050	33.2971	35.43125			
PF5-050	33.28626	35.39935				SG4-051	33.28116	35.48364			
PF5-051	33.28461	35.36644				SG4-052	33.25314	35.41979			
PF5-052	33.2721	35.39951				SG4-053	33.24193	35.45476			
						SG4-054	33.24111	35.46834			

Poultry Farms	Latitude	Longitude	Cattle Farms	Latitude	Longitude	Sheep/Goat Farms	Latitude	Longitude	Slaughterhouses	Latitude	Longitude
						SG4-055	33.23352	35.4325			
						SG4-056	33.21831	35.47467			
						SG4-057	33.21321	35.47497			
						SG4-058	33.20631	35.49406			
						SG4-059	33.20312	35.49546			
						SG4-060	33.19663	35.50492			
						SG4-061	33.19474	35.47432			
						SG4-062	33.18498	35.47633			
						SG4-063	33.18325	35.47981			
						SG4-064	33.10753	35.45381			
						SG4-065	33.09803	35.46211			
						SG5-066	33.32991	35.38198			
						SG5-067	33.31982	35.36531			
						SG5-068	33.28634	35.37084			
						SG5-069	33.28246	35.40267			

*Note: The locations reported in this table do not include all of the farms and slaughterhouses in the LLB Study Area. Although the municipalities reported larger numbers as summarized in **Error! Reference source not found.**, the exact locations of all of the farms and slaughterhouses could not be determined.*

Table D-4. Geographical Coordinates of Quarries in the LLB Study Area

ID	Quarry Type - Specific	Village	Caza	Zone	Latitude	Longitude	Distance (m) to Litani River or Tributary		Remarks
Q01	Cem	Qaraaoun	West Bekaa	1	33.577915	35.731678	3,796	Maabour	/
Q02	Sand washing	Qaraaoun	West Bekaa	1	33.545204	35.718523	850	Maabour	Unlicensed
Q03	Cem	Machghara	West Bekaa	1	33.543978	35.677766	440	Jbatb	/
Q04	NA	Majdel Balhis	Rachaiya	1	33.538919	35.718605	155	Maabour	Licensed
Q05	Cem	Sohmor	West Bekaa	1	33.52526	35.704391	266	Mecheq	/
Q06	Cem	Kfar Michki	Rachaiya	1	33.524181	35.759803	459	Mecheq	/
Q07	Cem	Maydoun	West Bekaa	1	33.484196	35.643721	296	Markabe	/
Q08	Crushed Stone	Ain Et Tine (B-G)	West Bekaa	1	33.473277	35.634438	1,037	Bouqaa	/
Q09	Cem	Yohmor (B-G)	West Bekaa	1	33.472725	35.683285	504	Mazraa	/
Q10	Dec	Libbaya	Hasbaiya	1	33.472377	35.705467	1,152	Mazraa	/
Q11	Cem	Libbaya	Hasbaiya	1	33.469765	35.699986	576	Mazraa	/
Q12	Cem	Libbaya	Hasbaiya	1	33.468747	35.697878	363	Mazraa	/
Q13	Dec	Libbaya	Hasbaiya	1	33.467593	35.699553	396	Mazraa	/
Q14	Dec	Yohmor (B-G)	West Bekaa	1	33.464912	35.6685	286	Mazraa	/
Q15	Dec	Yohmor (B-G)	West Bekaa	1	33.464396	35.683619	389	Mazraa	/
Q16	Cem	Libbaya	Hasbaiya	1	33.46192	35.693439	451	Mazraa	/
Q17	Cem	Libbaya	Hasbaiya	1	33.458043	35.695524	771	Mazraa	/
Q18	Cem	Libbaya	Hasbaiya	1	33.457217	35.697424	857	Mazraa	/
Q19	Sand	Qatrani	Jezzine	2	33.456506	35.599361	146	Soubaigh	Licensed
Q20	NA	Maydoun	West Bekaa	1	33.456088	35.639289	882	Safsafe	Unlicensed
Q21	NA	Maydoun	West Bekaa	1	33.454999	35.638413	797	Safsafe	Unlicensed
Q22	NA	Maydoun	West Bekaa	2	33.454474	35.628658	75	Safsafe	Licensed
Q23	NA	Maydoun	West Bekaa	1	33.453301	35.639726	940	Safsafe	Unlicensed
Q24	NA	Maydoun	West Bekaa	1	33.449874	35.635742	694	Safsafe	Unlicensed
Q25	Crushed Stone	Aaramta	Jezzine	2	33.449871	35.583965	1,062	Soubaigh	/

ID	Quarry Type - Specific	Village	Caza	Zone	Latitude	Longitude	Distance (m) to Litani River or Tributary		Remarks
Q26	Crushed Stone	Aaramta	Jezzine	2	33.446031	35.58782	506	Soubaigh	/
Q27	Ind Sand	Qatrani	Jezzine	2	33.445488	35.598236	237	Soubaigh	/
Q28	Crushed Stone	Rihane	Jezzine	2	33.440099	35.573899	280	Aaziz	/
Q29	Crushed Stone	Rihane	Jezzine	2	33.435194	35.575679	1	Aaziz	/
Q30	Cem	Srayri	Jezzine	2	33.435074	35.620529	17	Safsafe	/
Q31	Crushed Stone	Rihane	Jezzine	2	33.431235	35.575283	77	Aaziz	/
Q32	NA	Qelaya	West Bekaa	2	33.427793	35.658338	1,124	Qotn	Unlicensed
Q33	Cem	Srayri	Jezzine	2	33.42528	35.618106	190	Safsafe	/
Q34	NA	Qelaya	West Bekaa	2	33.425064	35.658925	1,262	Qotn	Unlicensed
Q35	Crushed Stone	Aaychiyeh	Jezzine	2	33.422529	35.565101	928	Aaziz	/
Q36	Crushed Stone	Aaychiyeh	Jezzine	2	33.418799	35.571926	303	Aaziz	/
Q37	Cem	Blat (Marjaayoun)	Marjaayoun	2	33.415564	35.654389	957	Qotn	/
Q38	Crushed Stone	Aaychiyeh	Jezzine	2	33.413154	35.573706	369	Hidiane	/
Q39	Cem	Bourghos	Hasbaiya	2	33.411586	35.61333	282	Litani River	/
Q40	Crushed Stone	Aaychiyeh	Jezzine	2	33.410879	35.575563	391	Aaziz	/
Q41	NA	Kfar Roummane	Nabatiye	2	33.409263	35.513809	1,829	Zaghrfne	Licensed
Q42	Cem	Bourghos	Hasbaiya	2	33.405105	35.63457	1,061	Qotn	/
Q43	Cem	Aaychiyeh	Jezzine	2	33.404556	35.555661	1,397	Hidiane	/
Q44	Crushed Stone	Aaychiyeh	Jezzine	2	33.399032	35.573407	75	Hidiane	/
Q45	Cem	Bourghos	Hasbaiya	2	33.395502	35.618405	416	Haour	/
Q46	Cem	Blat (Marjaayoun)	Marjaayoun	2	33.388353	35.614977	15	Haour	/
Q47	NA	Aaychieh	Jezzine	2	33.381118	35.561038	282	Litani River	Unlicensed
Q48	Cem	Blat (Marjaayoun)	Marjaayoun	2	33.375444	35.623832	1,118	Haour	/
Q49	Ind Sand	Qlaiaa	Marjaayoun	2	33.372352	35.553837	128	Litani River	/
Q50	Cem	Blat (Marjaayoun)	Marjaayoun	2	33.372212	35.608239	1,432	Haour	/
Q51	NA	Bouayda (Marjaayoun)	Marjaayoun	2	33.356874	35.561435	1,140	Litani River	Licensed

ID	Quarry Type - Specific	Village	Caza	Zone	Latitude	Longitude	Distance (m) to Litani River or Tributary		Remarks
Q52	Ind Sand	Qlaiaa	Marjaayoun	3	33.345168	35.552957	764	Litani River	/
Q53	Cem	Qaaqaaiyet Ej Jisr	Nabatiye	5	33.34001	35.453291	986	Chemali	/
Q54	Crushed Stone	Qlaiaa	Marjaayoun	3	33.332899	35.556788	1,357	Litani River	/
Q55	Cem	Ghandouriyeh (Bent Jbayl)	Bent Jbayl	4	33.276676	35.438238	636	Litani River	/
Q56	Dec	Markaba	Marjaayoun	3	33.22593	35.532503	646	Maaiqel	/
Q57	Cem	Markaba	Marjaayoun	4	33.223296	35.527213	1,219	Maaiqel	/
Q58	Cem	Chaqra	Bent Jbayl	4	33.202897	35.4736	14	Nahle	/
Q59	Cem	Chaqra	Bent Jbayl	4	33.199183	35.453494	28	Nahle	/
Q60	Sand & Aggr	Meiss Ej Jabal	Marjaayoun	4	33.199097	35.53559	461	Jamal	/
Q61	NA	Chaqra	Bent Jbayl	4	33.180193	35.485907	121	Litani River	Unlicensed
Q62	NA	Chaqra	Bent Jbayl	4	33.177191	35.485311	118	Litani River	Unlicensed
Q63	NA	Beit Yahoun	Bent Jbayl	4	33.157847	35.413906	1,835	Aaliqa	Licensed

Table D-5. Recreational Establishments in the LLB Study Area

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R001	1	Qaraaoun	1	OUT	Restaurant	NA	33.555018	35.705849	Al Andalos
R002	1	Qaraaoun	1	OUT	Restaurant	NA	33.551354	35.698284	
R003	1	Qaraaoun	1	OUT	Restaurant	NA	33.550931	35.698172	
R004	1	Qaraaoun	1	OUT	Restaurant	NA	33.550709	35.698211	
R005	1	Qaraaoun	1	OUT	Restaurant	NA	33.549583	35.698418	
R006	1	Qaraaoun	1	OUT	Restaurant	NA	33.548446	35.697711	
R007	1	Qaraaoun	1	OUT	Restaurant	NA	33.548205	35.698485	
R008	1	Qaraaoun	1	OUT	Restaurant	NA	33.547164	35.697073	
R009	1	Qaraaoun	1	OUT	Restaurant	NA	33.546992	35.69566	
R010	1	Yohmor (B-G)	1	3	Restaurant	Yes	33.486445	35.659663	Basme w Nasme
R011	3	Yohmor (B-G)	1	3	Restaurant	Yes	33.483768	35.660107	
R012	3	Yohmor (B-G)	1	3	Restaurant	Yes	33.482129	35.662619	Al Fawwar
R013	3	Yohmor (B-G)	1	3	Restaurant	Yes	33.481513	35.663667	Jar El Qamar
R014	3	Yohmor (B-G)	1	3	Restaurant	Yes	33.480291	35.664153	Shallalet Nabe' Ain Fares
R015	3	Yohmor (B-G)	1	3	Restaurant	Yes	33.479771	35.663157	Al Sama Qaribe
R016	3	Loussia	1	3	Restaurant	Yes	33.477354	35.664923	Al Agha
R017	1	Yohmor (B-G)	1	3	Restaurant	Yes	33.476787	35.666705	Ain El Jaouze
R018	3	Yohmor (B-G)	1	3	Restaurant	Yes	33.473919	35.666612	Mai w Fai
R019	1	Zilaya	1	3	Restaurant	Yes	33.461768	35.664249	
R020	3	Qelaya	1	3	Restaurant	Yes	33.445925	35.655398	
R021	1	Qelaya	1	3	Restaurant	Yes	33.442294	35.653563	
R022	1	Qelaya	1	3	Restaurant / Fishery	Yes	33.440857	35.652959	Al Kahef
R023	1	Qelaya	1	3	Restaurant / Fishery	Yes	33.440004	35.652197	
R024	3	Qelaya	1	3	Restaurant / Fishery	Yes	33.438875	35.648843	Al Abdallah
R025	3	Dellafi	1	3	Restaurant / Fishery	Yes	33.434223	35.645781	Abou Jad
R026	1	Aaychiyeh	2	4	Unspecified	No	33.388072	35.556381	
R027	2	Demachqiyeh	2	4	Restaurant	Yes	33.358306	35.548036	

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R028	1	Mazraat Tamra	2	4	Resort	No	33.357136	35.545773	Rio Verde Resort
R029	2	Mazraat Doumiat	2	4	Restaurant	Yes	33.351764	35.544379	
R030	1	Mazraat Doumiat	2	4	Restaurant	Yes	33.35129	35.543479	
R031	2	Mazraat Tamra	2	6	Restaurant	Yes	33.351254	35.542789	
R032	1	Arnoun	3	6	Restaurant	Yes	33.340067	35.541754	
R033	2	Jazira (Saida)	5	11	Hotel/Restaurant	Yes	33.337273	35.257661	Abou Dieb
R034	2	Jazira (Saida)	5	11	Restaurant	Yes	33.33391	35.25579	Al Kinayat
R035	1	Jazira (Saida)	5	11	Unspecified	No	33.331317	35.262317	Abou Dib
R036	2	Ain Abou Abdallah	5	11	Hotel/Restaurant	Yes	33.328805	35.259192	
R037	2	Tayr Falsay	5	10	Restaurant	Yes	33.32733	35.34131	Al Jisr
R038	2	Tayr Falsay	5	10	Restaurant	Yes	33.32667	35.34074	Al Karim
R039	2	Tayr Falsay	5	10	Restaurant	Yes	33.32646	35.339852	Chouman
R040	1	Tayr Falsay	5	10	Resort	Yes	33.325823	35.328608	Soultan
R041	2	Jazira (Saida)	5	11	Restaurant	Yes	33.32568	35.2678	Diwan Al Charq
R042	3	Jazira (Saida)	5	11	Restaurant	Yes	33.32559	35.2686	Al Balad
R043	3	Bedias	5	11	Resort	Yes	33.32533	35.30501	Al Na'oura
R044	2	Bedias	5	11	Resort	Yes	33.32512	35.30223	Masaya
R045	3	Bedias	5	11	Resort	Yes	33.32503	35.30632	Al Salam
R046	1	Bedias	5	11	Restaurant	Yes	33.32481	35.29464	Sarah
R047	1	Jazira (Saida)	5	11	Restaurant	Yes	33.32479	35.26364	Pavillon
R048	2	Bedias	5	11	Resort	Yes	33.32477	35.30091	Rawabi
R049	3	Bedias	5	11	Restaurant	Yes	33.32441	35.30022	Rayan
R050	1	Arzai	5	11	Restaurant	Yes	33.32432	35.28382	Al Safaa
R051	2	Bedias	5	11	Resort	Yes	33.32432	35.29311	Yasmine
R052	1	Qaaqaaiyet Ej Jisr	5	10	Resort	No	33.324317	35.424061	Litania
R053	1	Bedias	5	11	Unspecified	Yes	33.324303	35.294627	Salem Khalil
R054	1	Arzai	5	11	Restaurant	Yes	33.324239	35.296181	Lebnen El Akhdar
R055	1	Halloussiyeh	5	11	Restaurant	Yes	33.324165	35.316492	

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R056	1	Arzai	5	11	Resort	Yes	33.32416	35.29722	Nasr
R057	1	Tayr Falsay	5	10	Restaurant	Yes	33.324105	35.342514	Al Boustan
R058	3	Bedias	5	11	Restaurant	Yes	33.32407	35.29236	Al Rihab
R059	2	Zrariyeh	5	11	Restaurant	Yes	33.324028	35.314056	Abou Chady
R060	3	Bedias	5	11	Resort	Yes	33.32379	35.2923	Al Wafaa
R061	3	Tayr Falsay	5	10	Restaurant	Yes	33.32345	35.34277	Al Boustan
R062	1	Zrariyeh	5	11	Resort	Yes	33.32298	35.30944	Al Deek
R063	1	Tayr Falsay	5	10	Restaurant	Yes	33.32294	35.34243	Al Layali
R064	3	Bedias	5	11	Restaurant	Yes	33.32269	35.29147	Al Malak
R065	2	Bedias	5	11	Unspecified	Yes	33.322613	35.291793	Ismail Fakhoury
R066	2	Tayr Falsay	5	10	Restaurant	Yes	33.3221	35.34252	Al Fajr Al Jadeed
R067	2	Tayr Falsay	5	10	Restaurant	Yes	33.32209	35.34236	Qassem
R068	1	Jazira (Saida)	5	11	Recreational	Yes	33.321928	35.29056	
R069	2	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.321627	35.342307	
R070	1	Jazira (saida)	5	11	Restaurant	Yes	33.32137	35.28722	Al Ahlam
R071	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.321244	35.34646	
R072	3	Ain Abou Abdallah	5	11	Recreational	Yes	33.321236	35.265411	
R073	3	Arzai	5	11	Restaurant	Yes	33.321196	35.290753	Al Shalalat
R074	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.321118	35.348289	Al Malek
R075	3	Tayr Falsay	5	10	Restaurant	Yes	33.321088	35.341744	Hussein Sa'eed Hammoud
R076	2	Bedias	5	11	Unspecified	Yes	33.320908	35.306626	Huda
R077	2	Tayr Falsay	5	10	Restaurant	Yes	33.320837	35.341354	Hassan Sa'eed Hammoud
R078	1	Tayr Falsay	5	10	Restaurant	Yes	33.320822	35.347362	Ali Mazeh
R079	1	Tayr Falsay	5	10	Restaurant	Yes	33.320768	35.34705	Al Qoussair
R080	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.320744	35.341802	
R081	1	Bedias	5	11	Resort	Yes	33.320615	35.309612	Layalina
R082	1	Tayr Falsay	5	10	Restaurant	Yes	33.32056	35.347817	Elissar

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R083	1	Tayr Falsay	5	10	Restaurant	Yes	33.320516	35.348342	Malek
R084	1	Tayr Falsay	5	10	Restaurant	Yes	33.32039	35.345848	Al Qa'em
R085	1	Arnoun	3	6	Resort	No	33.320211	35.528579	Kalaa Resort
R086	1	Bedias	5	11	Unspecified	Yes	33.320209	35.308056	Khajara
R087	1	Sir El Gharbiyeh	5	10	Recreational	Yes	33.320125	35.341568	
R088	1	Tayr Falsay	5	10	Restaurant	Yes	33.320109	35.345445	Al Manara
R089	3	Jazira (saida)	5	11	Restaurant	Yes	33.32006	35.28841	Al Naseem
R090	1	Tayr Falsay	5	10	Restaurant	Yes	33.320017	35.349113	Al Jawad
R091	1	Tayr Falsay	5	10	Restaurant	Yes	33.319789	35.340817	Andoni
R092	1	Tayr Falsay	5	10	Camp Site	Yes	33.319553	35.344977	Jami'yet El Shabeb
R093	2	Tayr Falsay	5	10	Restaurant	Yes	33.319488	35.341153	Al Sayyed
R094	2	Tayr Falsay	5	10	Restaurant	Yes	33.318777	35.340824	Al Yasmine
R095	2	Tayr Falsay	5	10	Recreational	Yes	33.318353	35.34931	
R096	2	Sir El Gharbiyeh	5	10	Camp Site	Yes	33.31802	35.344059	
R097	3	Tayr Falsay	5	10	Camp Site	Yes	33.317907	35.340739	Sifsaf 2
R098	2	Sir El Gharbiyeh	5	10	Recreational	Yes	33.317804	35.348897	
R099	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.317585	35.343842	
R100	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.317318	35.348584	
R101	2	Tayr Falsay	5	10	Restaurant	Yes	33.317087	35.341091	Sifsaf 1
R102	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.317027	35.348292	
R103	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.316968	35.342212	
R104	2	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.316864	35.342809	
R105	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.316636	35.34793	
R106	2	Tayr Falsay	5	10	Restaurant	Yes	33.316616	35.341937	Maha
R107	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.316423	35.347743	
R108	1	Ain Abou Abdallah	5	11	Unspecified	No	33.3162	35.287992	
R109	1	Qaaqaaiyet Ej Jisr	5	10	Restaurant	Yes	33.31601721	35.4218065	Abbas Salameh
R110	1	Tayr Falsay	5	10	Restaurant	Yes	33.315625	35.346386	Al Mokhtar

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R111	3	Qaaqaaiyet Ej Jisr	5	10	Recreational	Yes	33.315247	35.428657	
R112	2	Kfar Sir	5	10	Recreational	Yes	33.315219	35.420642	
R113	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.315079	35.346621	
R114	3	Qaaqaaiyet Ej Jisr	5	10	Restaurant	Yes	33.314898	35.429082	
R115	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.31486	35.346567	
R116	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.314648	35.346583	
R117	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.314475	35.346715	Abou Fouad
R118	2	Qaaqaaiyet Ej Jisr	5	10	Restaurant	Yes	33.314411	35.430646	Helo El Rawa'
R119	2	Kfar Sir	5	10	Recreational	Yes	33.314345	35.420697	Muntazah Jradi
R120	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.314243	35.34695	
R121	2	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.314065	35.347121	
R122	1	Sir El Gharbiyeh	5	10	Camp Site	Yes	33.313986	35.348298	
R123	1	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.313912	35.351927	
R124	3	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.313881	35.350552	
R125	1	Kfar Sir	5	10	Resort	No	33.313747	35.420003	Jradi Resort
R126	2	Srifa	5	10	Restaurant	Yes	33.313637	35.430757	Helo El Rawa'
R127	1	Tayr Falsay	5	10	Restaurant	Yes	33.313448	35.351652	
R128	1	Tayr Falsay	5	10	Restaurant	Yes	33.313327	35.349449	Wadi El Arayesh
R129	2	Tayr Falsay	5	10	Restaurant	Yes	33.313133	35.353516	Al Hamza
R130	1	Zaoutar Ech-Charqiyeh	3	6	Unspecified	Yes	33.312863	35.48064	
R131	1	Tayr Falsay	5	10	Unspecified	Yes	33.312651	35.35494	Beit Jeddi
R132	1	Qaaqaaiyet Ej Jisr	5	10	Resort	Yes	33.312563	35.431606	Litonia
R133	1	Tayr Falsay	5	10	Unspecified	Yes	33.312405	35.355407	
R134	1	Zaoutar Ech-Charqiyeh	3	6	Unspecified	Yes	33.312147	35.474517	
R135	1	Srifa	5	10	Restaurant	Yes	33.312126	35.430262	
R136	1	Zaoutar Ech-Charqiyeh	3	6	Unspecified	Yes	33.311933	35.482302	
R137	3	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.311762	35.430937	Abou Wajih
R138	2	Zaoutar Ech-Charqiyeh	3	6	Camp Site	Yes	33.311308	35.471973	
R139	1	Zaoutar Ech-Charqiyeh	3	6	Camp Site	Yes	33.311199	35.479052	

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R140	3	Zaoutar Ech-Charqiyeh	3	6	Camp Site	Yes	33.311092	35.475258	
R141	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.310999	35.430358	Ali Halawi
R142	1	Qaaqaaiyet Ej Jisr	5	10	Restaurant	Yes	33.310889	35.445144	Jamil Salameh
R143	1	Qaaqaaiyet Ej Jisr	5	10	Recreational	Yes	33.310589	35.430397	
R144	1	Aalmane	3	6	Recreational	Yes	33.310526	35.47496	
R145	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.310437	35.433937	
R146	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.310367	35.430353	Al Boustan
R147	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.310317	35.432993	Safi
R148	2	Qaaqaaiyet Ej Jisr	5	10	Recreational	Yes	33.309925	35.435274	
R149	2	Sir El Gharbiyeh	5	10	Restaurant	Yes	33.309814	35.356892	
R150	1	Qaaqaaiyet Ej Jisr	5	10	Resort	Yes	33.309778	35.431516	Paradise Resort
R151	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.309634	35.432262	Kalakish
R152	1	Zaoutar Ech-Charqiyeh	3	6	Unspecified	Yes	33.309581	35.477656	
R153	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.309404	35.430546	Mai w Fai
R154	1	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.309329	35.432184	Kalakish
R155	1	Froun	5	10	Resort	Yes	33.309303	35.434048	K-Bridge Waterpark and Resort
R156	2	Qaaqaaiyet Ej Jisr	5	10	Restaurant	Yes	33.309298	35.436833	Jamil Halawi
R157	1	Zaoutar El Gharbiyeh	3	6	Public Garden	Yes	33.309298	35.451815	
R158	2	Kfar Sir	5	10	Restaurant	Yes	33.309197	35.417605	Shater Hasan
R159	2	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.309144	35.442651	Haydar Salameh
R160	1	Aalmane	3	6	Recreational	Yes	33.309052	35.475744	
R161	2	Kfar Sir	5	10	Restaurant	Yes	33.308815	35.41648	
R162	2	Qaaqaaiyet Ej Jisr	5	10	Restaurant	Yes	33.308553	35.438048	Ahmad Haydar
R163	1	Tayr Falsay	5	10	Restaurant	Yes	33.308459	35.356517	Amal Chalhoub
R164	2	Qaaqaaiyet Ej Jisr	5	10	Unspecified	Yes	33.308374	35.440575	Wesam
R165	1	Kfar Sir	5	10	Restaurant	Yes	33.307864	35.412898	

ID	Position w.r.t River*	Village	LLB Zone	Sub-watershed	Type	Bordering River	Latitude	Longitude	Name of Establishment
R166	1	Yohmor (Nabatiye)	3	6	Restaurant	No	33.307645	35.489409	Al Marej El Akhdar
R167	1	Froun	4	7	Restaurant	No	33.305685	35.438352	Al Hujair Castle Park
R168	2	Taybeh (Marjaayoun)	3	6	Restaurant	Yes	33.295611	35.526053	
R169	1	Ghandouriyeh (Bent Jbayl)	4	7	Restaurant	Yes	33.27489	35.445975	Firdous El Hujeir
R170	1	Ghandouriyeh (Bent Jbayl)	4	7	Restaurant	Yes	33.272815	35.446232	Ard El Ezz
R171	1	Borj Qalaouiyeh	4	9	Restaurant	No	33.267708	35.426625	
R172	1	Taybeh (Marjaayoun)	3	6	Resort	No	33.262923	35.522167	
R173	1	Taybeh (Marjaayoun)	4	8	Restaurant	No	33.260569	35.492756	
R174	1	Aadchit (Qoussair)	4	8	Restaurant	No	33.260238	35.474593	Aarsh El Molouk
R175	1	Borj Qalaouiyeh	4	9	Resort	No	33.260071	35.43157	
R176	1	Aadaysseh (Marjaayoun)	3	6	Restaurant	No	33.256606	35.532131	
R177	1	Qabrikha	4	8	Resort	Yes	33.253156	35.478777	Al E'rzal
R178	1	Aadaysseh (Marjaayoun)	3	6	Unspecified	No	33.251001	35.529601	
R179	1	Touline	4	9	Resort	No	33.236522	35.450498	Al Aawali
R180	1	Majdel Selm	4	8	Resort	No	33.204736	35.472102	Accaccia Land
R181	1	Meiss Ej Jabal	4	8	Restaurant	No	33.182961	35.489828	

* 1: Located within the 10 m river boundary; 2: Partially located within the 10 m river boundary; 3: Located outside the 10 m river boundary

Table D-6. Informal Tented Settlements in the LLB Study Area (March 2018)

PCode	Zone	PCode Name	Governorate	District	Cadastre	Latitude	Longitude	Size (Number of tents)	Population (Nu
52237-01-001	Zone 1	Qaraaoun 001	Bekaa	West Bekaa	Qaraaoun	33.57381157	35.7198142	2	13
52237-01-002	Zone 1	Qaraaoun 002	Bekaa	West Bekaa	Qaraaoun	33.56991944	35.71614667	22	118
52237-01-003	Zone 1	Qaraaoun 003	Bekaa	West Bekaa	Qaraaoun	33.57150007	35.71450033	17	99
52237-01-004	Zone 1	Qaraaoun 004	Bekaa	West Bekaa	Qaraaoun	33.58132289	35.72491406	11	51
52237-01-005	Zone 1	Qaraaoun 005	Bekaa	West Bekaa	Qaraaoun	33.5743002	35.71670016	31	180
52237-01-006	Zone 1	Qaraaoun 006	Bekaa	West Bekaa	Qaraaoun	33.580764	35.714025	9	57
52237-01-008	Zone 1	Qaraaoun 008	Bekaa	West Bekaa	Qaraaoun	33.5729424	35.71408388	10	56
52237-01-009	Zone 1	Qaraaoun 009	Bekaa	West Bekaa	Qaraaoun	33.58729964	35.71960018	6	33
52237-01-014	Zone 1	Qaraaoun 014	Bekaa	West Bekaa	Qaraaoun	33.57663143	35.71725	15	80
52237-01-016	Zone 1	Qaraaoun 016	Bekaa	West Bekaa	Qaraaoun	33.57822683	35.72126512	47	206
52237-01-017	Zone 1	Qaraaoun 017	Bekaa	West Bekaa	Qaraaoun	33.56637378	35.73030644	1	5
52237-01-018	Zone 1	Qaraaoun 018	Bekaa	West Bekaa	Qaraaoun	33.57255187	35.72042993	3	10
52237-01-019	Zone 1	Qaraaoun 019	Bekaa	West Bekaa	Qaraaoun	33.57598074	35.71964005	15	84
52237-01-020	Zone 1	Qaraaoun 020	Bekaa	West Bekaa	Qaraaoun	33.57551912	35.71971922	16	79
52237-01-021	Zone 1	Qaraaoun 021	Bekaa	West Bekaa	Qaraaoun	33.57542342	35.72006218	14	65
52237-01-022	Zone 1	Qaraaoun 022	Bekaa	West Bekaa	Qaraaoun	33.57911148	35.73123701	4	27
52237-01-023	Zone 1	Qaraaoun 023	Bekaa	West Bekaa	Qaraaoun	33.57517271	35.71263412	5	26
52237-01-024	Zone 1	Qaraaoun 024	Bekaa	West Bekaa	Qaraaoun	33.57477813	35.72387981	7	41
52237-01-026	Zone 1	Qaraaoun 026	Bekaa	West Bekaa	Qaraaoun	33.58399988	35.71529994	1	7
52237-01-028	Zone 1	Qaraaoun 028	Bekaa	West Bekaa	Qaraaoun	33.5698218	35.72110028	1	6
52237-01-029	Zone 1	Qaraaoun 029	Bekaa	West Bekaa	Qaraaoun	33.57718387	35.72454279	4	23
52237-01-030	Zone 1	Qaraaoun 030	Bekaa	West Bekaa	Qaraaoun	33.57313475	35.72083717	2	9
52237-01-031	Zone 1	Qaraaoun 031	Bekaa	West Bekaa	Qaraaoun	33.58306296	35.7121875	2	14

PCode	Zone	PCode Name	Governorate	District	Cadastre	Latitude	Longitude	Size (Number of tents)	Population (Nu
52237-01-032	Zone 1	Qaraaoun 032	Bekaa	West Bekaa	Qaraaoun	33.57321042	35.72159967	2	17
52237-01-033	Zone 1	Qaraaoun 033	Bekaa	West Bekaa	Qaraaoun	33.58589889	35.7193352	2	16
52237-01-034	Zone 1	Qaraaoun 034	Bekaa	West Bekaa	Qaraaoun	33.57735281	35.72135312	44	218
52237-01-035	Zone 1	Qaraaoun 035	Bekaa	West Bekaa	Qaraaoun	33.58374973	35.71126723	1	12
73135-01-001	Zone 2	Blat Marjaayoun 001	Nabatiye	Marjaayoun	Blat Marjaayoun	33.38550668	35.61035086	19	68
73135-01-003	Zone 2	Blat Marjaayoun 003	Nabatiye	Marjaayoun	Blat Marjaayoun	33.38568056	35.61043188	12	62
73135-01-004	Zone 2	Blat Marjaayoun 004	Nabatiye	Marjaayoun	Blat Marjaayoun	33.36861928	35.61931083	2	8
74133-01-001	Zone 2	Kaoukaba Hasbaiya 001	Nabatiye	Hasbaiya	Kaoukaba Hasbaiya	33.38400182	35.61635153	2	13
62276-01-002	Zone 5	Aabbassiyeh Sour 002	South	Sour	Aabbassiyeh Sour	33.30871031	35.2555586	4	24
62291-01-001	Zone 5	Aain Abou Abdallah 001	South	Sour	Aain Abou Abdallah	33.32379637	35.24638727	4	24
61411-01-002	Zone 5	Jazira Saida 002	South	Saida	Jazira Saida	33.326088	35.268562	2	9
61419-01-002	Zone 5	Kharayeb Saida 002	South	Saida	Kharayeb Saida	33.34735232	35.29647152	1	4
61419-01-003	Zone 5	Kharayeb Saida 003	South	Saida	Kharayeb Saida	33.34804665	35.28831072	1	4
61419-01-004	Zone 5	Kharayeb Saida 004	South	Saida	Kharayeb Saida	33.34388671	35.2832542	3	26
61419-01-007	Zone 5	Kharayeb Saida 007	South	Saida	Kharayeb Saida	33.34466094	35.28463105	3	19
61419-01-008	Zone 5	Kharayeb Saida 008	South	Saida	Kharayeb Saida	33.35208027	35.29945889	2	12
61419-01-011	Zone 5	Kharayeb Saida 011	South	Saida	Kharayeb Saida	33.3501615	35.28829447	1	5
61419-01-012	Zone 5	Kharayeb Saida 012	South	Saida	Kharayeb Saida	33.34691086	35.2857052	2	11
61419-01-013	Zone 5	Kharayeb Saida 013	South	Saida	Kharayeb Saida	33.34444854	35.27991477	1	6
61415-01-003	Zone 5	Matariyet Ech Choumar 003	South	Saida	Matariyet Ech Choumar	33.33525863	35.28126625	4	28
61415-01-004	Zone 5	Matariyet Ech Choumar 004	South	Saida	Matariyet Ech Choumar	33.33533754	35.28041163	1	6
61415-01-006	Zone 5	Matariyet Ech Choumar 006	South	Saida	Matariyet Ech Choumar	33.33313635	35.28246347	3	10
61415-01-007	Zone 5	Matariyet Ech Choumar 007	South	Saida	Matariyet Ech Choumar	33.33414168	35.27827642	4	22
61415-01-008	Zone 5	Matariyet Ech Choumar 008	South	Saida	Matariyet Ech Choumar	33.33258335	35.27479136	2	10

PCode	Zone	PCode Name	Governorate	District	Cadastre	Latitude	Longitude	Size (Number of tents)	Population (Nu
61415-01-009	Zone 5	Matariyet Ech Choumar 009	South	Saida	Matariyet Ech Choumar	33.33145214	35.27709302	3	19
61415-01-010	Zone 5	Matariyet Ech Choumar 010	South	Saida	Matariyet Ech Choumar	33.32882945	35.27076183	1	0
61415-01-011	Zone 5	Matariyet Ech Choumar 011	South	Saida	Matariyet Ech Choumar	33.3427124	35.28369141	2	7
61415-01-012	Zone 5	Matariyet Ech Choumar 012	South	Saida	Matariyet Ech Choumar	33.33383716	35.28323649	3	17
61415-01-014	Zone 5	Matariyet Ech Choumar 014	South	Saida	Matariyet Ech Choumar	33.33441009	35.27409019	2	4
61415-01-018	Zone 5	Matariyet Ech Choumar 018	South	Saida	Matariyet Ech Choumar	33.33419303	35.26997852	1	11
61415-01-019	Zone 5	Matariyet Ech Choumar 019	South	Saida	Matariyet Ech Choumar	33.33481602	35.27967027	1	7
61414-01-001	Zone 5	Mzaraat El-Ouasta 001	South	Saida	Mzaraat El-Ouasta	33.34136513	35.25503467	3	11
61414-01-012	Zone 5	Mzaraat El-Ouasta 012	South	Saida	Mzaraat El-Ouasta	33.34418382	35.26789733	1	6

APPENDIX E – AGRICULTURAL PESTICIDES AND FERTILIZERS

Table E-1. Types of Pesticides Used and the Recommended and Actual Doses Used per Crop

Common Name	Concentration & Formulation	Type (I,A,F,H)	Crop	Application Rate (On Label)	Application Rate (Used by farmer)	Nb of Applications
Methomyl	90% WP	I	Orange	250 g/du	800 g/ha	3
Sulfur	50% WP	F	Orange	750-1000 g/du	2500 g/du	1
Abamectin	1.8% EC	I,A	Orange	15-20 cc/20 l	20 cc/20 l	1-2
Dimethoate	40% EC	I	Orange	25 cc/20 l	30-40 cc/20 l	1-3
Glyphosate	50% WP	H	Orange	20 l/du	50-80 l/du	1-2
Fosetyl Aluminium	800g/kg	F	Banana	0.5 kg/du	1 kg/du	1
Carbufuran	NA	I	Banana	50 g/du	50 g/plant	1
Glyphosate	50% WP	H	Banana	20 l/du	30-50 l/du	1-2
Dimethoate	40% EC	I	Olives	25 cc/20 l	30 cc/20 l	1-3
Cypermethrin	25% EC	I	Olives	5-7 cc/20 l	10 cc/20 l	1-2
Copper oxychloride	25% WP	F	Olives	50-60 g/20 l	80 g/20 l	1-2
Carbendazim	50% SC	F	Olives	100-150 cc/200 l	200 cc/200 l	1-2
Triadimenol	25% EC	F	Olives	40-50 g/20 l	125 g/20 l	1
Thiocyclam	WP	F	Tomato	500 g/du	800 g/du	1-2
Cypermethrin	25% EC	I	Tomato	5-7 cc/20 l	15 cc/20 l	2-3
Indoxacarb	15% SC	I	Tomato	7-10 cc/20 l	10-12.5 cc/20 l	1
Chlorpyriphos	50% Ec	I	Tomato	20 cc/20 l	30-40 cc/ 20 l	1-2
Lufenuron	5% EC	I	Tomato	200 cc/200 l	200 cc/200 l	1
Thiametoxam	25% WG	I	Tomato	160-200 g/ha	100 g/ha	1-2
Alphacypermethrin	10% EC	I	Tomato	20-40 cc/20 l	50 cc/20 l	1-2
Deltamethrin	2.5% EC	I	Tomato	10 cc/20 l	20 cc/20 l	1-2
Mancozeb	64%	F	Tomato	25-35 g/20 l	40 g/20 l	2-3
Acetomiprid	20% SP	I	Cucumber	250 G/ha	500 g/ha	2
Carbosulfan	48% EC	I	Cucumber	20 cc/20 l	25 cc/20 l	2
Alphacypermethrin	10% EC	I	Cucumber	20-40 cc/20 l	30 cc/20 l	2
Abamectin	1.8% EC	I,A	Cucumber	15-20 cc/20 l	20 cc/20 l	2
Deltamethrin	2.5% EC	I	Cucumber	10 cc/20 l	10-20 cc/20 l	2
Mancozeb	75-80% WP	F	Cucumber	40-50 g/20 l	50 g/20 l	2
Hexaconazol	5% EC	F	Cucumber	5-10 cc/20 l	15 cc/20 l	1

Common Name	Concentration & Formulation	Type (I,A,F,H)	Crop	Application Rate (On Label)	Application Rate (Used by farmer)	Nb of Applic ations
Cypermethrin	25% EC	I	Pepper	5-7 cc/20 L	10-15 cc/20 l	1
Deltamethrin	2.5% EC	I	Pepper	10 cc/20 L	15-20 cc/20 l	1-2
Chlorpyriphos	50% EC	I	Pepper	20 cc/20 L	30-50 cc/20 l	2
Abamectin	1.8% EC	I,A	Pepper	15-20 cc/20 l	20 cc/20 l	1-2
Mancozeb	80% WP	F	Pepper	40 g/20 l	50-60 g/20 l	1
Carbendazim	50% SC	F	Pepper	10-15 cc/20 l	20 cc/20 l	1
Deltamethrin	2.5 % EC	I	Watermelon	10 cc/20 l	15-20 cc/20 l	1-2
Abamectin	1.8% EC	I,A	Watermelon	20 cc/20 l	20 cc/20 l	1-2
Mancozeb	75-80% WP	F	Watermelon	50 g/20 l	50 g/20 l	1
Hexaconazol	5% EC	F	Watermelon	15 cc/20 l	15 cc/20 l	1
Imidacloprid	20% SL	I	Watermelon	100-150 ml/200 l	200 ml/200 l	1
Cypermethrin	5% EC	I	Green beans	20 cc/20 l	30 cc/20 l	1-2
Deltamethrin	2.5% EC	I	Green beans	10 cc/20 l	20 cc/20 l	1
Zineb	80% WP	F	Green beans	40-50 g/20 l	50 g/20 l	1
Mancozeb	80% WP	F	Green beans	40-50 g/20 l	50 g/20 l	1-2
Abamectin	1.8% WP	I,A	Green beans	15-20 cc/20 l	20 cc/20 l	1-2
Copper oxychloride	80% WP	E	Wheat	50-60 g/20 l	80 g/20 l	1
Cyproconazole	50% SL	F	Wheat	50 g/hl	75 g/hl	1
2,4 D	72% SL	H	Wheat	100-150 ml/Dunum	100-150 ml/Dunum	1
Hexaconazol	5% EC	F	Wheat	5-10 cc/20 l	15 cc/20 l	1
Metamidaphos	60% SC	I	Onion	25 cc/20 l	30 cc/20 l	1-2
Methiocarb	50% WP	I	Onion	100-200 g/100 l	250 g/100 l	1
Dichlorovos	50% EC	I	Onion	150-200 cc/hl	250 cc/hl	1
Benomyl	50% WP	F	Onion	15 g/20 l	20-25 g/20 l	1-2
Carbendazim	50% WP	F	Onion	15 g/20 l	20 g/20 l	1-2
Cycloxydim	10% EC	H	Onion	1-2 l/ha	1-2 l/ha	1
Oxyfluorfen	24% EC	H	Onion	250 ml/ha	250 ml/ha	1
Deltamethrin	2.5% EC	I	Apple	10 cc/20 L	15-20 cc/20 l	1-2
Alphacypermeth rin	10% EC	I	Apple	20-40 cc/20 l	50 cc/20 l	1-2
Abamectin	1.8% EC	I,A	Apple	15-20 cc/20 l	20 cc/20 l	1

Common Name	Concentration & Formulation	Type (I,A,F,H)	Crop	Application Rate (On Label)	Application Rate (Used by farmer)	Nb of Applications
Imidacloprid	20% SL	I	Apple	10 ml/200 l/tree	12.5 ml/200 l/tree	1-2
Flufenexuron	10% DC	I	Apple	7.5-10 g/hl	10 g/hl	1
Cypermethrin	25% EC	I	Apple	5-7 cc/20 l	10 cc/20 l	1-2
Methamidophos	60% EC	I	Apple	25 cc/20 l	30-35 cc/20 l	1-2
Hexaconazol	5% EC	F	Apple	5-10 cc/20 l	15 cc/20 l	1-2
Mancozeb	80% WP	F	Apple	40-50 g/20 l	50-60 g/20 l	1-2
Triadimenol	25% EC	F	Apple	40-50 g/20 l	50 g/20 l	1
Endosulfan	35% EC	I	Peach	60 g/hl	75 g/hl	1
Imidacloprid	20% SL	I	Peach	350 ml/ha	500 ml/ha	1
Deltamethrin	2.5% EC	I	Peach	10 cc/20 l	20 cc/20 l	1
Propagite	57% EC	A	Peach	75-100 cc/200 l	120 cc/200 l	1
Copper hydroxide	77% WP	F	Peach	40-50 g/20 l	60 g/20 l	1
Mancozeb	80% WP	F	Peach	40-50 g/20 l	50 g/20 l	1
Carbendazim	50% SC	F	Peach	100-150 cc/200 l	200 cc/200 l	1
Methomyl	90% WP	I	Almonds	3-5 cc/20 l	10-15 cc/20 l	1
Thiamethoxam	25% WG	I	Almonds	10-20 g/100 l	20 g/100 l	1
Deltamethrin	2.5% EC	I	Almonds	10 cc/20 l	15 cc/20 l	1-2
Carbendazim	50% SC	F	Almonds	100-150 cc/200 l	200 cc/200 l	1-2
Cypermethrin	25% EC	I	Grapes	5-7 cc/20 l	10-15 cc/20 l	1
Deltamethrin	2.5% EC	I	Grapes	10 cc/20 l	15-20 cc/20 l	1-2
Lufenuron	5% EC	I	Grapes	200 ml/200 l	200 ml/200 l	1
Dichlorvos	50% EC	I	Grapes	150-200 cc/hl	250 cc/hl	1
Sulfur	50% WP	F	Grapes	750-1000 g/hl	1000 g/hl	1
Hexaconazol	5% EC	F	Grapes	5-10 cc/20 l	15-20 cc/20 l	1-2
Benomyl	50% WP	F	Grapes	15 g/20 l	25 g/20 l	1-2
Myclobutanil	40% WP	F	Grapes	15-20 g/hl	25 g/hl	1-2

NB: I (Insecticide), A (Acaricide), F (Fungicide), H (Herbicide)

Table E-2. Pesticides Banned by the Lebanese Ministry of Agriculture

Decision 94/1 - 20/5/1998	1,2 dibromo-ethane	Captafol	Demephion-O	Fosthietan	Phenylmercury acetate (PMA)
	1, 2 dichloro-ethane	Carbon tetrachloride	Demephion-S	HCH containing less than 99.0% of gamma isomer	Phospholan
	2,3,4,5- Bis (2-butylene) tetrahydro-2-furaldehide [Repellent-11]	Carbonphenothion	Diamidafos	Heptachlore	Potassium 2,3,5 trichlorophenate (2,4,5,-TCP)
	2,4,5-trichlorophenoxyacetic acid (2,4,5-T)	Chloranil	Dibromochloropropane	IFSP = Aphidan	Pyriminil [Vacor] - *Repellent-11*
	Acrolein	Chlordane	Dicrotophos	Isazophos	Safrole
	Acrylonitrile	Chlordecone	Dieldrin	Isobenzane	Salithion - *Schradan*
	Aldicarb	Chlordimefon	Dimefox	Isodrin	Silvex
	Adrin	Chlorinated camphene [Toxaphene]	Dimetilan	Isothioate	Sodium arsenate
	All compounds containing arsenic salts.	Chlormephos	Dinoterb salts	Isoxathion	Sodium arsenite
	Aminocarb	Chloromethoxyproylmercuric acetate (CMPA)	Dinoseb salts	Kepon	Sodium Cyanide
	Aramite	Chlorthiophos	Dioxathion	Lead arsenate	Sodium fluoroacetate
	Arsenious oxide	Copper Acetoarsenite	Edifenphos	Leptophos	Sodium pentachloro-phenoxide (Sodium pentachlorophenate) - *Strobane*
	BHC Technical (not Gamma HCH-Lindane)	Copper Arsenate	Endothion	Maleic hydrazine and its salts, other than salts of choline, potassium and sodium.	TDE (1,1- Dichloro-2,2-bis (p-chlorophenyl) Ethane

	Binapacryl	Copper Arsenite	Endrin	Medinoterb acetate	TEPP (Tetra ethyl diphosphate or Tetra ethyl pyrophosphate or Ethylpyrophosphate)
	Butocarboxium	Crimidine	EPN (Ethyl (p-nitrophenyl) thio benzene phosphonate)	Mercuric chloride	Terpene polychlorinates [strobane]
	Butoxycarboxium	Crotoxyphos	Erbon	Mercuric Compounds (Organic and Inorganic)	Thallium sulfate
	Cadminate	Cyanothoate	Ethylan	Mirex	Thionazin - *Toxaphene*
	Cadmium Calcium Copper Zinc Chromate Complex	Cycloheximide	Ethyl Parathion	Nitrofen	Triamiphos
	Cadmium compounds	DBCP (Dibromo chloro propane)	Ethylene Dibromide	OMPA [Schradan]	Trichloronate
	Calcium Arsenate	DDT	Ethylene oxide	Oxydeprofos - *Parathion ethyl*	Trysben - *Vacor*
	Calcium Arsenite	Decachlorooctahydro 1,3,4 methoxy 2H cyclobuta (cd) pentalen-2-one [Chlordecone]	Fensulfothion	Phenazine	Vinyl chloride
	Calcium cyanide	Dechlorane	Fluoroacetamide	Phenylmercuric oleate (PMO)	Wipeout
Decision 262/1 - 29/6/2001	Monocrotophos	Methyl Parathion (except 10% Methyl parathion + 50% Winter Oil)	Lindane		
Decision 570/1 - 24/12/2008	Chlorobenzilate	Dinitro-ortho-cresol (DNOC) and its salts	Hexachlorobenzene	Pentachlorophenol, its salts & esters	Dustable powder formations containing a combination of benomyl (>7%), carbofuran (>10%), thiram (≥15%)
	Methamidophos (soluble liquid formulations >600g active ingredient/l)	Phosphamidon (solubel liquid formulations >1000g active ingredient/l)			

Decision 79/1 - 13/2/2010 & Decision 868/1 - 14/12/2010	Methamidophos	Acephate	Endosulfan	Paraquat	Zineb
Decision 309/1 - 24/6/2010	Methidathion	Methyl Parathion	Cyhexatin	Simazine	Atrazine
Decision 674/1 - 29/10/2010	Abamectin				
Decision 294/1 - 19/3/2011	N-Phenyl Phthalamic acid	Naphtylacetic acid hydrazide (NAA)	Naphtyl oxyacetic acid (NOA)	4-Chlorophenoxyacetic acid (4-CPA)	β-Naphtyl oxyacetic acid (β-NOA)
Decision 403/1 - 8/5/2012	Propargite				
Decision 850/1 - 12/9/2012	Hexaconazole				
Decision 143/1 - 02/07/2014 *	Cypermethrin	Dichlorvos DDVP	Carbofuran	Carbosulfan	Hexoconazole

* Can be used only with the remaining quantities but not imported

APPENDIX F – METHODOLOGY FOR ANALYSIS OF THE DATA IN THE DATABASE OF PAST RIVER AND LAKE WATER AND SEDIMENT ANALYSIS RESULTS + SUMMARY OF DATA ANALYSIS

Water Quality Analysis

Water quality results for each analysed parameter were averaged across each section for the specific year and season for which the result is reported. The numerical averages were charted and compared across the water quality guidelines and maximal admissible values for drinking, swimming or bathing, irrigation and maintaining aquatic health. The guideline and standard values against which the results were compared appear in Appendix G, Table G-8. The parameters were grouped into physical, chemical parameters, biological parameters, metals, and organic compounds, phenols, TPH, etc. where available. To determine whether the state of the water quality was <u>on the overall in the indicated river or tributary section</u>, good, average or poor, the following grading was applied.

1- For physico-chemical parameters (P-C) which are considered to be pollutants, such as ammonia and nitrites, a parameter that was judged to exceed the standard for any use in one season was allocated ½ point. If it exceeds the standards for any use in both seasons, then the grade is 1 point. Parameters that are more indicative of the physical quality of water, such as calcium or conductivity were allocated ¼ point if they exceeded the standard for any type of use in one season and ½ point if the standard was judged to have been exceeded in both seasons. For some parameters that are considered to indicate the same P-C quality, such as conductivity and TDS or phosphates and total phosphorus, the parameter was allocated points only once.

6. The scores were translated into a qualitative description for P-C where the rating of:
    - 'Good' is for a P-C score between 0 and 3
    - 'Average' is for a P-C score between 3.5 and 5.5
    - 'Poor' is for P-C score greater than or equal to 6

2- For metals (M), a heavy metal that was judged to exceed the standard for any use in one season was allocated ½ point. If it exceeds the standards for any use in both seasons, then the grade is 1 point.

7. The scores were translated into a qualitative description for M where the rating of:
    - 'Good' is for an M score between 0 and 1
    - 'Average' is for an M score between 1.5 and 2
    - 'Poor' is for an M score greater than or equal to 2.5

3- For biological parameters (B), a parameter that was judged to exceed the standard for any use in one season was allocated ½ point. If it exceeds the standards for any use in both seasons, then the grade is 1 point. Care was taken not to double count some parameters, e.g. where results for faecal coliforms were present, total coliforms were not allocated any points.

8. The scores were translated into a qualitative description for B where the rating of:
    - 'Good' is for a B score of 0
    - 'Average' is for a B score between 0.5 and 1
    - 'Poor' is for a B score greater than 1

A summary of the colour-assignment for the score brackets for each parameter category is shown in Table F-1. The summary tables that were used to derive the scores appear in Table F-

2 through Table F-11 which summarise of the overall water analysis findings in the various sections of the Lower Litani River and its tributaries.

Table F-1. Colour-coding of the Water Quality based on Bracket Scores

Parameter Category	Good	Average	Poor
Physico-chemical	≤ 3	3.5-5.5	≥ 6
Metals	≤ 1	1.5-2	≥ 2.5
Biological	≤ 1	1.5-2	≥ 2.5

Main River Section 01

Table F-2. Summary of Main River Section 01 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
E. Coli	-	-	-	-	X[7]	NR	-	-
Fecal Coliform	-	-	-	-	X[8]	NR	√	NR
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	-	-	-	-	-	√	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	√	√	√	-	-	-	-
NH_3	-	-	-	-	√	√	-	-
NO_2	X	X	-	-	X[9]	X[10]	-	-
NO_3	-	-	-	-	X[11]	X[12]	√[13]	√[14]
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[15]	√[16]
SO_4^{2-}	-	-	-	-	√	√	X[17]	√[18]
Physical (P)								
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
TDS					X[19]	X[20]	√	√
Temperature	-	-	-	-	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

7 - Result limited to Kodeih Naji 2016_LitaniRiver_Pollution sampling campaign
8 - Result limited to Kodeih Naji 2016_LitaniRiver_Pollution sampling campaign
9 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
10 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
11 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
12 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
13 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
14 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
15 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
16 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
17 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
18 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
19 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
20 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016

Main River Section 03

Table F-3. Summary of Main River Section 03 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
E. Coli	-	-	-	-	X[21]	NR	-	-
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	√	NR
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[22]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	-	-	-	-	-	X	NR
Ca	-	-	-	-	-	-	X[23]	NR
Cl-	-	-	-	-	√	NR	√	NR
CO_3^{2-}	-	-	-	-	√	NR	X[24]	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	NR	√	NR	-	-	-	-
K^+	-	-	-	-	-	-	√	NR
Mg	-	-	-	-	-	-	√	√
Na^+	-	-	-	-	√	NR	√	NR
NH_4^+	-	-	-	-	-	-	√	NR
NO_2^-	√	NR	-	-	X[25]	NR	-	-
NO_3^-	-	-	-	-	X[26]	NR	√[27]	-
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[28]	NR
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	NR	√[29]	NR
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[30]	NR
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	√	√	√

21 - Result limited to Kodeih Naji 2016_LitaniRiver_Pollution sampling campaign
22 - Exceeds Swimming guideline value and result is below maximal admissible value (Lebanon MOE 52/1/1996)
23 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
24 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
25 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
26 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 and is below Lebanese Standard for Drinking Water NL 161:2016 and WHO 2002 Drinking Standard
27 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
28 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
29 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
30 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
TDS	-	-	-	-	X[31]	X[32]	√	√
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[33]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals								
Ag	-	-	-	-	√	√	√	√
Al	-	-	-	-	√	√	-	-
Ba	-	-	-	-	√	√	-	-
Cd	-	-	-	-	X[34]	X[35]	X[36]	√[37]
Cr	-	-	-	-	√	X	√	X[38]
Cu	X	√	-	-	√	√	√[39]	√
Fe	-	-	-	-	√	X	-	-
Mn	-	-	-	-	√	√	-	-
Ni	-	-	-	-	√	√	√[40]	√[41]
Pb	-	-	-	-	X[42]	X	√[43]	√[44]
V	-	-	-	-	-	-	√[45]	NR
Zn	√	X	-	-	√	√	√	√
Chlorobenzenes								
Pentachlorobenzene	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons								
TPH C21-C32	-	-	-	-	√	NR	-	-

*Concentrations compared to the usual range in irrigation water
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

31 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
32 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
33 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
34 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
35 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
36 - Average results' value is equal to the standard value
37 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
38 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
39 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
40 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
41 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
42 - Average results' value is equal to the standard value
43 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
44 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
45 - Result limited to ELARD sampling campaign

Main River Section 04

Table F-4. Summary of Main River Section 04 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
E. Coli	-	-	-	-	X[46]	NR	-	-
Enterococci	-	-	√	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	√	NR
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[47]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X[48]	NR
Ca	-	-	-	-	-	-	X[49]	NR
Cl-	-	-	-	-	√	NR	√	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	√	√	√	-	-	-	-
K^+	-	-	-	-	-	-	√	NR
Mg	-	-	-	-	-	-	√	NR
Na^+	-	-	-	-	√	NR	√	NR
NH_4^+	-	-	-	-	-	-	√	√
NO_2^-	X	X	-	-	X[50]	X	-	-
NO_3^-	-	-	-	-	√	√	√[51]	√[52]
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[53]	√[54]
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	NR	√[55]	NR
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[56]	NR
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	√	√	√
TDS	-	-	-	-	X[57]	X[58]	√	√

46 - Result limited to Kodeih Naji 2016_LitaniRiver_Pollution sampling campaign
47 - Exceeds Swimming guideline value and result is below maximal admissible value (Lebanon MOE 52/1/1996)
48 - Exceeds water for irrigation use: wastewater reuse category I (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005)) / Below the standards of Category II Wastewater reuse irrigation guidelines (LEBANON-FAO PROPOSED GUIDELINES (2010))
49 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
50 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
51 - Result below Water for Irrigation Use: Usual Range in In Irrigation Water (FAO)
52 - Result below Water for Irrigation Use: Usual Range in In Irrigation Water (FAO)
53 - Result below Water for Irrigation Use: Usual Range in In Irrigation Water (FAO)
54 - Result below Water for Irrigation Use: Usual Range in In Irrigation Water (FAO)
55 - Result below Water for Irrigation Use: Usual Range in In Irrigation Water (FAO)
56 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
57 Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
58 Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016

Parameter	**Aquatic**		**Bathing**		**Drinking**		**Irrigation**	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[59]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
Ba	-	-	-	-	√	NR	-	-
Fe	-	-	-	-	√	NR	-	-
V	-	-	-	-	-	-	√[60]	NR
Chlorobenzenes								
Pentachlorobenzene	-	-	-	-	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

59 Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
60 - Result limited to ELARD sampling campaign

Main River Section 06-01

Table F-5. Summary of Main River Section 06-01 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
E. Coli	-	-	-	-	X[61]	NR	-	-
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	X	NR
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[62]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X[63]	NR
Br	-	-	-	-	-	-	-	-
Ca	-	-	-	-	-	-	X[64]	NR
Cl^-	-	-	-	-	√	NR	√	NR
CO_3^{2-}	-	-	-	-	√	NR	X[65]	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	√	√	√	-	-	-	-
Dissolved Solid Substances	NR	X	-	-	-	-	-	-
K^+	-	-	-	-	-	-	√	NR
Mg	-	-	-	-	-	-	√	√
Na^+	-	-	-	-	√	NR	√	NR
NH_3	-	-	-	-	√	√	-	-
NH_4^+	-	-	-	-	-	-	√	√
NO_2^-	X	X	-	-	X	X	-	-
NO_3^-	-	-	-	-	X[66]	X[67]	√[68]	√[69]
P_2O_5	-	-	-	-	X	NR	-	-
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[70]	√[71]
SiO_2	-	-	-	-	-	-	-	-

61 - Result limited to Kodeih Naji 2016_LitaniRiver_Pollution sampling campaign
62 - Average results' value is equal to maximal admissible value for swimming standard (Lebanon-MOE 52/1/1996)
63 - Exceeds water for irrigation use: wastewater reuse category I and II (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005))
64 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
65 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
66 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
67 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
68 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
69 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
70 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
71 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
SO_4^{2-}	-	-	-	-	√	√	√[72]	X[73]
Total Nitrogen	√	NR	-	-	-	-	X[74]	NR
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[75]	NR
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	√	√	√
TDS	-	-	-	-	X[76]	X[77]	√	√
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[78]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
Ag	-	-	-	-	√	√	√	√
Al	-	-	-	-	X	√	-	-
As	-	-	-	-	-	-	-	-
Ba	-	-	-	-	√	√	-	-
Cd	-	-	-	-	X[79]	X[80]	X[81]	X[82]
Cr	-	-	-	-	√	X[83]	X[84]	X
Cu	X	X	-	-	√	√	√[85]	√[86]
Fe	-	-	-	-	√	X	-	-
Hg	-	-	-	-	X	NR	-	-
Mn	-	-	-	-	√	√	-	-
Ni	-	-	-	-	√	√	√[87]	√[88]
Pb	-	-	-	-	X	X	√[89]	√[90]
Zn	√	X[91]	-	-	√	√	√	√
Chlorobenzenes								
Pentachlorobenzene	-	-	-	-	-	-	-	-

72 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
73 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
74 - Exceeds Water for Irrigation Use: Degree of Restriction On Use Slight to Moderate (Sprinkler) (FAO)
75 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
76 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
77 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
78 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
79 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
80 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
81 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
82 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
83 - Average results' value is equal to standard
84 - Average results' value is equal to standard
85 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
86 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
87 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
88 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
89 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
90 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
91 - Average results' value is equal to standard

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

Main River Section 06-02

Table F-6. Summary of Main River Section 06-02 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
E. Coli	-	-	-	-	X[92]	-	-	-
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	-	√	NR
Pseudomonas aeruginosa	-	-	-	-	√	-	-	-
Total Coliform	-	-	X[93]	NR	X	-	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X[94]	NR
Ca	-	-	-	-	-	-	X[95]	NR
Cl^-	-	-	-	-	√	-	√	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	NR	√	NR	-	-	-	-
HCO_3	-	-	-	-	-	-	-	-
K^+	-	-	-	-	-	-	√	NR
Mg	-	-	-	-	-	-	√	NR
Na^+	-	-	-	-	√	NR	√	NR
NO_2^-	X	NR	-	-	X[96]	NR	-	-
NO_3^-	-	-	-	-	√	NR	√[97]	NR
P_2O_5	-	-	-	-	X	NR	-	-
pH	-	-	√	NR	√	NR	√	NR
PO_4^{3-}	-	-	-	-	-	-	√[98]	NR
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	NR	√[99]	NR
Total Nitrogen	√	NR	-	-	-	-	√	NR
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[100]	NR
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	NR	√	NR
TDS	-	-	-	-	X[101]	NR	√	NR
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[102]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
As	-	-	-	-	X	NR	X	NR
Ba	-	-	-	-	√	NR	-	-

92 - Result limited to Kodeih Naji 2016_LitaniRiver_Pollution sampling campaign
93 - Exceeds Swimming guideline value and result is below maximal admissible value (Lebanon MOE 52/1/1996)
94 - Exceeds water for irrigation use: wastewater reuse category I and II (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005))
95 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
96 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
97 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
98 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
99 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
100 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
101 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
102 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Fe	-	-	-	-	√	NR	-	-
Hg	-	-	-	-	X	NR	-	-
Pb	-	-	-	-	X	NR	√[103]	NR
Chlorobenzenes								
Pentachlorobenzene	-	-	-	-	-	-	-	-
Miscellaneous Organic Compounds								
Biphenyl	-	-	-	-	-	-	-	-
Phenols								
2, 5-Dimethylphenol	-	-	√	-	-	-	-	-
Volatile Halogenated Hydrocarbons								
1, 1-Dichloroethane	-	-	√	NR	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

103 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))

Qaaqaaiyet Ej Jisr Tributary Section 07

Table F-7. Summary of Qaaqaaiyet Ej Jisr Tributary Section 07 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Chemical (C)								
Dissolved Oxygen	√	√	√	√	-	-	-	-
NH_4^+	-	-	-	-	-	-	√	√
NO_2^-	√	X	-	-	√	X[104]	-	-
NO_3^-	-	-	-	-	√	√	√[105]	√[106]
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[107]	√[108]
Physical (P)								
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	√	√	√
TDS	-	-	-	-	X[109]	X[110]	√	√
Temperature	-	-	-	-	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

104 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
105 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
106 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
107 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
108 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
109 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
110 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016

Main River Section 10

Table F-8. Summary of Main River Section 10 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	√	-
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[111]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X[112]	NR
Br	-	-	-	-	-	-	-	-
Ca	-	-	-	-	-	-	X[113]	NR
Cl-	-	-	-	-	√	NR	√	NR
CO_3^{2-}	-	-	-	-	√	NR	X[114]	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	NR	√	NR	-	-	-	-
K^+	-	-	-	-	-	-	X[115]	-
Mg	-	-	-	-	-	-	√	√
Na^+	-	-	-	-	√	NR	√	NR
NH_4^+	-	-	-	-	-	-	√	NR
NO_2^-	X	NR	-	-	X[116]	NR	-	-
NO_3^-	-	-	-	-	X[117]	NR	√[118]	NR
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[119]	NR
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	NR	√[120]	NR
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[121]	NR
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	NR	√	NR

111 - Exceeds Swimming guideline value and result is below maximal admissible value (Lebanon MOE 52/1/1996)
112 - Exceeds water for irrigation use: wastewater reuse category I and II (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005))
113 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
114 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
115 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
116 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
117 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
118 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
119 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
120 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
121 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
TDS	-	-	-	-	X[122]	X[123]	√	√
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[124]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
Ag	-	-	-	-	√	√	√	√
Al	-	-	-	-	√	√	-	-
Ba	-	-	-	-	√	√	-	-
Cd	-	-	-	-	X[125]	X[126]	X[127]	X[128]
Cr	-	-	-	-	X[129]	X	√	X[130]
Cu	X	X	-	-	√	√	√[131]	√[132]
Fe	-	-	-	-	√	X	-	-
Mn	-	-	-	-	√	√	-	-
Ni	-	-	-	-	√	√	√[133]	√[134]
Pb	-	-	-	-	X	X	√[135]	√[136]
Zn	√	√	-	-	√	√	√	√
Miscellaneous Organic Compounds								
Nitrobenzene	-	-	-	-	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

122 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
123 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
124 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
125 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
126 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
127 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
128 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
129 - Average results are equal to standard value
130 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
131 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
132 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
133 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
134 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
135 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
136 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))

Main River Section 11-01

Table F-9. Summary of Main River Section 11-01 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	√	NR
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[137]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X[138]	NR
Br	-	-	-	-	-	-	-	-
Ca	-	-	-	-	-	-	X[139]	NR
Cl-	-	-	-	-	√	NR	√	NR
CO_3^{2-}	-	-	-	-	√	NR	X[140]	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	√	√	√	-	-	-	-
K^+	-	-	-	-	-	-	√	NR
Mg	-	-	-	-	-	-	√	√
Na^+	-	-	-	-	√	NR	√	NR
NH_3	-	-	-	-	√	√	-	-
NH_4^+	-	-	-	-	-	-	√	NR
NO_2^-	X	X	-	-	X[141]	X	-	-
NO_3^-	-	-	-	-	X[142]	X[143]	√[144]	√[145]
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[146]	√[147]
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	√	√[148]	√[149]
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[150]	NR

137 - Exceeds Swimming guideline value and result is below maximal admissible value (Lebanon MOE 52/1/1996)
138 - Exceeds water for irrigation use: wastewater reuse category I and II (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005))
139 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
140 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
141 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
142 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
143 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
144 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
145 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
146 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
147 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
148 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
149 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
150 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Color	-	-	-	-	-	-	-	-
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	NR	√	NR
TDS	-	-	-	-	X[151]	X[152]	√	√
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	X	NR	-	-	-	-	√[153]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
Ag	-	-	-	-	√	√	√	√
Al	-	-	-	-	√	√	-	-
Ba	-	-	-	-	√	√	-	-
Cd	-	-	-	-	X[154]	X[155]	X[156]	X[157]
Cr	-	-	-	-	√	X	X[158]	X[159]
Cu	X	X	-	-	√	√	√[160]	√[161]
Fe	-	-	-	-	√	X	-	-
Mn	-	-	-	-	√	√	-	-
Ni	-	-	-	-	√	√	√[162]	√[163]
Pb	-	-	-	-	X	X	√[164]	√[165]
V	-	-	-	-	-	-	√[166]	NR
Zn	√	√	-	-	√	√	√	√
Volatile Halogenated Hydrocarbons								
1,1,1-Trichloromethane	-	-	√	NR	-	-	-	-
Trichloroethane (sum)	-	-	√	NR	-	-	-	-
Volatile Organic Hydrocarbons								
Ethylbenzene	-	-	-	-	-	-	-	-
o-Xylene	-	-	-	-	√	NR	-	-

151 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
152 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
153 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
154 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
155 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
156 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
157 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
158 - Average results are equal to standard value
159 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
160 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
161 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
162 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
163 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
164 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
165 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
166 - Result limited to ELARD sampling campaign

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √ : No exceedance; -: No guideline or standard; NR: No Result

Main River Section 11-02

Table F-10. Summary of Main River Section 11-02 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	√	NR
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[167]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X[168]	NR
Ca	-	-	-	-	-	-	X[169]	NR
Cl-	-	-	-	-	√	NR	√	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	√	√	√	-	-	-	-
K^+	-	-	-	-	-	-	√	NR
Mg	-	-	-	-	-	-	√	NR
Na^+	-	-	-	-	√	NR	√	NR
NH_4^+	-	-	-	-	-	-	√	√
NO_2^-	X[170]	X	-	-	√	X[171]	-	-
NO_3^-	-	-	-	-	X[172]	X[173]	√[174]	√[175]
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[176]	√[177]
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	NR	√[178]	NR
Physical (P)								
Alkalinity	-	-	-	-	√	NR	X[179]	NR

167 - Average results' value is equal to maximal admissible value for swimming standard (Lebanon-MOE 52/1/1996)
168 - Exceeds water for irrigation use: wastewater reuse category I and II (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005))
169 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
170 - Average result is equal to aquatic standard value
171 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
172 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011
173 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011
174 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
175 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
176 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
177 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
178 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
179 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Electrical Conductivity	-	-	-	-	√	√	√	√
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	√	√	√
TDS	-	-	-	-	X[180]	X[181]	√	√
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[182]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
Ba	-	-	-	-	√	NR	-	-
V	-	-	-	-	-	-	√[183]	NR
Chlorobenzenes								
Pentachlorobenzene	-	-	-	-	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

180 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
181 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
182 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
183 - Result limited to ELARD sampling campaign

Main River Section 11-03

Table F-11. Summary of Main River Section 11-03 Water Findings

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Biological (B)								
E. Coli	-	-	-	-	X[184]	NR	-	-
Enterococci	-	-	X	-	X	-	-	-
Fecal Coliform	-	-	-	-	X	NR	X[185]	√
Pseudomonas aeruginosa	-	-	-	-	√	NR	-	-
Total Coliform	-	-	X[186]	NR	X	NR	-	-
Chemical (C)								
HCO_3^-	-	-	-	-	-	-	-	-
BOD_5	X	NR	-	-	-	-	X	NR
Br	-	-	-	-	-	-	-	-
Ca	-	-	-	-	-	-	X[187]	NR
Cl-	-	-	-	-	√	NR	√	NR
CO_3^{2-}	-	-	-	-	√	NR	X[188]	NR
COD	-	-	-	-	-	-	√	NR
Dissolved Oxygen	√	√	√	√	-	-	-	-
K^+	-	-	-	-	-	-	X[189]	NR
Mg	-	-	-	-	-	-	√	√
Na+	-	-	-	-	√	NR	√	NR
NH_4^+	-	-	-	-	-	-	√	√
NO_2^-	X	X	-	-	X[190]	X[191]	-	-
NO_3^-	-	-	-	-	X[192]	X[193]	√[194]	√[195]
pH	-	-	√	√	√	√	√	√
PO_4^{3-}	-	-	-	-	-	-	√[196]	√[197]
SiO_2	-	-	-	-	-	-	-	-
SO_4^{2-}	-	-	-	-	√	NR	√[198]	NR
Total Organic Carbon	-	-	-	-	-	-	-	-
Physical (P)								

184 - Result limited to Houri et al. 2007_Water_Quality sampling campaign
185 - Exceeds water for irrigation use: wastewater reuse category I and II (LEBANON-FAO PROPOSED GUIDELINES (2010)) and Reclaimed wastewater for irrigation class 1B and 2 (LEBANON-MOE PROPOSED GUIDELINES (2005))
186 - Exceeds Swimming guideline value and result is below maximal admissible value (Lebanon MOE 52/1/1996)
187 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
188 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
189 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
190 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
191 - Exceeds Lebanese Standard for Drinking Water NL 161:2016 / Below WHO 2002 Drinking standard
192 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
193 - Exceeds Max of National Primary Drinking Water Regulations: EPA 2011 / Result below Lebanese standard for drinking water NL 161:2016 and WHO 2002 drinking standard
194 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
195 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
196 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
197 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
198 - Result below Water for Irrigation Use: Usual Range in Irrigation Water (FAO)

Parameter	Aquatic		Bathing		Drinking		Irrigation	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Alkalinity	-	-	-	-	√	NR	X[199]	-
Color	-	-	-	-	-	-	-	-
Electrical Conductivity	-	-	-	-	√	√	√	X[200]
Salinity	-	-	-	-	-	-	-	-
Specific Conductivity	-	-	-	-	√	√	√	√
TDS	-	-	-	-	X[201]	X[202]	√	√
Temperature	-	-	-	-	-	-	-	-
Total Hardness	-	-	-	-	√	NR	-	-
Total Solids	-	-	-	-	-	-	-	-
TSS	√	NR	-	-	-	-	√[203]	NR
Turbidity	-	-	-	-	X	NR	-	-
Metals (M)								
Ag	-	-	-	-	√	√	√	√
Al	-	-	-	-	√	√	-	-
Ba	-	-	-	-	√	√	-	-
Cd	-	-	-	-	X[204]	X[205]	X[206]	X[207]
Cr	-	-	-	-	√	X	X[208]	X[209]
Cu	X	X	-	-	√	√	√[210]	√[211]
Fe	-	-	-	-	√	X	-	-
Mn	-	-	-	-	√	√	-	-
Ni	-	-	-	-	√	√	√[212]	√[213]
Pb	-	-	-	-	X	X	√[214]	√[215]
V	-	-	-	-	-	-	√[216]	NR
Zn	√	√	-	-	√	√	√	√
Chlorobenzenes								
Pentachlorobenzene	-	-	-	-	-	-	-	-

*Concentrations compared to the usual range in irrigation water;
X: Exceedance; √: No exceedance; -: No guideline or standard; NR: No Result

199 - Exceeds Water for Irrigation Use: Usual Range in Irrigation Water (FAO)
200 - Exceeds Max of Water for irrigation use: degree of restriction on use slight to moderate (Sprinkler) (FAO)
201 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
202 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
203 - Results below Water for Irrigation Use: Wastewater Reuse Category I, II, and III irrigation standards (Lebanon-FAO Proposed Guidelines (2010))
204 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
205 - Exceeds Max of Lebanese Standard for Drinking Water NL 161:2016
206 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
207 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
208 - Average results are equal to standard value
209 - Exceeds Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
210 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
211 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
212 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
213 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
214 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
215 - Result below Water for Irrigation Use: Wastewater Reuse (Lebanon-FAO Proposed Guidelines (2010))
216 - Result limited to ELARD sampling campaign

Sediment Quality Analysis

During the ELARD 2018 Confirmatory and Complementary Sampling campaign, sediment samples were analysed for a range of heavy metals, organic compounds, phenols, pesticides and hydrocarbons. The detected compounds are listed in Table F-12 through Table F-20, where applicable for the relevant river sections. The sampled metals results were also analysed and compared against the world averages, or Dutch intervention values for soil and sediments where world averages were missing (see Table G-9).

Main River Section 03

Table F-12. Sampled Metals and Organic Compounds Detected in Litani Main River Section 03 Sediments

Season	Dry		Wet
Year	2012	2018	2012
Sampled Metals	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, Zn	As, Ba, Cd, Co, Cr, Cu, Ni, Pb, V, Zn	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, Zn
Petroleum Hydrocarbons		EPH (C12-C16), EPH (C16-C21), EPH (C21-C30), EPH (C30-C35), EPH (C35-C40)	
Phenols		p-Cresol, Phenol	
Phthalates (sum)		Bisethylhexylphtalate	
Polycyclic Aromatic Hydrocarbons		Benzo(b)fluoranthene, PAH 16 EPA	

* Exceedances in metals' concentrations are shown in bold

Main River Section 04

Table F-13. Sampled Metals and Organic Compounds Detected in Main River Section 04 Sediments

Season	Wet
Year	2004
Sampled Metals	**Al_2O_3**, Cu, Fe_2O_3, Ni, Sr, TiO_2, Y, Zn, Zr

* Exceedances in metals' concentrations are shown in bold

Main River Section 06-01

Table F-14. Sampled Metals and Organic Compounds Detected in Litani Main River Section 06-01 Sediments

Season	Dry		Wet	
Year	2012	2018	2004	2012
Sampled Metals	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, Zn	Ba, Co, Cr, Cu, Ni, V, Zn	**Al_2O_3, As, Cr**, Cu, Fe_2O_3, Ga, **MnO**, Ni, Rb, Sr, **TiO_2, Y**, Zn, Zr	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, **Zn**

* Exceedances in metals' concentrations are shown in bold

Main River Section 06-02

Table F-15. Sampled Metals and Organic Compounds Detected in Main River Section 06-02 Sediments

Season	Dry
Year	2018
Sampled Metals	Ba, Co, Cr, Cu, Ni, V, Zn
Miscellaneous Organic Compounds	Biphenyl
Petroleum Hydrocarbons	EPH (C12-C16), EPH (C16-C21), EPH (C21-C30), EPH (C30-C35), EPH (C35-C40)
Phthalates	Bisethylhexylphtalate
Polycyclic Aromatic Hydrocarbons	Naphthalene, PAH 10 VROM, PAH 16 EPA, Phenanthrene, Pyrene

* Exceedances in metals' concentrations are shown in bold

Qaaqaaiyet Ej Jisr Tributary Section 07

Table F-16. Sampled Metals Detected in Qaaqaaiyet Ej Jisr Tributary Section 07 Sediments

Season	Wet
Year	2004
Sampled Metals	Al_2O_3, **As**, Cu, Fe_2O_3, Ni, Rb, Sr, TiO_2, Y, Zn, Zr

* Exceedances in metals' concentrations are shown in bold

Main River Section 10

Table F-17. Sampled Metals and Organic Compounds Detected in Main River Section 10 Sediments

Season	Dry	Wet
Year	2012	2012
Sampled Metals	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, Zn	Ag, Al, Ba, **Cd**, **Cr**, Cu, Fe, Mn, Ni, **Pb**, Zn

* Exceedances in metals' concentrations are shown in bold

Main River Section 11-01

Table F-18. Sampled Metals Detected in Main River Section 11-01 Sediments

Season	Dry	Wet
Year	2012	2012
Sampled Metals	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, Zn	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, Pb, Zn

* Exceedances in metals' concentrations are highlighted in bold

Main River Section 11-02

Table F-19. Sampled Metals Detected in Main River Section 11-02 Sediments

Season	**Wet**
Year	**2004**
Sampled Metals	Al_2O_3, As, Cu, Fe_2O_3, Ga, MnO, Ni, Rb, Sr, **TiO_2**, **Y**, Zn, Zr

* Exceedances in metals' concentrations are shown in bold

Main River Section 11-03

Table F-20. Sampled Metals Detected in Main River Section 11-03 Sediments

Season	**Dry**	**Wet**	
Year	**2012**	**2004**	**2012**
Sampled Metals	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, **Pb**, Zn	Al_2O_3, As, Cu, Fe_2O_3, Ga, MnO, Pb, **Rb**, Sr, TiO_2, **Y, Zn**, Zr	Ag, Al, Ba, **Cd**, Cr, Cu, Fe, Mn, Ni, **Pb**, Zn

* Exceedances in metals' concentrations are shown in bold

Determination of the Suitability of Surface Water for Different End Uses

As with the determination of the state of water quality through the grading of exceedance events for the bacteriological, physico-chemical and metal concentrations across time and space, the determination of the suitability of surface water for maintaining aquatic life, swimming or bathing, drinking and irrigation used a similar grading methodology.

To determine whether the surface water was on the overall in the indicated river or tributary section, fit, moderately fit or unfit for one or more uses – depending on the availability of relevant guidelines or admissible values – the following grading was applied.

1- For maintaining aquatic life (Aqua), a parameter that was judged to exceed the standard in one season was allocated ½ point. If it exceeds the standards for this use in both seasons, then the grade is 1 point. The scores were translated into a qualitative 'fitness' profile where the rating of:
    - 'Fit' is for an aquatic life score between 0 and 2
    - 'Moderately fit' is for an aquatic life score between 2.5 and 3.5
    - 'Unfit' is for an aquatic life score greater than or equal to 4
2- For swimming (Swim), a parameter that was judged to exceed the standard in one season was allocated ½ point. If it exceeds the standards for this use in both seasons, then the grade is 1 point. The scores were translated into a qualitative 'fitness' profile where the rating of:
    - 'Fit' is for a swimming score between 0 and 0.5
    - 'Moderately fit' is for a swimming score of 1
    - 'Unfit' is for a swimming score greater than or equal to 1.5

    The low score given to swimming is a result of the paucity of parameters for which a 'swimming' standard exists. The ELARD 2018 sampling campaign analysed water samples for enterococci species which are, besides E.coli, the recommended parameters to monitor in bathing waters as per the US EPA.
3- For drinking (Drink), a parameter that was judged to exceed the standard in one season was allocated ½ point. If it exceeds the standards for this use in both seasons, then the grade is 1 point. Care was taken not to double count some parameters, e.g. where results for faecal coliforms were present, total coliforms were not allocated any points.
9. The scores were translated into a qualitative 'fitness' profile where the rating of:
    - 'Fit' is for a drinking score between 0 and 1
    - 'Moderately fit' is for a drinking score between 1.5 and 2
    - 'Unfit' is for a drinking score greater than or equal to 2.5
4- For irrigation (Irrig), a parameter that was judged to exceed the standard in one season was allocated ½ point. If it exceeds the standards for this use in both seasons, then the grade is 1 point. Parameters for which there is no standard, but are judged against the 'usual range in irrigation water', were allocated ¼ point if the usual range is exceeded in one season and ½ point if it exceeded in both seasons. No distinction was made between slight to moderate and severe restrictions or classes of irrigation. This determination is not quite straightforward because while some parameters may give the water a Class 1B or 2, others may entirely restrict the use of the same water or assign it to Class 3. The scores were translated into a qualitative 'fitness' profile where the rating of:
    - 'Fit' is for an irrigation score between 0 and 2

- 'Moderately fit' is for an irrigation score between 2.5 and 4
- 'Unfit' is for an irrigation score greater than or equal to 4.5

A summary of the colour-assignment for the score brackets for each end use is shown in Table F-21. The summary tables that were used to derive the scores appear in Table F-2 through Table F-11 which summarise of the overall water analysis findings in the various sections of the Lower Litani River and its tributaries.

Table F-21. Colour-coding of the Suitability of Water for Different End Uses Based on Bracket Scores

End Use	Fit for the indicated use	Moderately fit for the indicated use	Unfit for the indicated use
Maintaining aquatic health	≤ 2	2.5-3.5	≥ 4
Swimming	≤ 0.5	1	≥ 1.5
Drinking	≤ 1	1.5-2	≥ 2.5
Irrigation	≤ 2	2.5-4	≥ 4.5

APPENDIX G – SAMPLING PLAN AND ANALYSIS RESULTS OF THE CONFIRMATORY AND COMPLEMENTARY SAMPLING CAMPAIGN CONDUCTED IN JUNE 2018

The sampling approach that was followed for the Confirmatory and Complementary Sampling is based upon an analytical and critical review of the sources of pressure in the Lower Litani River catchment, and the past sampling results and previous studies' interpretations.

Sampling Locations

In principle, the tributaries drain their catchment areas, thus collecting polluted runoff, and presenting themselves as the 'open sewer' that households, factories and any wastewater-generating facility can "freely" use to divert their discharge into. Notwithstanding the possibility that the sub-catchments of the Lower Litani Catchment could be connected through their underlying aquifers, contaminants could cross the sub-catchment boundaries. Although this 'leakage' issue is important to be investigated, it is beyond the objective of studying the overall effects and flow of contamination into the river water and sediments.

The Confirmatory and Complementary Sampling conducted within this project aimed to verify the field survey findings on the sources of pollution pressure which were identified through field work carried out in the spring of 2018. It also aims to **measure the load of pollution** arising from the different sub-catchments. While all previous studies have measured concentrations of pollutants, none of the studies reviewed as part of this work reported the flow at the time of sample collection, thus limiting our knowledge of the load of contaminants over time.

The river water flow was measured at the point where sampling was conducted if conditions such as depth and accessibility allowed. The flow recording points and sampling locations are shown in Figure G-1and described in Table G-1.

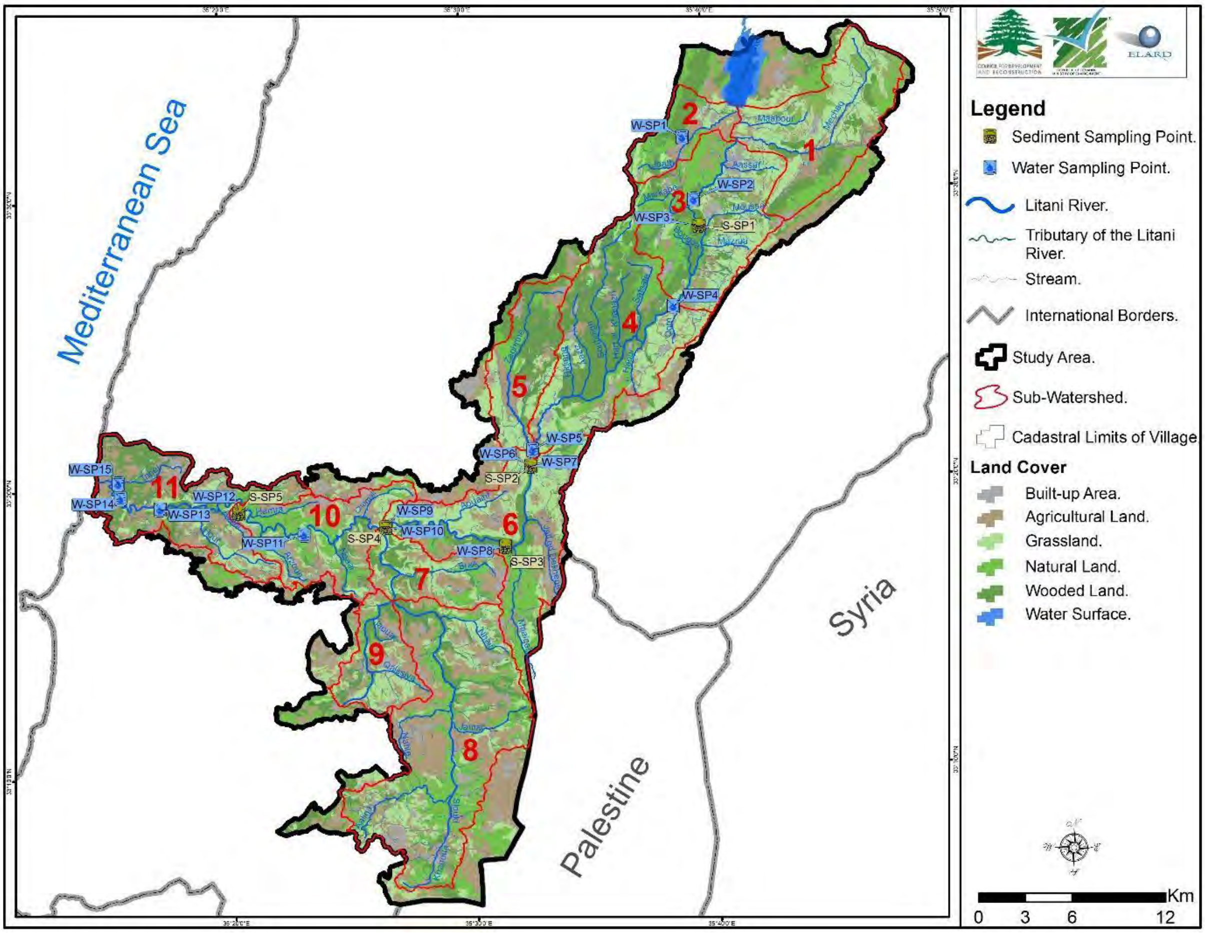

Figure G-1. Sampling Locations of the ELARD June 2018 Sampling Campaign

Table G-1. Description of the Sampling Locations

Sample #	Coordinates		Sample type	Location
	N	E		
W-SP01	33.5305000	35.6527000	Spring Water	Ain al Dayaa in Machghara
W-SP02	33.4944640	35.6595060	Spring Water	Ain ez Zarqa Spring before entering the Jezzine tunnel
W-SP03 S-SP01	33.4790720	35.6628900	River Water and Sediments	Resthouses after Ain ez Zarqa and after the Jezzine tunnel outlet
W-SP04	33.4329850	35.6436600	River Water	Dellafi Bridge
W-SP05	33.3518950	35.5444190	River Water	Resthouse in Mazraat Tamra before feeding tributary joins the main river course
W-SP06 S-SP02	33.3423950	35.5427460	River Water and Sediments	Khardali Bridge
W-SP07	33.3423950	35.5427460	River Water	Duplicate of W-SP6

Sample #	Coordinates		Sample type	Location
	N	E		
W-SP08 S-SP03	33.2963900	35.5240700	River Water and Sediments	Taybeh Pumping Station
W-SP09 S-SP04	33.3089000	35.4418000	River Water and Sediments	Resthouse at Qaaqaaiyet Ej Jisr
W-SP10	33.3089000	35.4418000	River Water	Duplicate of W-SP9
W-SP11	33.3056610	35.3857630	River Water	Chehour before feeding tributary joins the main river course
W-SP12 S-SP05	33.319102	35.341237	River Water and Sediments	Tayr Falsay after series of resthouses on the riverbank
W-SP13	33.3221700	35.2869960	River Water	After LRA's Main Dam and resthouses in Jazira
W-SP14	33.3290940	35.2598860	River Water	LRA Station in Qassmiyeh
W-SP15	33.3376290	35.2586970	River Water	Tributary coming from Matariyet Ech Choumar feeding main river course in Jazira

The water analysis and sediment results are one of the many factors that will be taken into account when prioritizing the measures needed to address pollution in the zones and sub-catchments. The results from the Confirmatory and Complementary Sampling campaign were studied together with the results of previous studies (2003-2018) to form a sketch of the water quality in the basin across time and seasons.

Parameters for Analysis

Parameters of Industrial Origin

Industrial activity in the Lower Litani Catchment area is mostly small scale, with the majority being olive mills, rock cutting and shaping and concrete block manufacturing. The field survey by the ELARD team recorded a total of 223 industries. The industries were further categorized in two priority groups based on their manufacturing process, proximity to the Litani River and its tributaries and effluent discharge. The production of these industries was categorised using the latest ISIC classification, Rev. 4, which turned out 23 categories. For each category and given the scale and profile of the production, the parameters of concern in the wastewater effluent of such facilities were noted down based on international and national references. Table G-2 shows the parameters of concern by category from the different international and national sources.

The primary pollutants of concern from the different manufacturing processes were obtained from various literature sources. First, a review of the international literature was conducted. Second, the MoE's list of parameters to be analysed for in the wastewater discharge of these manufacturing industries was reviewed. The list appears in the Audit Manual. Third, a review was conducted of the MSC-IPP reports that document findings from surveys conducted on some of these facilities in 2004-2005.

The far right column in Table G-2 entitled "Parameters relevant in the Area of Study Context" includes the authors' judgment of the parameters that are relevant to the scale of production and type of processes in the industries surveyed.

Based on the parameters listed in Table G-2, a matrix of the parameters of concern of an industrial nature in each sub-catchment was prepared (Table G-3).

Table G-2. Parameters of Concern from the Different Manufacturing Processes in the Lower Litani River Catchment Area

			Primary pollutants in wastewater				Parameters relevant in the Area of Study Context
			International		Lebanon		
Number of manufacturing processes	ISIC Rev. 4 (UN, 2008)		Primary pollutants in wastewater	Reference	Audit Manual Checklist (where available)	EWL as cited by MoE/MSC-IPP, 2005	
89	C-1040	Manufacture of vegetable and animal oils and fats	pH; TSS; TOC; COD; Cl^-; PO_4^{3-}.	Mohammadi & Esmaeelifar 2004; Mohammadi & Esmaeelifar 2005	*Edible oil and Vanaspati:* pH; Temperature; SS; FOG; BOD; COD.	Production of vegetable oils: These effluents contain organic compounds generated during the various refining stages (oil, fat, paraffin wax, filtration media stained with fat), high levels of carbonaceous pollution (high COD levels), a fraction of which is difficult to treat by biological processes, variable pH, which can either be strongly acidic or alkaline, based on the process, natural tendency for acidification, high contents of fats (substance extracted with chloroform or hexane).	pH; FOG; BOD; COD; Total-N.
			pH; SS; FOG; COD.	Decloux et al. 2007			
			Temperature; Colour; pH; DO; TDS; FOG; COD; S^{2-}; SO_4^{2-}; PO_4^{3-}; Heavy metals (Cd; Cr; Cu; Fe; Mn; Ni; Pb; Zn).	Pandey et al. 2003			
			Olive Oil: pH; Density; Dry residue; Conductivity; COD.	De la Casa et al., 2009			
			SS; FOG; BOD; COD.	*Tarbox, 1993*			
			pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b			
7	C-1050	Manufacture of dairy products	pH; TS; SS; VS; VSS; VFA; COD.	Chen & Shyu. 1996	*Dairy Industry:* pH; Temperature; SS; FOG; BOD; COD; Total-N; Total-P; Coliform Bacteria.	Drip loss of production, cleaning water with high loads of suspended solids, cleaning lye, cleaning acid, floor cleaning, butter washing water, fat losses with the cleaning of the	Temperature; pH; TSS; FOG; BOD; COD; Total-N, Total-P; Coliform Bacteria.
			Temperature; pH; SS; BOD; COD; standard FOG test using non-aqueous solvent extraction.	*Tarbox, 1993*			

Number of manufacturing processes	ISIC Rev. 4 (UN, 2008)		Primary pollutants in wastewater (International)	Reference (International)	Audit Manual Checklist (where available) (Lebanon)	EWL as cited by MoE/MSC-IPP, 2005 (Lebanon)	Parameters relevant in the Area of Study Context
			pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; Zn.	EPA, 1995b		installations and pipes. Product loss while bottling and cleaning, whey losses with further processing. Losses of whey and curd, discharged salt baths, washing water with salts, lactose and acid - and casein rests.	
1	C-1061	Manufacture of grain mill products	pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; Zn.	EPA, 1995b	X	X	None
4	C-1071	Manufacture of bakery products	pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b	X	X	None
1	C-1072	Manufacture of sugar	pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b	X	X	None
3	C-1073	Manufacture of cocoa, chocolate and sugar confectionery	pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b	*Food and Beverages*: pH; SS; FOG; BOD; COD; NH_3-N; Total-N; Total-P.	X	pH; TSS; FOG; BOD; COD; Total N; Total-P.
			SS; BOD; COD.	Tarbox, 1993			
1	C-1104	Manufacture of soft drinks; production of mineral waters and other bottled waters	Alkalinity; TSS; VSS; BOD; COD; NH_3-N; SO_4^{2-}; PO_4-P; Na^+; K^+; Fe; Ni; Mo; Co; Zn.	Chen & Seng, 2006	*Food and Beverages*: pH; SS; FOG; BOD; COD; NH_3-N; Total-N; Total-P.	High BOD Levels and may be coloured	pH. BOD.
2	C-1410	Manufacture of wearing apparel, except fur apparel	*Raw material storage and handling:* pH; TSS; FOG; BOD; COD; Pb; Cr; Benzene.	EPA, 1995b	*Textiles:* pH; SS; FOG; BOD; COD; NH_3-N; S^{2-}; Cr; AOX;	Wastewater containing SS, detergents, hazardous compounds (oxidising	None
			Storage and handling of materials for dyeing: Acids; Phenols, Al; Cu; Cr; Pb; Zn.	EPA, 1995b			

			Primary pollutants in wastewater				Parameters relevant in the Area of Study Context
			International		Lebanon		
Number of manufacturing processes	ISIC Rev. 4 (UN, 2008)		Primary pollutants in wastewater	Reference	Audit Manual Checklist (where available)	EWL as cited by MoE/MSC-IPP, 2005	
			Storage and handling of materials for scouring and cleaning: pH; TSS; FOG; BOD; COD; S^{2-}; Phenols; Cr.	EPA, 1995b	Phenolic Compounds; Bioassay test.	agent such as hydrogen peroxide or bleach).	
			Storage and handling of materials for bleaching, printing, finishing, and other activities: Dyes; Bleaches; Detergents; Finishing agents; Printing products.	EPA, 1995b			
4	C1610	Sawmilling and planning of wood					
3	C-1709	Manufacture of other articles of paper and paperboard	pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b	*Pulp and paper products:* pH; SS; BOD; COD.	Wastewater: Organic substances (COD, BOD), chlorinated organics (AOX), Total-N, Total-P, SS, salts, coloured substances.	None
2	C-1811	Printing					
4	C-2220	Manufacture of plastics products	pH; SS; TDS; BOD; COD.	Kumlanghan et al. 2008	X	Wastewater: contamination by organics and chemicals such as herbicides	None
			Plastic Materials and Synthetic Resins, Synthetic Rubbers, Cellulosic and other Manmade Fibers: pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; Zn.	EPA, 1995b			
1	C-2392	Manufacture of building materials					
51	C-2395	Manufacture of articles of concrete, cement and plaster	pH; SS; FOG; COD.	EPA, 1999	*Cement Industry:* pH; Temperature; Suspended Solids; FOG.	Suspended solids in wastewater	pH; TSS; COD (for ready mix concrete) None (for concrete blocks)
			pH; TDS (K(OH) & Na(OH)); TSS.	EPA, 1995a			
			Concrete, Gypsum and Plaster Products: pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; Fe.	EPA, 1995b			
28	C-2396		Wastewater containing dust	EPA, 1995a	X	X	

			Primary pollutants in wastewater				Parameters relevant in the Area of Study Context
			International		Lebanon		
Number of manufacturing processes	**ISIC Rev. 4 (UN, 2008)**		**Primary pollutants in wastewater**	**Reference**	**Audit Manual Checklist (where available)**	**EWL as cited by MoE/MSC-IPP, 2005**	
		Cutting, shaping and finishing of stone	*Dimension Stone and Crushed Products:* pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b			pH; FOG; TSS; COD.
2	C-2399	Manufacture of other non-metallic mineral products n.e.c.	*Asphalt Paving and Roofing Materials Manufacturing:* pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P.	EPA, 1995b	X	Wastewater: contamination by organics and chemicals such as herbicides	Asphalt Paving and Roofing Materials Manufacturing: pH; TSS; FOG; COD; TKN; NO_3-N; NO_2-N; Total-P.
			pH; SS; TDS; BOD; COD.	Kumlanghan et al. 2008			
			Plastic Materials and Synthetic Resins, Synthetic Rubbers, Cellulosic and other Manmade Fibers: pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; Zn.	EPA, 1995b			
8	C-2511	Manufacture of structural metal products	TSS; TTO; TOC; FOG; Cyanide (T); Cyanide (A); Ag; Cd; Cr; Cu; Mn; Mo; Ni; Pb; Sn; Zn; S^{2-}.	Whalen, 2001; EPA, 2000	X	X	FOG
			pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; Al; Fe; Zn.	EPA, 1995b			
2	C-2512	Manufacture of tanks, reservoirs and containers of metal	TSS; TTO; TOC; FOG; Cyanide (T); Cyanide (A); Ag; Cd; Cr; Cu; Mn; Mo; Ni; Pb; Sn; Zn; S^{2-}.	Whalen, 2001; EPA, 2000 (p. 436 for list of pollutants)	X	X	FOG
1	C-2733	Manufacture of wiring devices					
4	C-3100	Manufacture of furniture	*Chrome Tanning:* pH; TS; SS; BOD; Al; Cr (III); Cr (IV); Fe; SO_4^{2-}; NaCl.	Agrawal et al. 2006	X	*Textile:* Wastewater containing SS, detergents, hazardous compounds (oxidising agent such as hydrogen peroxide or bleach).	None
			Leather Tanning: pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; As; Cd, Pb.	EPA, 1995b			
			Textile Sludge: pH; Water content; Specific gravity; Total Hardness; TVS; S^{2-}; SO_4^{2-}; Ca^{2+}, Mg^{2+}; Cl^-; Cd; Total Cr; Cu; Fe, Ni; Pb; Zn.	Balasubramanian et al. 2006			

			Primary pollutants in wastewater				Parameters relevant in the Area of Study Context
			International		Lebanon		
Number of manufacturing processes	ISIC Rev. 4 (UN, 2008)		Primary pollutants in wastewater	Reference	Audit Manual Checklist (where available)	EWL as cited by MoE/MSC-IPP, 2005	
			pH; TSS; FOG; BOD; COD; TKN; NO_3-N; NO_2-N; Total-P; As; Cd; Pb; Zn.	EPA, 1995b			
1	E-3600	Water collection, treatment and supply					
3	G-4661	Wholesale of solid, liquid and gaseous fuels and related products					
1	N-8292	Packaging Activities					

Table G-3. Parameters of Concern of Industrial Origin by Sub-catchment according to International and Local Sources of Information

Parameters	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb
Sub-Catchment	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**8**		**9**		**10**		**11**	
Acids											X										X	
Ag									X		X				X						X	
Al									X		X				X						X	
Chlorinated Organics (AOX)												X										X
As															X						X	
Benzene											X										X	
Biochemical Oxygen Demand (BOD)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ca^{2+}															X						X	
Cd	X		X		X		X		X		X		X		X		X		X		X	
Cl-	X		X		X		X				X		X		X		X		X		X	
Co											X											
Chemical Oxygen Demand (COD)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Colour	X		X		X		X				X		X		X		X		X		X	
Coliform Bacteria										X								X		X		
Conductivity	X		X		X		X				X		X		X		X		X		X	
Cr	X		X		X		X		X		X	X	X		X		X		X		X	X
Cr (III)															X						X	
Cr (IV)															X						X	
Cu	X		X		X		X		X		X		X		X		X		X		X	
Cyanide (A)									X		X				X						X	
Cyanide (T)									X		X				X						X	
Density	X																					
Dissolved Oxygen (DO)	X		X		X		X				X		X		X		X		X		X	
Dry Residue	X		X		X		X				X		X		X		X		X		X	
Fe	X		X		X		X		X		X		X		X		X		X		X	

Parameters	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb
Fats, Oil and Grease (FOG)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
K^+											X											
Mg^{2+}															X						X	
Mn	X								X		X				X						X	
Mo									X		X				X						X	
Na^+											X											
NaCl															X						X	
NH_3-N											X	X										X
Ni	X		X		X		X		X		X		X		X		X		X		X	
NO_2-N	X		X		X		X		X		X		X		X		X		X		X	
NO_3-N	X		X		X		X		X		X		X		X		X		X		X	
Pb	X		X		X		X		X		X		X		X		X		X		X	
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Phenols											X	X									X	X
PO_4-P	X		X		X		X				X		X		X		X		X		X	
Sulphides	X		X		X		X		X		X	X	X		X		X		X		X	X
Sn									X		X				X						X	
Sulphate	X		X		X		X				X		X		X		X		X		X	
SS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TDS	X		X		X		X				X		X		X		X		X		X	
Temperature	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Total Kjeldahl Nitrogen (TKN)	X		X		X		X		X		X		X		X		X		X		X	
Total Organic Carbon	X		X		X		X		X		X		X		X		X		X		X	
Total N										X		X				X		X		X		
Total P	X		X		X		X		X	X	X	X	X		X	X	X	X	X	X	X	
Total Solids (TS)									X												X	
Total Suspended Solids (TSS)	X		X		X		X		X		X		X		X		X		X		X	
Total Toxic Organics (TTO)									X		X				X						X	

Parameters	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb	Int	Leb
Total Volatile Solids (TVS)															X						X	
Volatile Fatty Acids (VFA)									X										X		X	
Volatile Solids (VS)									X										X		X	
Volatile Suspended Solids (VSS)									X		X								X		X	
Zn	X		X		X		X		X		X		X		X		X		X		X	

Parameters of Agricultural Origin

Agriculture, being one of the major economic activities in the Lower Litani Basin, and covering about a quarter of the land mass in the catchment area, it is inevitable that fertilizers and pesticides will make way into the surface water through soil erosion and runoff. The runoff quantities of both soluble pesticides and fertilizers are highly correlated with the application rates and irrigation practices. The fertilizers that cause most concern are Phosphates, Nitrates, and Potassium.

Due to the great variety in herbicides, insecticides, acaricides, nematicides and fungicides applied onto different crops, the identification of pesticides of concern is les straightforward.

A list of pesticides of concern (by active ingredient) was generated through questionnaires and interviews with farmers and verified with agricultural input suppliers operating in the different cazas of the study area: West Bekaa, Rachaiya, Hasbaiya, Jezzine, Marjaayoun, Nabatiye, Bent Jbayl, Saida and Sour. Information was collected by crop – i.e. which pesticides are used for which crops (see

The lower Litani Study Area comprises seven main crops or crop categories including but not limited to: olives, bananas, citrus, fruit trees, vineyards, field crops, and horticultural crops. The latter have been identified based on the farmers/crops surveys, Atlas Agricole du Liban and the Agricultural Census 2010.

Water and sediment samples were tested for the presence of some of the pesticides' residues, specifically the persistent ones such as DDT. The analysis of water and sediments' samples also featured some of the banned pesticides.

It is important to note however that analyzing for pesticides is best done around the period of application due to short half-lives of some of these compounds. At the time of sampling in June, agricultural activity is considered low especially for olives and some field crops, which are considered dominant in the study area.

Parameters of Domestic Origin

Parameters of concern in household waste are almost entirely covered by the list of parameters of concern of industrial origin. It is noted however that pathogens, such as fecal coliform are strong evidence of fresh contamination with domestic wastewater.

Proposed Parameters for Testing

In summary, and taking into account previous sampling results, the parameters of concern in the effluents of industries and runoff from agricultural areas, and the period of sampling, a list of parameters that was analyzed for in surface water and sediment appears in Table G-4.

The parameters were analyzed at all locations in order to track whether concentrations of certain parameters are attenuated or enhanced, and which will allow for a better correlation between the sources of pressure and quality of water in the surface water.

Table G-4. Parameters Analyzed in All Samples

	Medium	
Parameter	**Water**	**Sediment**
1, 1, 1-Trichloromethane	x	
1, 1-Dichloroethane	x	
2, 5-Dimethylphenol	x	
Alkalinity	x	x
Arsenic		x
Barium	x	x
Benzo(b)fluoranthene		x
Bicarbonate	x	
Biphenyl	x	x
Bisethylhexylphtalate		x
BOD5	x	x
Cadmium		x
Calcium	x	x
Chlorine	x	x
Chromium	x	x
Cobalt		x
COD	x	x
Color	x	
Copper		x
Cresols (sum)		x
Dissolved Oxygen	x	x
Dry Matter		x
Enterococci	x	x
Ethylbenzene	x	
Fecal Coliform	x	x
Fraction < 2µg (Clay)		x
Iron	x	
Lead		x
Magnesium	x	x
Naphthalene		x
Nickel	x	
Nitrate	x	x
Nitrite	x	
Nitrobenzene	x	
Organic Matter		x
o-Xylene	x	
PAH 10 VROM (sum)		x

	Medium	
Parameter	**Water**	**Sediment**
PAH 16 EPA (sum)		x
p-Cresol		x
Pentachlorobenzene	x	
pH	x	
Phenanthrene		x
Phenol		x
Phosphate	x	
Phthalates (sum)		x
Potassium	x	x
Pseudomonas aeruginosa	x	
Pyrene		x
Salinity	x	
Silica	x	
Sodium	x	x
Specific Conductivity	x	
Sulphate	x	
TDS	x	
Temperature	x	
Total Coliform	x	
Total Hardness	x	
Total Organic Carbon	x	
Total Solids	x	
TPH (C12-C16)	x	x
TPH (C16-C21)	x	x
TPH (C21-C30)	x	x
TPH (C30-C35)	x	x
TPH (C35-C40)	x	x
TPH Sum (C10-C40)	x	x
Trichloroethane (sum)	x	
TSS	x	
Turbidity	x	
Vanadium	x	x
Zinc	x	x

The objective from this **Confirmatory and Complementary Sampling at 8 locations** was to fill in the gaps from previous sampling campaigns, such as the analysis for specific pesticides and industrial effluents and to confirm past findings.

The bottom line was to be able to confirm which activities and regions in the Lower Litani River catchment area are contributing to the pollution of the Litani River water, detect contaminants making way from the Upper Litani into the Lower Litani Basin, and assign geographical priorities for tackling the sources of pollution pressure on the entirety of the Lower Litani Basin.

Sampling Procedures and Results

Two reconnaissance site visits were conducted to assess the conditions of the sampling locations with regard to accessibility, water flow, and sample collection and transportation logistics.

The flow at the time of sample collection was measured by using the electromagnetic flow meter, where applicable. The recorded flow values are shown in Table 3-50.

Water samples from the River were collected through direct bottle immersion at shallow depths. Sediment samples from the River bed were collected using a shovel.

In-situ readings for the pH, conductivity, temperature, turbidity, and dissolved oxygen were taken using the MANTA 2 and its Amphibian reader. Water samples to be analysed for a set of bacteriological, physical, and chemical parameters were collected in a 250ml glass bottle and a 1L plastic bottle. Both bottles were transported in cooler boxes to the laboratory on the same day. Water to be analysed for heavy metals, pesticides, and other micro-pollutants was filled in vials, some of which were preserved with HNO_3, and transported to the lab in cooler boxes.

All sampling locations' coordinates were recorded using a GPS (Garmin e-trex).

All samples were labelled and given unique IDs. Chains of custody were filled including the identification of samples by number, location, and type of matrix.

During the process, sample collection, transport, storage and handling were conducted in accordance with the New Jersey Field Sampling Procedure Manual (2005) where sample bottles were treated with special care to avoid contamination. Sample containers were stored and transported in clean environments and at temperatures less than 4°C.

The complete results of the River analysis are displayed in Table G-5 which also shows the exceedance values according to different standards and target end uses as per the guidelines in Table G-8. Results for the River sediment analysis are shown in Table G-6. The sediment results were compared to the world averages for river sediments, as well as to the Dutch intervention values for soil and sediments which appear in Table G-9. The results of spring water samples collected from Machghara and Ain ez Zarqa are shown in Table G-7.

Table G-5. Results of the River Water Analysis

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
As	µg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Sb	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ba	µg/l	38	44	35	37	35	32	36	37	38	49	76	87	210
Be	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cd	µg/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Cr	µg/l	2.4	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Co	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cu	µg/l	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Hg	µg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Pb	µg/l	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Mo	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ni	µg/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Se	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Sn	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
V	µg/l	2.2	2.5	<2	<2	<2	<2	<2	<2	<2	4.4	2	2.7	6.3
Zn	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	8.9	<5	<5	<5
Benzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1
Toluene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o-Xylene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.17	<0.1	<0.1	<0.1
m/p-Xylene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes (sum)	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.17	<0.1	<0.1	<0.1
Styrene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,4-Trimethylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
1,3,5-Trimethylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
n-Propylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isopropylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
n-Butylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
sec-Butylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
tert-Butylbenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p-Cymene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenol	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Cresol	µg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
m-Cresol	µg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
p-Cresol	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cresoles (sum)	µg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
2,4-Dimethylphenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2,5-Dimethylphenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2,6-Dimethylphenol	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
3,4-Dimethylphenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
o-Ethylphenol	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
m-Ethylphenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thymol	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
2,3/3,5-Dimethylphenol + 4-Ethylphenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Naphthalene	µg/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Acenaphtylene	µg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Acenaphtene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pyrene	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Benzo(a)anthracene	µg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Chrysene	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(b/k)fluoranthene	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Benzo(a)pyrene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)anthracene	µg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Indeno(123cd)pyrene	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
PAHs (sum 16 US EPA)	µg/l													
Chloromethane	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dichloromethane	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Vinylchlorine	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Surface Water Results		**Samples**												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
1,1 Dichloroethene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
tr-1,2 Dichloroethene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
cis- 1,2 Dichloroethene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichlorofluoromethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1, 1, 1-Trichloromethane	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.6	<0.2	<0.2	<0.2
Tetrachloromethane (tetra)	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1 Dichloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.98	<0.1	<0.1	<0.1	<0.1	<0.1
1,2 Dichloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-Trichloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,2-Trichloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloroethanes (sum)	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.6	<0.1	<0.1	<0.1
1,1,1,2-Tetrachloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,2,2-Tetrachloroethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrachloroethanes (sum)	µg/l													
Trichloroethene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
Tetrachloroethene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,2-Dichloropropane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloropropane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dichloropropane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,3-Trichloropropane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloropropylene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
cis 1,3-Dichloropropylene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans 1,3-Dichloropropylene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dichloropropylene (sum)	µg/l													
Bromomethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromochloromethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibromomethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dibromoethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Surface Water Results		**Samples**												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
Tribromomethane (Bromoform)	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromodichloromethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibromochloromethane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dibromo-3-chloropropane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Monochlorobenzene	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,2-Dichlorobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dichlorobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dichlorobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorobenzenes (sum)	µg/l													
1,2,3-Trichlobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,4-Trichlorobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3,5-Trichlorobenzene	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorobenzene (sum)	µg/l													

Surface Water Results		**Samples**												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
1,2,3,4-Tetrachlorobenzene	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.21	<0.02	<0.02	<0.02	<0.02
1,2,3,5/1,2,4,5-Tetrachlorobenzene	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachlorobenzene (sum)	µg/l													
Pentachlorobenzene	µg/l	0.017	0.014	0.012	0.017	0.013	0.013	0.013	0.014	<0.01	<0.01	0.019	0.015	<0.01
Hexachlorobenzene	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
o-Chlorophenol	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
m-Chlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
p-Chlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Monochlorophenols (sum)	µg/l													
2,3-Dichlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2,4/2,5-Dichlorophenol	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,6-Dichlorophenol	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
3,4-Dichlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
3,5-Dichlorophenol	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Dichlorophenols (sum)	µg/l													
2,3,4-Trichlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Surface Water Results		**Samples**												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
2,3,5/2,4,5-Trichlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2,3,6-Trichlorophenol	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,6-Trichlorophenol	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
3,4,5-Trichlorophenol	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorophenols (sum)	µg/l	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
2,3,4,5-Tetrachlorophenol	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,4,6/2,3,5,6-Tetrachlorophenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachlorophenols (sum)	µg/l													
Pentachlorophenol	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4-Chloro-3-methylphenol	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PCB 28	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB 52	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB 101	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB 118	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB 138	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB 153	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB 180	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB (sum 6)	µg/l													
PCB (sum 7)	µg/l													

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
o/p-Chloronitrobenzene	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
m-Chloronitrobenzene	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Monochloronitrobenzenes (sum)	µg/l													
2,3-Dichloronitrobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-Dichloronitrobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,5-Dichloronitrobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3,4-Dichloronitrobenzene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3,5-Dichloronitrobenzene	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Dichloronitrobenzenes (sum)	µg/l													
2-Chlorotoluene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-Chlorotoluene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorotoluenes (sum)	µg/l													
1-Chloronaphtalene	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
4,4-DDE	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
2,4-DDE	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4,4-DDT	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
4,4-DDD/2,4-DDT	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2,4-DDD	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DDT/DDE/DDD (sum)	µg/l													
Aldrin	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.21	<0.02	<0.02	<0.02	<0.02
Dieldrin	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Endrin	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Drins (sum)	µg/l													
alfa-HCH	µg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
beta-HCH	µg/l	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
gamma-HCH	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
delta-HCH	µg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
HCH (sum)	µg/l													
Alfaendosulfan	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Alfaendosulfans ulphate	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Alfa-chlordane	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Gamma-chlordan2	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chlordanes (sum)	µg/l													
Heptachlor	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachloroepo xide	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Isodrin	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobuta diene	µg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

Surface Water Results		**Samples**												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
Telodrin	µg/l	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Tedion	µg/l	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Azinphos-ethyl	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Azinphos-methyl	µg/l	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.82	<0.07	0.81	<0.07	<0.07	<0.07	<0.07
Bromophos-ethyl	µg/l	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Bromophos-methyl	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloropyrophos-ethyl	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloropyrophos-methyl	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cumaphos	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Demethon-S/Demethon-O (ethyl)	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	µg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Dichlorovos	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Disulfoton	µg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Fenitrothion	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fenthion	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion-ethyl	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Parathion-methyl	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pyrazophos	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Triazophos	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ametryne	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Atrazine	µg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

Surface Water Results		**Samples**												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
Cyanazine	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Desmetryne	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Prometryne	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Propazine	µg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Simazine	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Terbutylazine	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Terbutryne	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bifenthrin	µg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Carbaryl	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cypermethrin (A,B,C,D)	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Deltamethrin	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Linuron	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Permethrin A	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Permethrin B	µg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Permethrin (sum)	µg/l													
Propachloor	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trifluralin	µg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Biphenyl	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrobenzene	µg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.8	<0.3	<0.3	<0.3	<0.3
Dibenzofurane	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TPH C10-C12	µg/l	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
TPH C12-C16	µg/l	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
TPH C16-C21	µg/l	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
TPH C21-C30	µg/l	23	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
TPH C30-C35	µg/l	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
TPH C35-C40	µg/l	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
TPH (sum C10-C40)	µg/l	23	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Bicarbonate alkalinity	me/l	1.90	1.84	1.70	1.60	1.62	1.00 [13]	1.50	7.42	1.40	1.40	2.10	2.36	2.06
Sulphate	mg/l	10	7	7	7	7	9	9	9	9	9	13	13	22[13]
Nitrate	mg/l NO_3^-	10.4[1]	10.9[1]	12[1]	10.5[1]	8.6	6.7	7.5	10.2[1]	9.8	9.8	7.4	10.5[1]	13.5[1]
Nitrite	mg/l NO_2^-	0.1[2, 3, 4]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05[2, 3, 4]	0.12[2, 3, 4]	0.08[2, 3, 4]
Ammonium	mg/l NH_4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphates	mg/l o-PO_4^{3-}	0.31	0.2	0.1	0.17	0.19	0.3	0.2	0.08	0.12	0.1	0.33	0.45	0.9
BOD	mg/l BOD 5	210[3, 7, 8, 9, 10, 11, 12]	200[3, 7, 8, 9, 10, 11, 12]	185[3, 7, 8, 9, 10, 11, 12]	240[3, 7, 8, 9, 10, 11, 12]	250[3, 7, 8, 9, 10, 11, 12]	227[3, 7, 8, 9, 10, 11, 12]	220[3, 7, 8, 9, 10, 11, 12]	195[3, 7, 8, 9, 10, 11, 12]	225[3, 7, 8, 9, 10, 11, 12]	218[3, 7, 8, 9, 10, 11, 12]	240[3, 7, 8, 9, 10, 11, 12]	270[3, 7, 8, 9, 10, 11, 12]	305[3, 7, 8, 9, 10, 11, 12]
COD**	mg/l O_2	4.99	3.92	4.16	6.4	8.1	4.38	4.12	3.91	4.17	4.83	5.1	10.8	7.81
TDS	mg/l 25°C	264.9[2]	265.5[2]	213.1[2]	214.1[2]	211.9[2]	195.8[2]	196.3[2]	203.2[2]	189.8[2]	185.7[2]	262.7[2]	322.3[2]	381.7[2]
TSS	mg/l	3.3	5.6	4.6	4.6	15.3	1.6	14.6	32.6[3]	22.6	40[3]	2.3	5	28[3]
Enterococci sp.	CFU/ 250 ml	124[2]	48[2]	55[2]	470[2]	770[2]	322[2]	105[2]	300[2]	455[2]	350[2]	315[2]	1000[2]	580[2]
DO (in-situ)	mg/l	9.46	9.36	8.59	8.81	8.81	8.95	8.61	8.47	8.47	8.27	6.82[3]	7.75	9.61
Turbidity (in-situ)	NTU	1.67	5.2[2]	13.2[2]	21.7[2]	2.38	26.7[2]	57.1[2]	5.12[2]	68.5[2]	171.2[2]	10.2[2]	17.1[2]	146.5[2]
pH (in-situ)	8.21	8.1	8.17	8.14	7.8	8.16	8.02	7.9	7.9	8.09	8.05	7.7	7.8	8.15

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
Specific Conductivity (in-situ)	µS/cm	493.1	463.6	437.6	445	380	417.4	417.1	360	340	386.2	548.2	649.5	756.9[14]
Total Coliforms	CFU/100 ml	7900[1, 2, 5]	6165[1, 2, 5]	1948[1, 2, 5]	10000[1, 2, 5, 6]	10000[1, 2, 5, 6]	10000[1, 2, 5, 6]	7628[1, 2, 5]	6301[1, 2, 5]	9758[1, 2, 5]	8871[1, 2, 5]	10000[1, 2, 5, 6]	10000[1, 2, 5, 6]	10000[1, 2, 5, 6]
Faecal Coliforms	CFU/250 ml	689[2]	201[2]	164[2]	1899[2]	4101[2]	1056[2]	486[2]	946[2]	1437[2]	1359[2]	1180[2]	6336[2]	2514[2]
Temperature (in-situ)	°C	16.11	17.75	22.6	19.44	19.44	23.17	23.96	23.96	24.65	25.08	23.58	27.38	23.73
Pseudomonas aeruginosa	CFU/250 ml	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Hardness ($CaCO_3$)	mg/l	227	213	200	197	191	180	176	174	164	162	246	293	271
Bicarbonates (HCO_3)	mg/l	232	224	207	195	198	122	183	173	170	170	256	288	251
Chlorides	mg/l	18	15	14	13	12	12	14	12	13	12	20	29	72
Calcium	mg/l	79.1[13]	76.2[13]	70.8[13]	69.1[13]	66.9[13]	62[13]	60.2[13]	59.4[13]	55.6[13]	55.5[13]	69.6[13]	79.9[13]	83.9[13]
Magnesium	mg/l	7.2	5.5	5.6	5.9	5.8	6.1	6.3	6.1	6	5.8	17.3	22.6	14.8
Potassium	mg/l	1.2	1	0.82	0.4	0.37	0.47	0.73	0.53	0.52	0.58	0.55	1.13	1.8
Sodium	mg/l	9.7	8.1	7	7.2	7.3	6.25	6.7	6.9	7	7.2	10.9	16	30.5
Aluminium	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	0.08	<0.3	0.05	0.07	0.05	<0.3	<0.3	<0.3
Manganese	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sulphides	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silica	mg/l	5.2	3.5	5.7	8	8.8	8	8.7	9	9.7	9.7	12.8	14.2	23.8

Surface Water Results		Samples												
Parameter	**Unit**	**W-SP03**	**W-SP04**	**W-SP05**	**W-SP06**	**W-SP07**	**W-SP08**	**W-SP09**	**W-SP10**	**W-SP11**	**W-SP12**	**W-SP13**	**W-SP14**	**W-SP15**
Salinity	mg/l	210	199	184	189	183	156	167	168	160	159	230	282	300
Total Solids	mg/l	3.3	271.1	235.7	218.76	227.23	197.46	210.96	235.86	212.46	225.7	265.03	327.3	409.7
Colour	U.Pt-Co	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2	<0.1	<0.1	19
TOC	mg/l	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.7

* See **Error! Reference source not found.** for the guidelines and standards for different water uses against which the results are compared. The Superscript numbers indicate exceedance of the specified standard, as listed:
** COD analysed using Potassium Permanganate ($KMnO_4$) as oxidizing agent.

1. National Primary Drinking Water Regulations: US EPA 2011
2. Lebanese Standard for Drinking Water NL 161:2016
3. Aquatic Std: Guideline Value (Lebanon MoE Decision No. 52/1/1996)
4. Aquatic Std: Maximal Admissible Value (Lebanon MoE Decision No. 52/1/1996)
5. Swimming Guideline Value (Lebanon MoE Decision No. 52/1/1996)
6. Swimming Maximal Admissible Value (Lebanon MoE Decision No. 52/1/1996)
7. Reclaimed Wastewater for Irrigation, Class 1B (max) (Lebanon-MoE proposed guidelines 2005)
8. Reclaimed Wastewater for Irrigation, Class 2 (max) (Lebanon-MoE proposed guidelines 2005)
9. Reclaimed Wastewater for Irrigation, Class 3 (max) (Lebanon-MoE proposed guidelines 2005)
10. Water for Irrigation Use: Wastewater reuse category I (Lebanon-FAO proposed guidelines (2010))
11. Water for Irrigation Use: wastewater reuse category II (Lebanon-FAO proposed guidelines (2010))
12. Water for Irrigation Use: wastewater reuse category III (Lebanon-FAO proposed guidelines (2010))
13. Water for Irrigation Use: usual range in irrigation water (FAO)
14. Water for Irrigation Use: Degree of restriction on use slight to moderate (sprinkler) (FAO)

Table G-6. Results of the River Sediments Analysis

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
Dry matter	% (w/w)	52.8	81.5	78	76.3	79.4
Organic matter	% (w/w)	20.4	0.9	1.5	2.6	2.3
Fraction < 2µm (Clay)	% (w/w)	16.8	3.2	14.7	12.4	10.8
As	mg/kg	4.5	<3	<3	<3	<3
Sb	mg/kg	<3	<3	<3	<3	<3
Ba	mg/kg	120	19	28	47	31
Be	mg/kg	<1	<1	<1	<1	<1
Cd	mg/kg	0.6	<0.3	<0.3	<0.3	<0.3
Cr	mg/kg	61	14	21	25	26
Co	mg/kg	11	7.4	11	11	12
Cu	mg/kg	19	4.9	8.2	12	10
Hg	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Pb	mg/kg	9.2	<3	<3	<3	<3
Mo	mg/kg	<1	<1	<1	<1	<1
Ni	mg/kg	43	11	17	21	20
Se	mg/kg	<5	<5	<5	<5	<5
Sn	mg/kg	<5	<5	<5	<5	<5
V	mg/kg	50(1)	28	37	35	40
Zn	mg/kg	81	24	37	44	44
Benzene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.2	<0.2	25	<0.2	<0.2
o-Xylene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
m/p-Xylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes (sum)	mg/kg					
Styrene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,4-Trimethylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,3,5-Trimethylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
n-Propylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Isopropylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
n-Butylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
sec-Butylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
tert-Butylbenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
p-Isopropyltoluene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Phenol	mg/kg	0.03	<0.01	<0.01	<0.01	<0.01
o-Cresol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
m-Cresol	mg/kg	<0.01	<0.01	0.01	<0.01	<0.01
p-Cresol	mg/kg	<0.01	2	<0.01	<0.01	<0.01
Cresoles (sum)	mg/kg		2			
2,4-Dimethylphenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
2,5-Dimethylphenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
2,6-Dimethylphenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
3,4-Dimethylphenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
o-Ethylphenol	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
m-Ethylphenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Thymol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
2,3/3,5-Dimethylphenol + 4-Ethylphenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Naphtalene	mg/kg	<0.01	<0.01	0.03	<0.01	<0.01
Acenaphtylene	mg/kg	<0.01	<0.01	0.01	<0.01	<0.01

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
Acenaphtene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	<0.01	<0.01	0.02	<0.01	0.01
Anthracene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	mg/kg	<0.01	<0.01	0.01	<0.01	<0.01
Benzo(a)anthracene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	<0.01	<0.01	<0.01	<0.01	0.01
Benzo(b)fluoranthene	mg/kg	0.01	<0.01	<0.01	<0.01	0.01
Benzo(k)fluoranthene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi)perylene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(ah)anthracene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(123cd)pyrene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
PAHs (sum 10 Dutch VROM)	mg/kg			0.04		
PAHs (sum 16 US EPA)	mg/kg	0.01		0.05		
Tetrachloromethane (tetra)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,2 Dichloroethane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1- Trichloroethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,1,2-Trichloroethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Trichloroethanes (sum)	mg/kg					
1,1,1,2-Tetrachloroethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,1,2,2-Tetrachloroethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Tetrachloroethanes (sum)	mg/kg					
Trichloroethene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachloroethene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
1,2-Dichloropropane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,3-Dichloropropane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,2,3-Trichloropropane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,1-Dichloropropylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
cis 1,3-Dichloropropylene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
trans 1,3-Dichloropropylene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,3-Dichloropropylene (sum)	mg/kg					
Dibromomethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,2-Dibromoethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Tribromomethane (Bromoform)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bromodichloromethane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibromochloromethane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
1,2-Dibromo-3-chloropropane	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bromobenzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Monochlorobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
1,2-Dichlorobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
1,3-Dichlorobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
1,4-Dichlorobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Dichlorobenzenes (sum)	mg/kg					
1,2,3-Trichlobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
1,2,4-Trichlorobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
1,3,5-Trichlorobenzene	mg/kg	<0.003	<0.003	<0.003	<0.003	<0.003
Trichlorobenzene (sum)	mg/kg					
1,2,3,4-Tetrachlorobenzene	mg/kg	<0.003	<0.003	<0.003	<0.003	<0.003
1,2,3,5/1,2,4,5-Tetrachlorobenzene	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Tetrachlorobenzene (sum)	mg/kg					

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
Pentachlorobenzene	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobenzene	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
o-Chlorophenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
m-Chlorophenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
p-chlorophenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Monochlorophenols (sum)	mg/kg					
2,3-Dichlorophenol	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
2,4/2,5-Dichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
2,6-dichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
3,4-Dichlorophenol	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
3,5-Dichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorophenols (sum)	mg/kg					
2,3,4-Trichlorophenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,5-Trichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
2,3,6-Trichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
2,4,5-Trichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
2,4,6-Trichlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
3,4,5-Trichlorophenol	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Trichlorophenols (sum)	mg/kg					
2,3,4,5-Tetrachlorophenol	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
2,3,4,6/2,3,5,6-Tetrachlorophenol	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Tetrachlorophenols (sum)	mg/kg					
Pentachlorophenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chloro-3-methylphenol	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
PCB 28	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
PCB 52	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
PCB 101	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
PCB 118	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
PCB 138	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
PCB 153	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
PCB 180	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
PCB (sum 6)	mg/kg					
PCB (sum 7)	mg/kg					
o/p-Chloronitrobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
m-Chloronitrobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Monochloronitrobenzenes (sum)	mg/kg					
2,3/3,4-Dichloronitrobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
2,4-Dichloronitrobenzene	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
2,5-Dichloronitrobenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
3,5-Dichloronitrobenzene	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloronitrobenzenes (sum)	mg/kg					
2-Chlorotoluene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
4-Chlorotoluene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorotoluenes (sum)	mg/kg					
1-Chloronaphtalene	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
4,4-DDE	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-DDE	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
4,4-DDT	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
4,4-DDD/2,4-DDT	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-DDD	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
DDT/DDE/DDD (sum)	mg/kg					
Aldrin	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
Dieldrin	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Drins (sum)	mg/kg					
alfa-HCH	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-HCH	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
gamma-HCH	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
delta-HCH	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
HCH (sum)	mg/kg					
Alfaendosulfan	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Alfaendosulfansulphate	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Alfa-chlordane	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Gamma-chlordan2	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Chlordanes (sum)	mg/kg					
Heptachlor	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachloroepoxide	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Isodrin	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Hexachlorobutadiene	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Telodrin	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Tedion	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Azinphos-ethyl	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Azinphos-methyl	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Bromophos-ethyl	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Bromophos-methyl	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Chloropyrophos-ethyl	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Chloropyrophos-methyl	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Cumaphos	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
Demethon-S/Demethon-O (ethyl)	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Diazinon	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Disulfoton	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Fenitrothion	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Fenthion	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002
Malathion	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Parathion-ethyl	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Parathion-methyl	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrazophos	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Triazophos	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Ametryne	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Atrazine	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Cyanazine	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Desmetryne	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Prometryne	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Propazine	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Simazine	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Terbutylazine	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Terbutryne	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bifenthrin	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005
Cypermethrin (A,B,C,D)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Deltamethrin	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Permethrin	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Permethrin A	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Propachloor	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02
Trifluralin	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005

Sediments Parameter	Unit	S-SP1	S-SP2	S-SP3	S-SP4	S-SP5
Biphenyl	mg/kg	<0.005	<0.005	0.03	<0.005	<0.005
Nitrobenzene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzofurane	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Dimethylphthalate	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Diethylphthalate	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Di-isobutylphthalate	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Dibutylphthalate	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Butylbenzylphthalate	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Bis(ethylhexyl)phthalate	mg/kg	1.1	<0.2	0.3	<0.2	0.4
Di-n-octylphtalate	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Phthalates (sum)	mg/kg	1.1		0.3		
TPH C10-C12	mg/kg	<6	<6	<6	<6	<6
TPH C12-C16	mg/kg	7.2	<6	<6	<6	<6
TPH C16-C21	mg/kg	22	<6	<6	6	<6
TPH C21-C30	mg/kg	71	<6	<6	23	<6
TPH C30-C35	mg/kg	51	<6	<6	19	7.2
TPH C35-C40	mg/kg	18	<6	<6	7	<6
TPH (sum C10-C40)	mg/kg	170			60	7.2
Cyanides Total	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0

* See **Error! Reference source not found.** for the norms against which the results are compared. The Superscript numbers indicate exceedance of the specified norm, as listed:

1. Dutch Intervention Values for Soil and Sediments

Table G-7. Results of the Spring Water Analysis

Spring Water Parameter	**Unit**	**W-SP01**	**W-SP02**
As	µg/l	<4	<4
Sb	µg/l	<5	<5
Ba	µg/l	3.8	34
Be	µg/l	<1	<1
Cd	µg/l	<0.4	<0.4
Cr	µg/l	<2	<2
Co	µg/l	<1	<1
Cu	µg/l	<3	<3
Hg	µg/l	<0.04	<0.04
Pb	µg/l	<3	<3
Mo	µg/l	<2	<2
Ni	µg/l	<2	<2
Se	µg/l	<5	<5
Sn	µg/l	<5	<5
V	µg/l	<2	2.5
Zn	µg/l	<5	<5
Benzene	µg/l	<0.1	<0.1
Ethylbenzene	µg/l	<0.1	<0.1
Toluene	µg/l	<0.1	<0.1
o-Xylene	µg/l	<0.1	<0.1
m/p-Xylene	µg/l	<0.1	<0.1
Xylenes (sum)	µg/l	<0.1	<0.1
Styrene	µg/l	<0.1	<0.1
1,2,4-Trimethylbenzene	µg/l	<0.1	<0.1
1,3,5-Trimethylbenzene	µg/l	<0.1	<0.1
n-Propylbenzene	µg/l	<0.1	<0.1
Isopropylbenzene	µg/l	<0.1	<0.1
n-Butylbenzene	µg/l	<0.1	<0.1
sec-Butylbenzene	µg/l	<0.1	<0.1
tert-Butylbenzene	µg/l	<0.1	<0.1
p-Cymene	µg/l	<0.1	<0.1
Phenol	µg/l	<0.5	<0.5
o-Cresol	µg/l	<0.3	<0.3
m-Cresol	µg/l	<0.3	<0.3
p-Cresol	µg/l	<0.2	<0.2
Cresoles (sum)	µg/l	<0.3	<0.3
2,4-Dimethylphenol	µg/l	<0.02	<0.02
2,5-Dimethylphenol	µg/l	<0.02	<0.02
2,6-Dimethylphenol	µg/l	<0.03	<0.03
3,4-Dimethylphenol	µg/l	<0.02	<0.02
o-Ethylphenol	µg/l	<0.03	<0.03
m-Ethylphenol	µg/l	<0.02	<0.02
Thymol	µg/l	<0.01	<0.01

Spring Water Parameter	Unit	W-SP01	W-SP02
2,3/3,5-Dimethylphenol + 4-Ethylphenol	µg/l	<0.02	<0.02
Naphthalene	µg/l	<0.4	<0.4
Acenaphtylene	µg/l	<0.04	<0.04
Acenaphtene	µg/l	<0.1	<0.1
Fluorene	µg/l	<0.01	<0.01
Phenanthrene	µg/l	<0.02	<0.02
Anthracene	µg/l	<0.01	<0.01
Fluoranthene	µg/l	<0.02	<0.02
Pyrene	µg/l	<0.06	<0.06
Benzo(a)anthracene	µg/l	<0.04	<0.04
Chrysene	µg/l	<0.02	<0.02
Benzo(b/k)fluoranthene	µg/l	<0.06	<0.06
Benzo(a)pyrene	µg/l	<0.1	<0.1
Benzo(ghi)perylene	µg/l	<0.1	<0.1
Dibenzo(ah)anthracene	µg/l	<0.08	<0.08
Indeno(123cd)pyrene	µg/l	<0.06	<0.06
PAHs (sum 16 US EPA)	µg/l		
Chloromethane	µg/l	<0.2	<0.2
Dichloromethane	µg/l	<0.2	<0.2
Vinylchlorine	µg/l	<0.2	<0.2
1,1 Dichloroethene	µg/l	<0.1	<0.1
tr-1,2 Dichloroethene	µg/l	<0.1	<0.1
cis- 1,2 Dichloroethene	µg/l	<0.1	<0.1
Chloroethane	µg/l	<0.1	<0.1
Trichlorofluoromethane	µg/l	<0.1	<0.1
1, 1, 1-Trichloromethane	µg/l	<0.2	<0.2
Tetrachloromethane (tetra)	µg/l	<0.1	<0.1
1,1 Dichloroethane	µg/l	<0.1	<0.1
1,2 Dichloroethane	µg/l	<0.1	<0.1
1,1,1- Trichloroethane	µg/l	<0.1	<0.1
1,1,2-Trichloroethane	µg/l	<0.1	<0.1
Trichloroethanes (sum)	µg/l	<0.1	<0.1
1,1,1,2-Tetrachloroethane	µg/l	<0.1	<0.1
1,1,2,2-Tetrachloroethane	µg/l	<0.1	<0.1
Tetrachloroethanes (sum)	µg/l		
Trichloroethene	µg/l	<0.1	<0.1
Tetrachloroethene	µg/l	<0.1	<0.1
2,2-Dichloropropane	µg/l	<0.1	<0.1
1,2-Dichloropropane	µg/l	<0.1	<0.1
1,3-Dichloropropane	µg/l	<0.1	<0.1
1,2,3-Trichloropropane	µg/l	<0.1	<0.1
1,1-Dichloropropylene	µg/l	<0.1	<0.1
cis 1,3-Dichloropropylene	µg/l	<0.1	<0.1
trans 1,3-Dichloropropylene	µg/l	<0.1	<0.1

Spring Water Parameter	Unit	W-SP01	W-SP02
1,3-Dichloropropylene (sum)	µg/l		
Bromomethane	µg/l	<0.1	<0.1
Bromochloromethane	µg/l	<0.1	<0.1
Dibromomethane	µg/l	<0.1	<0.1
1,2-Dibromoethane	µg/l	<0.1	<0.1
Tribromomethane (Bromoform)	µg/l	<0.1	<0.1
Bromodichloromethane	µg/l	<0.1	<0.1
Dibromochloromethane	µg/l	<0.1	<0.1
1,2-Dibromo-3-chloropropane	µg/l	<0.1	<0.1
Bromobenzene	µg/l	<0.1	<0.1
Monochlorobenzene	µg/l	<0.05	<0.05
1,2-Dichlorobenzene	µg/l	<0.1	<0.1
1,3-Dichlorobenzene	µg/l	<0.1	<0.1
1,4-Dichlorobenzene	µg/l	<0.1	<0.1
Dichlorobenzenes (sum)	µg/l		
1,2,3-Trichlobenzene	µg/l	<0.1	<0.1
1,2,4-Trichlorobenzene	µg/l	<0.1	<0.1
1,3,5-Trichlorobenzene	µg/l	<0.01	<0.01
Trichlorobenzene (sum)	µg/l		
1,2,3,4-Tetrachlorobenzene	µg/l	<0.02	<0.02
1,2,3,5/1,2,4,5-Tetrachlorobenzene	µg/l	<0.02	<0.02
Tetrachlorobenzene (sum)	µg/l		
Pentachlorobenzene	µg/l	<0.01	0.01
Hexachlorobenzene	µg/l	<0.03	<0.03
o-Chlorophenol	µg/l	<0.1	<0.1
m-Chlorophenol	µg/l	<0.02	<0.02
p-Chlorophenol	µg/l	<0.02	<0.02
Monochlorophenols (sum)	µg/l		
2,3-Dichlorophenol	µg/l	<0.02	<0.02
2,4/2,5-Dichlorophenol	µg/l	<0.01	<0.01
2,6-Dichlorophenol	µg/l	<0.03	<0.03
3,4-Dichlorophenol	µg/l	<0.02	<0.02
3,5-Dichlorophenol	µg/l	<0.03	<0.03
Dichlorophenols (sum)	µg/l		
2,3,4-Trichlorophenol	µg/l	<0.02	<0.02
2,3,5/2,4,5-Trichlorophenol	µg/l	<0.02	<0.02
2,3,6-Trichlorophenol	µg/l	<0.01	<0.01
2,4,6-Trichlorophenol	µg/l	<0.05	<0.05
3,4,5-Trichlorophenol	µg/l	<0.01	<0.01
Trichlorophenols (sum)	µg/l	<0.11	<0.11
2,3,4,5-Tetrachlorophenol	µg/l	<0.01	<0.01
2,3,4,6/2,3,5,6-Tetrachlorophenol	µg/l	<0.02	<0.02
Tetrachlorophenols (sum)	µg/l		
Pentachlorophenol	µg/l	<0.01	<0.01
4-Chloro-3-methylphenol	µg/l	<0.02	<0.02

Spring Water Parameter	**Unit**	**W-SP01**	**W-SP02**
PCB 28	µg/l	<0.01	<0.01
PCB 52	µg/l	<0.01	<0.01
PCB 101	µg/l	<0.01	<0.01
PCB 118	µg/l	<0.01	<0.01
PCB 138	µg/l	<0.01	<0.01
PCB 153	µg/l	<0.01	<0.01
PCB 180	µg/l	<0.01	<0.01
PCB (sum 6)	µg/l		
PCB (sum 7)	µg/l		
o/p-Chloronitrobenzene	µg/l	<0.2	<0.2
m-Chloronitrobenzene	µg/l	<0.2	<0.2
Monochloronitrobenzenes (sum)	µg/l		
2,3-Dichloronitrobenzene	µg/l	<0.1	<0.1
2,4-Dichloronitrobenzene	µg/l	<0.1	<0.1
2,5-Dichloronitrobenzene	µg/l	<0.1	<0.1
3,4-Dichloronitrobenzene	µg/l	<0.1	<0.1
3,5-Dichloronitrobenzene	µg/l	<0.06	<0.06
Dichloronitrobenzenes (sum)	µg/l		
2-Chlorotoluene	µg/l	<0.1	<0.1
4-Chlorotoluene	µg/l	<0.1	<0.1
Chlorotoluenes (sum)	µg/l		
1-Chloronaphtalene	µg/l	<0.02	<0.02
4,4-DDE	µg/l	<0.01	<0.01
2,4-DDE	µg/l	<0.01	<0.01
4,4-DDT	µg/l	<0.2	<0.2
4,4-DDD/2,4-DDT	µg/l	<0.02	<0.02
2,4-DDD	µg/l	<0.01	<0.01
DDT/DDE/DDD (sum)	µg/l		
Aldrin	µg/l	<0.02	<0.02
Dieldrin	µg/l	<0.02	<0.02
Endrin	µg/l	<0.02	<0.02
Drins (sum)	µg/l		
alfa-HCH	µg/l	<0.08	<0.08
beta-HCH	µg/l	<0.07	<0.07
gamma-HCH	µg/l	<0.1	<0.1
delta-HCH	µg/l	<0.04	<0.04
HCH (sum)	µg/l		
Alfaendosulfan	µg/l	<0.05	<0.05
Alfaendosulfansulphate	µg/l	<0.03	<0.03
Alfa-chlordane	µg/l	<0.01	<0.01
Gamma-chlordan2	µg/l	<0.01	<0.01
Chlordanes (sum)	µg/l		
Heptachlor	µg/l	<0.01	<0.01
Heptachloroepoxide	µg/l	<0.03	<0.03
Isodrin	µg/l	<0.1	<0.1

Spring Water Parameter	**Unit**	**W-SP01**	**W-SP02**
Hexachlorobutadiene	µg/l	<0.03	<0.03
Telodrin	µg/l	<0.07	<0.07
Tedion	µg/l	<0.07	<0.07
Azinphos-ethyl	µg/l	<0.1	<0.1
Azinphos-methyl	µg/l	<0.07	<0.07
Bromophos-ethyl	µg/l	<0.07	<0.07
Bromophos-methyl	µg/l	<0.06	<0.06
Chloropyrophos-ethyl	µg/l	<0.06	<0.06
Chloropyrophos-methyl	µg/l	<0.1	<0.1
Cumaphos	µg/l	<0.02	<0.02
Demethon-S/Demethon-O (ethyl)	µg/l	<0.1	<0.1
Diazinon	µg/l	<0.04	<0.04
Dichlorovos	µg/l	<0.1	<0.1
Disulfoton	µg/l	<0.04	<0.04
Fenitrothion	µg/l	<0.1	<0.1
Fenthion	µg/l	<0.1	<0.1
Malathion	µg/l	<0.1	<0.1
Parathion-ethyl	µg/l	<0.2	<0.2
Parathion-methyl	µg/l	<0.2	<0.2
Pyrazophos	µg/l	<0.2	<0.2
Triazophos	µg/l	<0.2	<0.2
Ametryne	µg/l	<0.1	<0.1
Atrazine	µg/l	<0.08	<0.08
Cyanazine	µg/l	<0.1	<0.1
Desmetryne	µg/l	<0.1	<0.1
Prometryne	µg/l	<0.1	<0.1
Propazine	µg/l	<0.08	<0.08
Simazine	µg/l	<0.2	<0.2
Terbutylazine	µg/l	<0.06	<0.06
Terbutryne	µg/l	<0.1	<0.1
Bifenthrin	µg/l	<0.08	<0.08
Carbaryl	µg/l	<0.1	<0.1
Cypermethrin (A,B,C,D)	µg/l	<0.2	<0.2
Deltamethrin	µg/l	<0.2	<0.2
Linuron	µg/l	<0.1	<0.1
Permethrin A	µg/l	<0.06	<0.06
Permethrin B	µg/l	<0.06	<0.06
Permethrin (sum)	µg/l		
Propachloor	µg/l	<0.02	<0.02
Trifluralin	µg/l	<0.02	<0.02
Biphenyl	µg/l	<0.01	<0.01
Nitrobenzene	µg/l	<0.3	<0.3
Dibenzofurane	µg/l	<0.1	<0.1
TPH C10-C12	µg/l	<15	<15
TPH C12-C16	µg/l	<15	<15

Spring Water Parameter	Unit	W-SP01	W-SP02
TPH C16-C21	µg/l	<15	<15
TPH C21-C30	µg/l	<15	<15
TPH C30-C35	µg/l	<15	<15
TPH C35-C40	µg/l	<15	<15
TPH (sum C10-C40)	µg/l	<100	<100
Bicarbonate alkalinity	me/l	1.44(11)	1.96(11)
Sulphate	mg/l	10	8
Nitrate	mg/l NO_3^-	3.8	11.7(1)
Nitrite	mg/l NO_2^-	<0.05	<0.05
Ammonium	mg/l NH_4	<0.05	<0.05
Phosphates	mg/l o-PO_4^{3-}	<0.05	0.28
BOD	mg/l BOD5	132(3, 5, 6, 7, 8, 9, 10)	181(3, 5, 6, 7, 8, 9, 10)
COD**	mg/l O_2	2.07	4.44
TDS	mg/l 25°C	185.1(2)	252.5(2)
TSS	mg/l	0.3(3, 8, 9, 10)	35.3(3)
Enterococci sp.	CFU/250ml	0	12(2)
DO (in-situ)	mg/l	8.28	8.52
Turbidity (in-situ)	NTU	0.12	1.2
pH (in-situ)	8.21	7.8	8.27
Specific Conductivity (in-situ)	µS/cm	357.7	466.2
Total Coliforms	CFU/100ml	50(1, 2, 4)	1332(1, 2, 4)
Faecal Coliforms	CFU/250ml	0	88(2)
Temperature (in-situ)	°C	12.33	14.7
Pseudomonas aeruginosa	CFU/250ml	0	0
Total Hardness ($CaCO_3$)	mg/l	170	230
Bicarbonates (HCO_3)	mg/l		239
Chlorides	mg/l	9	16
Calcium	mg/l	56.1(11)	80.8(11)
Magnesium	mg/l	7.3	6.8
Potassium	mg/l	0.53	1.11
Sodium	mg/l	3.5	8.4
Aluminium	mg/l	<0.2	<0.2
Boron	mg/l	<0.05	<0.05
Fluoride	mg/l	<0.1	<0.1
Iron	mg/l	<0.3	<0.3
Manganese	mg/l	<0.05	<0.05
Sulphides	mg/l	<0.1	<0.1
Silica	mg/l	0.8	2.6
Salinity	mg/l	169	204
Total Solids	mg/l	185.4	35.3
Color	U.Pt-Co	<0.1	<0.1
TOC	mg/l	<2.0	<2.0

* See **Error! Reference source not found.** for the guidelines and standards for different water uses against which the results are compared. The Superscript numbers indicate exceedance of the specified standard, as listed:
** COD analysed using Potassium Permanganate ($KMnO_4$) as oxidizing agent.

1. National Primary Drinking Water Regulations: US EPA 2011
2. Lebanese Standard for Drinking Water NL 161:2016
3. Aquatic Std: Guideline Value (Lebanon MoE Decision No. 52/1/1996)
4. Swimming Guideline Value (Lebanon MoE Decision No. 52/1/1996)
5. Reclaimed Wastewater for Irrigation, Class 1B (max) (Lebanon-MoE proposed guidelines 2005)
6. Reclaimed Wastewater for Irrigation, Class 2 (max) (Lebanon-MoE proposed guidelines 2005)
7. Reclaimed Wastewater for Irrigation, Class 3 (max) (Lebanon-MoE proposed guidelines 2005)
8. Water for Irrigation Use: Wastewater reuse category I (Lebanon-FAO proposed guidelines (2010))
9. Water for Irrigation Use: wastewater reuse category II (Lebanon-FAO proposed guidelines (2010))
10. Water for Irrigation Use: wastewater reuse category III (Lebanon-FAO proposed guidelines (2010))
11. Water for Irrigation Use: usual range in irrigation water (FAO)

Guidelines

National and international guidelines for water quality for different end uses are found in Table G-8. The different guideline values to which the sediments' results were compared are listed in Table G-9.

Table G-8. National and International Guidelines for Water Quality for Different End Uses

Reference	Medium	Type	Parameter	Value	Unit
WHO (2008)	Drinking water	Guideline Value	Aldrin and Dieldrin	0.03	µg/l
WHO (2011)	Drinking Water	Guideline Value	Aluminum	100	µg/l
EPA (2011)	Drinking water	Guideline Value	Aluminum	200	µg/l
WHO (2002)	Drinking water	Guideline Value	Aluminum	300	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Aluminum	200	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Aluminum	200	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Alkalinity	300	me/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Ammonia	0.5	mg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Guideline Value	Ammonia	<0.005	mg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	Ammonia	<0.025	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Ammonium	0 to 6.43	mg/l
WHO (2011)	Drinking Water	Guideline Value	Arsenic	10	µg/l
EPA (2011)	Drinking water	Guideline Value	Arsenic	10	µg/l
USEPA	Drinking water	Guideline Value	Arsenic	10	µg/l
WHO (2008)	Drinking water	Guideline Value	Arsenic	10	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Arsenic	10	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Arsenic	50	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Arsenic	100	µg/l

Reference	Medium	Type	Parameter	Value	Unit
EPA (2011)	Drinking water	Guideline Value	Barium	2000	µg/l
WHO (2011)	Drinking Water	Guideline Value	Barium	700	µg/l
WHO (2002)	Drinking water	Guideline Value	Barium	700	µg/l
WHO (2008)	Drinking water	Guideline Value	Barium	700	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Barium	700	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Barium	500	µg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none) (sprinkling)	Bicarbonate alkalinity	<1.5	me/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Severe)	Bicarbonate alkalinity	>8.5	me/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Bicarbonate alkalinity	1.5-8.5	me/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Bicarbonate alkalinity	0 to 10	me/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Guideline Value	Biological Oxygen Demand (BOD_5)	<3	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1A (Avg)	Biological Oxygen Demand (BOD_5)	10	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1A (Max)	Biological Oxygen Demand (BOD_5)	15	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1B (Avg)	Biological Oxygen Demand (BOD_5)	25	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1B (Max)	Biological Oxygen Demand (BOD_5)	40	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 2 (Avg)	Biological Oxygen Demand (BOD_5)	30	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 2 (Max)	Biological Oxygen Demand (BOD_5)	45	mg/l O_2

Reference	Medium	Type	Parameter	Value	Unit
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 3 (Avg)	Biological Oxygen Demand (BOD_5)	30	mg/l O_2
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 3 (Max)	Biological Oxygen Demand (BOD_5)	45	mg/l O_2
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category I)	Biological Oxygen Demand (BOD_5)	25	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category II)	Biological Oxygen Demand (BOD_5)	100	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category III)	Biological Oxygen Demand (BOD_5)	100	mg/l
WHO (2002)	Drinking water	Guideline Value	Cadmium	10	µg/l
WHO (2008)	Drinking water	Guideline Value	Cadmium	3	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Cadmium	3	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Cadmium	5	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Cadmium	10	µg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Calcium	0 to 20	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Carbonate	300	me/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Carbonate alkalinity	0 to 1	me/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category I)	Chemical Oxygen Demand (COD)	125	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category II)	Chemical Oxygen Demand (COD)	250	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category III)	Chemical Oxygen Demand (COD)	250	mg/l
WHO (2011)	Drinking Water	Guideline Value	Chlorides	250	mg/l

Reference	Medium	Type	Parameter	Value	Unit
EPA (2011)	Drinking water	Guideline Value	Chlorides	250	mg/l
WHO (2002)	Drinking water	Guideline Value	Chlorides	400	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Chlorides	250	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Chlorides	200	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none) (sprinkler irrigation)	Chlorides	<106.4	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none) (surface irrigation)	Chlorides	<141.8	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Severe)	Chlorides	>354.5	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Chlorides	>106.4	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Chlorides	141.8 to 354.5	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Chlorides	0 to 1063.6	mg/l
EPA (2011)	Drinking water	Guideline Value	Chromium	100	µg/l
WHO (2011)	Drinking Water	Guideline Value	Chromium	50	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Chromium	50	µg/l
WHO (2002)	Drinking water	Guideline Value	Chromium (total)	50	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Chromium (total)	10	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Cobalt	50	µg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none)	Conductivity	<700	µS/cm
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Severe)	Conductivity	>3,000	µS/cm

Reference	Medium	Type	Parameter	Value	Unit
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Conductivity	700 to 3,000	µS/cm
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Conductivity	0 to 3,000	µS/cm
WHO (2011)	Drinking Water	Guideline Value	Copper	2000	µg/l
EPA (2011)	Drinking water	Guideline Value	Copper	1300	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Copper	1000	µg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	Copper	<40	µg/l
WHO (2008)	Drinking water	Guideline Value	Copper	2,000	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Copper	1,000	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Copper	200	µg/l
WHO (2008)	Drinking water	Guideline Value	Cyanide (as free Cyanide)	70	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Cyanide (as free Cyanide)	50	µg/l
WHO (2008)	Drinking water	Guideline Value	DDT and metabolites (DDD & DDE)	1	ng/ml
Lebanon - MOE Decision 52/1/1996	Aquatic life	Guideline Value	DO	100% >7	mg/l O_2
Lebanon - MOE Decision 52/1/1996	Aquatic life	Guideline Value	DO	50% >9	mg/l O_2
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	DO	50% >9	mg/l O_2
EPA (2011)	Drinking Water	Guideline Value	E. Coli	0	CFU/100 ml
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	E. Coli	0	CFU/100 ml

Reference	Medium	Type	Parameter	Value	Unit
USEPA (1986)	Bathing (Full Body Contact) Recreational Waters	Maximal Admissible Value	E. coli	126	Colonies/ 100ml
WHO (2011)	Drinking Water	Guideline Value	E. Coli	0	CFU/100 ml
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Electrical Conductivity	1500	µS/cm
USEPA (1986)	Bathing (Full Body Contact) Recreational Waters	Maximal Admissible Value	Enterococci	33	Colonies/ 100ml
WHO (2011)	Drinking Water	Guideline Value	Fecal Coliform	0	CFU/100 ml
EPA (2011)	Drinking Water	Guideline Value	Fecal Coliform	0	CFU/100 ml
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Fecal Coliform	0	CFU/100 ml
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category I)	Fecal coliform	<200	in 100 ml
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category II)	Fecal coliform	<1,000	in 100 ml
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category III)	Fecal coliform	none required	
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Fecal coliform	0	in 250 mL
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1A (Avg)	Fecal coliform	5	in 100 ml
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1A (Max)	Fecal coliform	23	in 100 ml
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1B (Avg)	Fecal coliform	100	in 100 ml
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 1B (Max)	Fecal coliform	200	in 100 ml
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 2 (Avg)	Fecal coliform	200	in 100 ml

Reference	Medium	Type	Parameter	Value	Unit
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 2 (Max)	Fecal coliform	400	in 100 ml
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 3 (Avg)	Fecal coliform	1,000	in 100 ml
Lebanon - MOE Proposed Guidelines (2005)	Waste water discharge	Reclaimed wastewater for irrigation, Class 3 (Max)	Fecal coliform	2,000	in 100 ml
WHO (2008)	Drinking water	Guideline Value	Hexachlorobenzene (HCB)	1	mg/l
WHO (2011)	Drinking Water	Guideline Value	Iron	0.1	mg/l
EPA (2011)	Drinking water	Guideline Value	Iron	0.3	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Iron	0.5	mg/l
WHO (2011)	Drinking Water	Guideline Value	Lead	10	µg/l
EPA (2011)	Drinking water	Guideline Value	Lead	15	µg/l
WHO (2002)	Drinking water	Guideline Value	Lead	10	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Lead	10	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Lead	10	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Lead	5,000	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Magnesium	50	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Magnesium	0 to 121.5	mg/l
WHO (2011)	Drinking Water	Guideline Value	Manganese	400	µg/l
EPA (2011)	Drinking water	Guideline Value	Manganese	50	µg/l
WHO (2002)	Drinking water	Guideline Value	Manganese	500	µg/l
WHO (2008)	Drinking water	Guideline Value	Manganese	400	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Manganese	100	µg/l

Reference	Medium	Type	Parameter	Value	Unit
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Manganese	50	µg/l
WHO (2011)	Drinking Water	Guideline Value	Mercury	6	µg/l
EPA (2011)	Drinking water	Guideline Value	Mercury	2	µg/l
WHO (2008)	Drinking water	Guideline Value	Mercury	6	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Mercury	6	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Mercury	1	µg/l
WHO (2008)	Drinking water	Guideline Value	Molybdenum	70	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Molybdenum	10	µg/l
WHO (2011)	Drinking Water	Guideline Value	Nickel	70	µg/l
WHO (2002)	Drinking water	Guideline Value	Nickel	70	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Nickel	70	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Nickel	20	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Nickel	200	µg/l
EPA (2011)	Drinking water	Guideline Value	Nitrates	10	mg/l
USEPA	Drinking water	Guideline Value	Nitrates	10	mg/l
WHO (2002)	Drinking water	Guideline Value	Nitrates	50	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Nitrates	45	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Nitrates	45	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Nitrates	0 to 44.22	mg/l
EPA (2011)	Drinking water	Guideline Value	Nitrites	1	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Nitrites	0.05	Mg/l

Reference	Medium	Type	Parameter	Value	Unit
Lebanon - MOE Decision 52/1/1996	Aquatic life	Guideline Value	Nitrites	<0.01	mg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	Nitrites	<0.01	mg/l
WHO (2002)	Drinking water	Guideline Value	Nitrites	1	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Nitrites	0.05	mg/l
WHO (2011)	Drinking Water	Guideline Value	o-Xylene	500	µg/l
WHO (2011)	Drinking Water	Guideline Value	pH	8.5	
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	pH	6 to 9	
WHO (2002)	Drinking water	Guideline Value	pH	6 to 8	
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	pH	6.5 to 8.5	
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	pH	6.5 to 8.5	
Lebanon - MOE Decision 52/1/1996	Swimming (sea)	Guideline Value	pH	6 to 9	
FAO (1994)	Water for irrigation use	Normal range	pH	6.5 to 8.4	
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category I)	pH	6 to 9	
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category II)	pH	6 to 9	
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category III)	pH	6 to 9	
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	Phenolic compounds	should not change taste of fish	
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Phenolic compounds	1	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Phosphates	1	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Phosphates	0 to 6.13	mg/l

Reference	Medium	Type	Parameter	Value	Unit
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Phosphorus Pentoxide	0.35	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Potassium	12	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Potassium	0 to 2	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Pseudomonas Aeruginosa	0	CFU/250 ml
EPA (2011)	Drinking water	Guideline Value	Silver	0.1	mg/l
WHO (2011)	Drinking Water	Guideline Value	Sodium	200	mg/l
WHO (2008)	Drinking water	Guideline Value	Sodium	200	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Sodium	200	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Sodium	150	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none) (sprinkler irrigation)	Sodium	<69.0	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Sodium	>69.0	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Sodium	0 to 919.6	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Specific Conductivity	1500	µS/cm
WHO (2011)	Drinking Water	Guideline Value	Sulfates	250	mg/l
WHO (2002)	Drinking water	Guideline Value	Sulfates	500	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Sulfates	250	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Sulfates	0 to 20	mg/l
WHO (2008)	Drinking water	Guideline Value	Toluene	700	µg/l
EPA (2011)	Drinking Water	Guideline Value	Total Coliform	0.0005	CFU/100 ml

Reference	Medium	Type	Parameter	Value	Unit
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Total Coliform	0.0005	CFU/100 ml
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Total coliform	0	in 100 ml
Lebanon - MOE Decision 52/1/1996	Swimming (sea)	Guideline Value	Total coliform	500	Colonies/ 100 ml
Lebanon - MOE Decision 52/1/1996	Swimming (sea)	Maximal Admissible Value	Total coliform	10,000	Colonies/ 100 ml
WHO (2011)	Drinking Water	Guideline Value	Total Coliform	0	CFU/100 ml
EPA (2011)	Drinking water	Guideline Value	Total Dissolved Solids (TDS)	500	mg/l
WHO (2002)	Drinking water	Guideline Value	Total Dissolved Solids (TDS)	1,000	mg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Total Dissolved Solids (TDS)	100-750	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Total Dissolved Solids (TDS)	500	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none) (sprinkling)	Total Dissolved Solids (TDS)	<450	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Severe)	Total Dissolved Solids (TDS)	>2,000	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Total Dissolved Solids (TDS)	450 to 2,000	mg/l
FAO (1994)	Water for irrigation use	Usual range in irrigation water	Total Dissolved Solids (TDS)	0 to 2000	mg/l
WHO (2002)	Drinking water	Guideline Value	Total Hardness	500	mg/l as Calcium carbonat e
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Total Hardness	500	mg/l

Reference	Medium	Type	Parameter	Value	Unit
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Total Hardness	250	mg/l as Calcium carbonate
FAO (1994)	Water for irrigation use	Degree of Restriction on use (none)	Total Nitrogen	<5	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Severe)	Total Nitrogen	>30	mg/l
FAO (1994)	Water for irrigation use	Degree of Restriction on use (Slight to moderate)	Total Nitrogen	5 to 30	mg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Total Organic Carbon (TOC)	0.5	mg/l
WHO (2005)	Drinking water	Guideline Value	Total Petroleum Hydrocarbon (TPH)	90	µg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	Total Phosphorus	0.0652	mg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Guideline Value	Total Suspended Solids (TSS)	<25	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category I)	Total Suspended Solids (TSS)	60	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category II)	Total Suspended Solids (TSS)	200	mg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse (Category III)	Total Suspended Solids (TSS)	200	mg/l
WHO (2002)	Drinking water	Guideline Value	Turbidity	5	NTU
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Turbidity	5	NTU
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Turbidity	20	NTU
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Vanadium	100	µg/l
WHO (2008)	Drinking water	Guideline Value	Xylenes	500	µg/l

Reference	Medium	Type	Parameter	Value	Unit
EPA (2011)	Drinking water	Guideline Value	Zinc	5000	µg/l
Lebanese Standard for Drinking Water NL 161:2016	Drinking Water	Guideline Value	Zinc	4000	µg/l
Lebanon - MOE Decision 52/1/1996	Aquatic life	Maximal Admissible Value	Zinc	<300	µg/l
Lebanon - Decree 1039/1999	Drinking water	Maximal Admissible Value	Zinc	5,000	µg/l
Lebanon - FAO Proposed Guidelines (2010)	Water for irrigation use	Wastewater reuse	Zinc	2,000	µg/l

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Table G-9. World Average Concentrations and Standards for River Sediments

Parameter	River Sediments			
	Dutch intervention values for soil and sediments[1]	Lebanon and Syria (Thomas *et al* 2005)	World Average (Chapman 1996-UNESCO/WHO/UNEP as cited by Thomas *et al* 2005)	World Average (Chapman 1996-UNESCO/WHO/UNEP)
Minerals				
Calcium (Ca) (mg/kg)				23,600
Phosphorus (P) (mg/kg)				1,400
P_2O_5		0.53	0.5	
Potassium (K) (mg/kg)				20,900
Silicon (Si) (mg/kg)				274,000
Sodium (Na) (mg/kg)				6,900
Metals				
Aluminium (Al) (mg/kg)				91,000
Antimony (Sb) (mg/kg)	15			
Arsenic (As) (mg/kg)	85	6.7	8	8
Barium (Ba) (mg/kg)	160			600
Beryllium (Be) (mg/kg)	1.1			
Cadmium (Cd) (mg/kg)	14		0.3	0.3
Chromium (Cr) (mg/kg)	380	732	120	120
Cobalt (Co) (mg/kg)	240			20
Copper (Cu) (mg/kg)	190	81	50	50
Gallium (Ga) (mg/kg)		28		
Iron (Fe) (mg/kg)				51,800
Lead (Pb) (mg/kg)	580	11	40	40
Manganese (Mn) (mg/kg)				1,000
Mercury (Hg) (mg/kg)	10			
Molybdenum (Mo) (mg/kg)	200			
Nickel (Ni) (mg/kg)	210	486	80	80
Rubidium (Rb) (mg/kg)		16		
Selenium (Se) (mg/kg)	0.7			
Strontium (Sr) (mg/kg)		483		
Thallium (Tl) (mg/kg)	1			
Tin (Sn) (mg/kg)	19			
Titanium (Ti) (mg/kg)				5,800
Vanadium (V) (mg/kg)	42			
Yttrium (Y) (mg/kg)		30		
Zinc (Zn) (mg/kg)	2000	200	110	110
Zirconium (Zr) (mg/kg)		207		
Polyaromatic hydrocarbons (PAHs)				
Halogenated hydrocarbons				

Parameter	River Sediments			
	Dutch intervention values for soil and sediments[1]	**Lebanon and Syria (Thomas *et al* 2005)**	**World Average (Chapman 1996-UNESCO/WHO/UNEP as cited by Thomas *et al* 2005)**	**World Average (Chapman 1996-UNESCO/WHO/UNEP)**
Hexachlorobenzene (HCB)		2 samples average = 0.03 ppb		
Pesticides				
Chlorine Pesticides				
pp'-DDE (ppb)		2.02		
pp'-DDT (ppb)		3.84		

[1] Values for soil/sediment are expressed as the concentration in a standard soil (10% organic matter and 25% clay).

APPENDIX H – MANDATES OF THE DIFFERENT INSTITUTIONAL PUBLIC STAKEHOLDERS AND ROLES OF NON-PUBLIC STAKEHOLDERS

Table H-1. Mandates of the Institutional Public Stakeholders

Stakeholder	Type	Role & Responsibilities
Council for Development and Reconstruction (CDR)	Central Government	The Council for Development and Reconstruction was established on 31 January 1977 by virtue of the legislative decree 5. Main tasks of the CDR are the planning functions within the objectives of development in addition to the preparation of studies and research concerning development and reconstruction which includes solid waste and waste water management. Specifically CDR's goal is to formulate a plan and a time schedule for resuming the reconstruction and development, guarantee the funding of projects presented, supervise their execution and utilisation by contributing to the process of rehabilitation of public institutions, therefore enabling it to assume responsibility for the execution of a number of projects under the supervision of the Council of Ministers. Contrary to other authorities, CDR avoids the routine administrative issues to accelerate the process of projects' execution. CDR's funding sources are development partners' funds, regular projects' subsidies granted by line ministries, transfers coming from budget and treasury, and municipalities through the Independent Municipal Fund. CDR is trying to increase soft and long term loans from multilateral, bilateral and commercial banks. CDR's spending summed US$8.95 Billion from 1992 to 2008 where US$3.1 Billion were spent between 1999 and 2008 with an annual average of US$560 Million.
Litani River Authority (LRA)	Regional Governing Institution	The Litani River Authority was established in 1954 by the virtue of a law for the purpose of the execution of the Litani project schemes: irrigation, drinking water and power generation. Decree 9631 dated 13 December 1996 expanded the tasks of LRA to include planning, studying, managing and investing the irrigation water in the middle and north Bekaa including the Yammouneh project, Wadi Massa and Yahfoufa in addition to all small projects located between the Damascus International Road and the southern Lebanese borders. The study of the construction of Bisri Dam and Ebel El Saki Dam on the Hasbani River were merged under the LRA mandate (LRA website). Competencies of the LRA also include agricultural research, rural development, studies and construction of dams and irrigation projects, the management of hydrometric gauge stations on all the Lebanese rivers, in addition to the monitoring and the prevention of pollution.
Bekaa Water Establishment (BWE) & South Lebanon Water Establishment (SLWE)	Regional Governing Institution	Law 241 issued in August 2007 amended Law 221 dated May 2000 by creating one water establishment in the Bekaa instead of the two north and south Bekaa water establishments. The tasks of the BWE are to: - Carry out studies, implementation, operation, maintenance and renewing of projects for drinking and irrigation water distribution, (except for irrigation water in the South and South Bekaa that remains under the responsibility of the LRA), within the frame of a General Master Plan and with the MOEW's prior permission to use public water resources. - Suggest tariffs for drinking and irrigation water services. - Monitor the quality of the distributed drinking and irrigation water. The establishment is managed by a board of directors including a President and six members.
Ministry of Energy and Water (MoEW)	Central Government	The Ministry of Energy and Water is responsible for the preparation and implementation of a framework water policy, master plan, hydraulic and electric projects equipping, in addition to the sponsorship of autonomous authorities and control of concessionary companies. The Ministry's tasks include the application of laws and regulations relative to the protection of public water and its exploitation.

Stakeholder	Type	Role & Responsibilities
Ministry of Environment (MoE)	Central Government	The Ministry of Environment was created in April 1993 by virtue of Law 216. Major roles of the MOE include: - Formulating laws and specifications, a general strategy, and long-term plans for environmental management and natural resources use. - Developing detailed plans for environmental protection, including monitoring plans, and control of all sorts of pollution caused by solid waste, industrial waste, domestic wastewater, and air pollutants. - Defining requirements and conditions for issuing permits for the construction of industrial establishments and plants, industrial zones, various kinds of animal farms, quarries, and cemeteries. - Monitoring and supervising waste treatment and disposal through its Service of Protection of the Urban Environment. - Dealing with the violations of the set requirements through the Department of Control. MOE's average annual budget allocation of US$2 Million (1999-2008) is one of the smallest among all ministries and public institutions. Only 3% of the Ministry's Budget is allocated for studies and monitoring and the rest is earmarked for administration (WB-CEA 2010).
Ministry of Industry (MoI)	Government	The Ministry of Industry was created by virtue of Law 642 in 1997. Decree 13173/1998 gave the MOI through the Department of Industrial Permits the tasks of: - Proposing the establishment of industrial cities and zones - Commenting on all industrial projects and their designs - Preparation of studies, proposals, and decrees related to the classification of industrial zones and industries Decree 5243/2001 gave the MOI the responsibility of verification of the waste management measures taken by industries to protect public health and prevent pollution of surface and groundwater. Decree 9675 dated March 2003 gave the MOI the responsibility of conducting regular inspections to check the compliance of industrial facilities with the conditions specified in their permits.
Ministry of Agriculture (MoA)	Central Government	The Legislative Decree 97 dated 13 September 1983 gave the MOA the responsibility for the general management of the agricultural sector. Decree 5246/1994 added to the Ministry's tasks those of monitoring the slaughterhouses' compliance with technical and health conditions. The MOA is responsible for supervising the food, animal, and herbal industry and its packaging in addition to suggesting the best sanitary conditions. The MOA is also responsible for supervising the pesticides during their manufacturing process and disposal (Legislative Decree 31/1955) in addition to monitoring pesticide use. Moreover, the MOA's role is to provide farmers with appropriate extension and training services and introduce modern on-farm irrigation methods and techniques.
Office of the Minister of State for Administrative Reform (OMSAR)	Central Government	OMSAR is implementing awareness campaigns related to solid wastes management to encourage the public to participate in sorting household waste at its source while engaging the municipalities. The target is to improve waste management with the help of the local people, thus introducing the concept of sustainable development to civil society.
Ministry of Interior and Municipalities (MoIM)	Central Government	The Internal Security Forces Members and the Municipalities' Police are responsible for controlling violations of environmental permits, including those concerning solid waste management requirements.

Stakeholder	Type	Role & Responsibilities
Municipalities and Unions of Municipalities	Local Government	Municipalities are the elected local government and represent individual water users. The legislative decree 118 dated 1977 gave the Unions of Municipalities a lot of authority within their municipal boundaries. Unions of Municipalities are responsible for physical development plans in their jurisdiction like cleanliness and public health issues, water works, sewage networks, licensing sewage connections, public transport, urban projects as well as local tax collection. They may implement urban master plans with the approval of the Directorate General of Urban Planning, provided they can raise the necessary funding. Municipalities have the right to establish in their territories waste treatment and disposal facilities. They are also responsible for controlling the violations occurring due to improper wastewater management and disposal practices.
Ministry of Finance (MoF)	Central Government	The Ministry's role is to develop and maintain a stable economic environment in addition to facilitating cooperation among public agencies through finance.
Ministry of Economy and Trade (MoET)	Central Government	The General Directorate supports the production of grains and sugar beets through subsidies. It may also purchase the locally produced wheat from Lebanese farmers according to a decree issued by the Council of Ministers which determines the purchase price of the local wheat.
Ministry of Public Health (MoPH)	Central Government	The protection and improvement of public health is the responsibility of the MOPH. Decree 8377 dated 30 December 1961 gave the Ministry the responsibility of: - Supervising private health care institutions - Drafting and proposing laws - Proposing amendments to existing laws relevant to public health. Other tasks of the Ministry include: - Carrying out studies and developing action plans aiming at protecting the environment from factors that threaten public health - Developing technical specifications for public and private sewage networks, potable water supply networks, and collection and disposal of solid waste projects.
Lebanese Agricultural Research Institute (LARI)	Research Institute	Located in Tal Amara (Riyaq), LARI is a governmental organisation under the supervision of the Minister of Agriculture. LARI conducts applied and basic scientific research for the development and advancement of the agricultural sector in Lebanon. In addition, the Institute keeps close ties to the farmers and tries to develop research activities aiming at solving their problems. The LARI has at its disposal eight experimental stations. LARI participates in cooperative research projects and provides the following services: - Direct public services related to modern technological needs in the farming society and by the Lebanese public - Organisation of extension services for farmers, including field days and extension booklets - Implementation of the National Research Strategy
National Council for Scientific Research (NCSR)	Research Institute	The National Council for Scientific Research (NCSR) is a public institution established in 1962 and assigned with the task of formulating the national science and technology policy, initiating, guiding, supporting and conducting scientific research programmes and activities in Lebanon. It advises the Government on all science and technology issues. The NCSR conducts research through its specialised centres and supports research projects having an impact on the socio-economic development of the country. The NCSR has an active co-

Stakeholder	Type	Role & Responsibilities
		operation programme with various ministries, public institutions, international organisations and academic institutions.

Sources: SELDAS 2004; CDR website; LRA website; Comair 2007; BAMAS 2005 (Rapid Review Report); Catafago; LARI website; MOF website; WB-CEA, 2011

Table H-2. Roles of Other Stakeholders

Stakeholder	**Type**	**Role & Responsibilities**
American University of Beirut's Agricultural, Research and Education Center (AREC) in Hawch Sneid (North Bekaa)	University	AREC is a multifunctional and interdisciplinary centre devoted to the improvement of rural livelihoods in the drylands. Located in Hawch Sneid, AREC includes a research farm, an agricultural library, a clinic, several staff resident houses, a student cafeteria and dormitories, classrooms, laboratories, a weather station, a seed bank, cold storages, workshop, and recreation and sports facilities. A good portion of the land is devoted to teaching, research, and demonstration in the production of fruits, vegetables, cereals, forage and various other field crops, while the rest of the farm is used to produce locally adapted crops. The 100-hectare farm serves students to obtain practical experience in various sectors of agriculture.
St. Joseph's University (USJ) School of Agriculture in Taanayel (Central Bekaa), Lebanese International University (LIU) in Khiyara (West Bekaa)	University	Agriculture faculties at the universities play a major role in research and studies related to agriculture where they highlight issues related to the use of pesticides emphasising on the pollution of irrigation water sources which affect the quality of cultivated crops.
International and Local NGOs	NGO	The roles of international NGOs such as the U.S. Agency for International Development (USAID), Deutsche Gesellschaft für Internationale Zusammenarbeite (GIZ previously GTZ), Italian Cooperation in Lebanon, among others and local NGOs are reviewed in Appendix I.
Association of the Friends of Ibrahim Abd El Al (AFIAL)	NGO	The Association aims at promoting the objectives that guided Ibrahim Abd El Al throughout his professional work, namely the development of hydraulic and power projects in Lebanon as part of a planned vision at the national scale and as an Integrated Water Resource Management (IWRM). The Association aims to develop the potential of the decision makers and the public through awareness raising campaigns in order to strengthen public understanding of water issues and is actively involved in organising water management events.
International Banks	Financing Institution	The Islamic bank is funding the wastewater collection and treatment project in Joub Jannine, Saghbine and neighbouring villages. The role of the Islamic Bank and other international banks are reviewed in Appendix I.
Agricultural Banks	Financing Institution	Agricultural banks contribute to the improvement of the products and crops by providing the required financial aids requested by the farmers.
The Chamber of Commerce, Industry and Agriculture of Zahlé and the Bekaa (CCIAZ) and The Chamber of Commerce, Industry and Agriculture in Sidon and South Lebanon (CCIAS)	Private agent	The CCIAZ and CCIAS represent in general the interests of the commercial, industrial and agricultural sectors in Lebanon, provide information, proposals and projects aiming at the development of the Lebanese economy to government departments and affiliated members, facilitate contacts between members and local authorities and foreign embassies, resolve disputes among members by means of reconciliation or arbitration, deliver certificates of origin, validate bills and documents as well as the signatures of registered members, and provide information about the dates and venues of international exhibitions. The CCIAZ & CCIAS contribute, within their capabilities and competences, to the economic development of the Bekaa & South Lebanon region and promotion of its members' activities at the local, regional and international levels.

Stakeholder	Type	Role & Responsibilities
The Association of Lebanese Industrialists (ALI)	Private agent	The Association of Lebanese Industrialists is a Lebanese economic organisation grouping industrialists from all over Lebanon. ALI advocates a policy of balanced industrial development for all Lebanese regions. The Association seeks to create and maintain an environment which is favourable to industrial investment, growth and development. Considering that industry in Lebanon, except for cigarettes' manufacturing, is purely private, the Association's role becomes even more significant.
Agricultural Input Firms, Service Providers and Distributors	Private agent	Agricultural products suppliers are key players in the process of transferring the fertilisers and pesticides to the farmers. In the absence of extension programmes, they play a major role in guiding the farmers on the proper practices while applying fertilisers and pesticides.
Individual Farmers	Private agent	They play the most important role in practicing the right procedures and applying the recommended dosage of fertilisers and pesticides, thus minimising the pollution of groundwater resources, soil and crops.
Farmers' Cooperatives	Private agent	Farmers' coops can benefit from sharing of the use of machinery, seed funding from the Government and special tax breaks. Their role is portrayed through the representation of the collective demands of the farmers.
Owners and managers of industrial facilities in the catchment area	Private agent	Owners and managers of industrial facilities can aim for cleaner production and put the prevention of pollution as their target for the future.
Owners and managers of tourism and recreational facilities in the catchment area	Private agent	They play a role in keeping their surroundings clean by applying clean practices in managing the solid waste and wastewater generated by their facilities.

Sources: GIZ Website; AFIAL Website

APPENDIX I – SOURCES OF NATIONAL AND DONOR FUNDING: CAPACITIES AND PROGRAMMING

Table I-1. National and International Donor Programming and Information

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
1	Abu Dhabi Fund for Development (ADFD)	Operating	Bainuna St. P.O.Box 814 Al-Bateen Area Abu Dhabi - UAE Tel: +97126677100 Fax: +97126677070 info@adfd.ae www.adfd.ae	Abu Dhabi Fund for Development is an autonomous institution owned by the government of Abu Dhabi. Since its establishment, ADFD has embarked on partnership with both public and private sectors in 53 countries to support various development projects. These span a wide range of sectors including infrastructure, agriculture, electricity and water, transportation, industry, social & healthcare services, tourism & hospitality, telecommunications and technical support.	To help developing countries achieve sustainable economic growth and reduce poverty by providing financial resources, forging partnerships in the public and private sectors, and adopting international best practices to ensure aid effectiveness.	Water, land use and environment, and transportation projects	Concessionary loans, developments grants and equity participation	Infrastructure, agriculture, electricity and water, transportation, industry, social & healthcare services, tourism & hospitality, telecommunications, and technical support.

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
2	Agence Française de Développement (AFD)	Operating	Ambassade de France au Liban, Espace des Lettres, Bâtiment K Rue de Damas Beyrouth - LIBAN Tel: +9611420150 +9611420192 Fax: +9611611099 afdbeyrouth@afd.fr www.afd.fr	AFD acts as a representative of the French Fund for Global Environment (FFEM). The FFEM is a bilateral fund which promotes global environment through projects for economic and social development. AFD executes the French government's development aid policies.	- To fight poverty, support economic growth, and promote and protect global public goods in developing and emerging countries and the French Overseas Communities. - To improve living conditions, bolster economic recovery and protect the planet.	Water, economic security, and project management and capacity	Public authorities, the private sector and local associate networks can apply for funding. AFD provides subsidies, loans, guarantees, and equity. The project ideas should be conceived by the contracting authority and submitted to the local AFD office.	Primary-school education, support for farmers, water supply, infrastructure construction, preservation of tropical forests, and fighting climate change
3	Arab Authority for Agricultural Investment and Development (AAAID)	Operating	Regional Office: AAAID P.O. Box 51250 Dubai - UAE Tel: +97146032555 Fax: +97146032510 info@aaaid.org www.aaid.org	In the strategy of 2002-2012, interactions with the Arab agricultural development institutions are one of the goals. The Arab Authority for Agricultural Investment and Development (AAAID) gives priorities to projects that can effectively contribute to the production of the main food items according to the size of the food gap and comparative	- Contributing to achieving Arab food security. - Development of agricultural resources in Arab member states with emphasis on the production of the maximum possible amounts of food. - Increasing the exchange of agricultural products and inputs between Arab Countries.	Projects under Study: - Milk Collection and Processing in Bekaa - Olive Oil Production and Distribution	Promotion, financing and implementation of projects, research, studies and other activities	Agricultural production: Agriculture processing, services & research; plant production; animal production.

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
				advantage in the production of those products.				
4	Arab Fund For Economic & Social Developm ent (AFESD)	Operating	H.E. Mr Abdulatif Youssef Al-Hamad Director General / Chairman of the Board of Directors P.O. Box 21923 SAFAT 13080 Kuwait State of Kuwait Tel: +96524959000 Fax: +96524850/60/71 hq@arabfund.org www.arabfund.org	The principal purpose of the Arab Fund is to contribute to the financing of economic and social development projects in the Arab countries. To attain this purpose, the Arab Fund provides financing for economic development projects by extending loans, on concessionary terms, to governments and public corporations and enterprises of member states, giving preference to projects which are vital to the Arab World and joint Arab projects. It serves as a catalyst for	- Financing economic and social development projects - Financing private sectors projects - Providing expertise and technical assistance - Encouraging investment - Establishing and administering special funds whose purposes are compatible with Arab funds and whose resources are provided by the Fund or other sources	- Electricity Sector: KWD 35 million - Damaged Infrastructure: KWD 30 million - Support for administrative reforms: KWD 9 million - Water & wastewater: KWD 25 million	- The Fund's assistance takes various forms, including direct loans, equity investment, guarantees, and lines of credits, other financing forms, as well as institutional support and advisory services. - Loans for financing economic development projects are provided on concessionary terms to governments and to public enterprises and corporations, giving preference	Economic and social development, transport & telecommunications, energy & electricity, water & wastewater

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
				encouraging investment, directly or indirectly, of public and private capital in a manner conducive to the development of the Arab economy and provides expertise and technical support in the various spheres of economic development.			to projects which are vital to the Arab world, as well as joint Arab projects - The Fund also allocates grants that contribute to its undertaking of feasibility studies and preparing projects, in addition to developing educational and health services, member states' goals including and carrying out population censuses.	
5	Arab Gulf Program for the Support of the United Nations Development Commissions (AGFUND)	Operating	Prince Sattam Street, Fakhiriya, Riyadh11415, Saudi Arabia Tel: +96614418888 Fax: +96614412962/63 prize@agfund.org www.agfund.org	The Arab Gulf Program for Development (AGFUND) is a regional organisation based in Riyadh, Saudi Arabia. AGFUND was established in 1980 upon the initiative of His Royal Highness, Prince Talal Bin Abdul Aziz Al Saud with the support of leaders of the Gulf Cooperation Council Countries: United Arab Emirates,	- To contribute to the reduction of misery and the eradication of poverty focusing on the support of vulnerable and disabled groups. - To enrich the knowledge and enhance the skills of needy social segments and help them meet requirements of the labour market by increasing their access to decent work opportunities. - Providing the essential	Social & economic development projects	All the financial assistance is in the form of grants and all projects are prepared and carried out by one of the 15 UN organisations	Poverty, education, health, childhood, women, human rights, special needs, civil society, and natural disasters.

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
				Kingdom of Bahrain, Kingdom of Saudi Arabia, State of Qatar, Sultanate of Oman and the State of Kuwait.	methods for the development of women and children, by giving them access to existing public services, and by giving them the means to exercise their rights. - To encourage innovation and modernization through the implementation of its programs, AGFUND provides support to vulnerable groups to help facilitate their full access to basic and fundamental social needs such as education and health care. Under the umbrella of fair national and international legislations towards the prevailing of security in the areas of human development by focusing on issues and concerns related to vulnerable groups evacuated from their homes due to living circumstances similar to catastrophic natural conditions or war and security situations. - To initiate pioneering programs that can serve as an example and a			

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
					model in various areas of human development.			
6	Association for the Development of Rural Capacities (ADR)	Operating	Hamra Street, Piccadilly Centre, 6th floor, room 601 Beirut – Lebanon Tel/Fax: +9611742046 Ali.ezzddine@adr.org.lb Adriana.doumet@adr.org.lb Rosa.rodriguez@adr.org.lb Nisrine.elteryaky@adr.org.lb www.adr.org.lb	ADR's mission is to empower the marginalized and help them make a better living through economic and social development projects.	- Give access to training, tools, information and financial services. - Give better access to labour market and help to set income generating projects. - Encourage partnership and decentralized cooperation.	Vocational Training for Former Detainees, Capacity Building for Small Agro-Tourism Businesses, Assistance program for working children and growers of tobacco plantations in south Lebanon, Assessment and recommendations on agricultural practices and policies in South Lebanon	Financial and Projects	Agriculture, micro credit, vocational training, and social services
7	Associazione Volontari per il Servizio Internazionale (AVSI)	Operating	Riad El Solh, Stephan Building, Beirut Tel/Fax: +9611637748 info-avsi@avsi.org www.avsi.org	Not-for-profit, non-governmental organisation, founded in Italy in 1972 and presently active in 39 countries of the world, with more than 100 development cooperation projects.	To support human development in developing countries with special attention to education and promotion of the global dignity of every person, according to the Social Teaching of the Catholic Church	- Programme of rehabilitation and reorganisation of the health system in North Lebanon and the rehabilitation of the Quarantina Hospital in Beirut - Service centre for farmers and ranchers - Centre for training and technical assistance to farmers and agricultural farmers in the region of Jbeil	Financing projects and activities	Health and sanitation, care of children in difficult conditions, education, vocational training, upgrading of informal urban areas, agriculture, environment, promotion of small businesses, food security, ICT, and emergency relief

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
8	Australian Embassy, Lebanon/ Direct Aid Program	Operating	Embassy Complex, Serail Hill, Downtown Beirut, Lebanon Tel: +9611960600 Fax: +9611960601 austemle@dfat.gov.au www.lebanon.embassy.gov.au/birt/development_cooperat.html	The Direct Aid Program (DAP) of the Australian Embassy focuses on relieving humanitarian hardship and advancing developmental objectives in Lebanon through projects that are consistent with the international relations and public diplomacy objectives of the Embassy.	To relief humanitarian hardship and advancing developmental objectives in Lebanon through projects that are consistent with the international relations and public diplomacy objectives of the Embassy.	Direct Aid Program funded the purchase of equipment like computers, wheel chairs, medical equipment, furniture...	Grants/An internal committee of the Embassy assesses proposals for small development projects from individuals, community groups and non-government organisations engaged in development activities on a not-for-profit basis. Government bodies are not eligible for funding under the Direct Aid Program.	Poverty alleviation, community sanitation, environment and education, basic human rights, rural development and gender equality
9	Canadian International Development Agency (CIDA)	Operating	The Embassy of Canada43 Jal El Dib Highway, Coolrite Bldg.Beirut, Lebanon Tel: +119614713 900 Fax: +119614711664 beirut@international.gc.ca www.cida.gc.ca	The Canadian International Development Agency (CIDA) is the principal vehicle of Canada's official development assistance around the world, committed to supporting sustainable development, reducing poverty and providing humanitarian assistance in order to promote a more	- To manage Canada's support and resources effectively and accountably to achieve meaningful, sustainable results;- To engage in policy development in Canada and internationally, enabling Canada's effort to realize its development objectives.	$7.5 million Canadian Fund for Social Development managed by Oxfam-Québec. The fund contributes to small projects proposed by local communities and organisations with the goal of contributing to the economic and social well-being of people in rural and semi-urban areas.	Grants	Democratic governance, Private sector development, Health, Basic education, Gender Equality, Environmental sustainability

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
				secure, equitable and prosperous world.				
10	CARE International	Operating	Lebanon office: Tannous tower, Dora highway, 3rd floor Headquarters (Atlanta, USA): Mailing Address: CARE USA P.O. Box 7039 Merrifield, VA 22116 Tel: +14046812552 www.care.org	CARE tackles underlying causes of poverty so that people can become self-sufficient. Recognising that women and children suffer disproportionately from poverty, CARE places special emphasis on working with women to create permanent social change. Women are at the heart of CARE's community-based efforts. CARE also delivers emergency aid to survivors of war and natural disasters, and helps people rebuild their lives.	To improve basic education, prevent the spread of HIV, increase access to clean water and sanitation, expand economic opportunities and protect natural resources.	- 2006: Distributing relief supplies in three Beirut suburbs. - 2007: Providing aid to civilians caught in an on-going confrontation between the Lebanese Army and militants of the Fatah al-Islam faction.	Financing projects and activities	Agriculture and Natural Resources, Economic Development, Education, Emergency Relief, Health, HIV/AIDS, Nutrition, Water

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
11	Cooperative Housing Foundation (CHF International)	Operating	Jnah, Adnan El Hakim Street, Mubarak Bldg. 3rd floor, Beirut, Lebanon Tel: +9611853263 Fax: +9611853262 cdl@cyberia.net.lb office@chflebanon.org www.chflebanon.org	CHF International is a non-profit development organisation that is dedicated to helping thousands of clients each day improve their economic conditions from the bottom up.	To be a catalyst for long-lasting positive change in low- and moderate-income communities around the world, helping them to improve their social, economic and environmental conditions.	Since 1997, CHF International has been working in a wide variety of programmatic arenas in Lebanon, ranging from quick impact projects to more complex economic development and education programming.	Financing projects and activities	Economic Development, Global Health, Emergency Response and Transition, Governance and Civil Society, Housing and Infrastructure, and Urban Development
12	Danish Embassy	Operating	Royal Danish Embassy Embassy Complex Army Street, Sérail Hill Down Town P.O.Box 11-5190 Beirut Tel: +9611991001/2/3 Fax: +961 1 991 006 beyamb@um.dk www.um.dk	The Danish-Arab Partnership Programme was launched in 2003 by the Danish Government with the objective to establish a basis for improved dialogue, understanding and cooperation between Denmark and the Arab region and to support existing local reform processes in the Middle East and North Africa.	The Millennium Development Goals are the guideline for Danish development policy	The Danish government is through its membership of the EU contributing financially to the European Commission's projects, including ECHO's projects, in Lebanon. In addition to the general contributions to a number of UN agencies (present in Lebanon) such as UNDP, UNRWA, UNICEF, WHO and UNHCR, the Danish government is also contributing to specific UN relief and humanitarian activities and NGOs working in Lebanon.	Grants	Media, youth, human rights, labour and women's programmes
13	Deutsche Gesellschaft für Internationale Zusamme	Operating	Syria Office/ Branch Beirut Syria Address: Abo Romane Mahde bin Barake Str. 26	Established on 1 January 2011, it brings together under one roof the long-standing expertise of the Deutsche	- Economic development and employment - Governance and democracy - Health, education,	- 2008 to 2011: Assistance to the Water Sector Reform in Lebanon, water supply and wastewater management services of	Grants and technical assistance	The following programmes and projects have been agreed for German-Lebanese cooperation:

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
	narbeite (GIZ)		Damascus - Syria Tel: +9613818440 Fax: +961692794 hana.nasser@gtz.de www.giz.de	Entwicklungsdienst (DED) GmbH (German Development Service), the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (German technical cooperation) and Inwent – Capacity Building International, Germany. GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development and international education work around the globe.	social protection - Water, energy, transport - Rural development - Environment and climate change - Security, reconstruction and peace	measurably improved quality - GIZ is helping the MOEW in water sector reform in Lebanon to improve the quality of water supply and wastewater management. In this context, an inventory of water supply systems in the Bekaa valley was completed, providing reliable data for planning and expanding water supply services. - 2007 to 2010: Environmental Fund for Lebanon (EFL) for the reduction of environmental risks and economic impacts of the war in Lebanon – Through the EFL, GIZ is implementing the following projects: - Enhancing the economic status of farmers using the land around the Kfar Zabad Hima through the adoption of environmentally friendly agricultural practices. - Co-financing pre-treatment of industrial wastewater discharges in the Litani River catchment.		- Promotion of vocational training and the development of SMEs - Assistance to the Water Sector Reform - Environmental Fund for Lebanon - Border management - Three international programmes and projects for vocational training, integrated development of the water resources and for promoting implementation of the United Nations Convention to Combat Desertification (UNCCD)

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
14	Economic and Social Commission for Western Asia (ESCWA)	Operating	P.O. Box 11-8575, Riad el-Solh Square, Beirut, Lebanon Tel: +9611981301 Fax:+9611981510 webmaster-escwa@un.org www.escwa.un.org	ESCWA forms part of the United Nations Secretariat and, similar to the other regional commissions, operates under the supervision of the United Nations Economic and Social Council.	- To support economic and social development in the countries of the region - To promote cooperation between the countries of the region; - To encourage interaction between member countries and promote the exchange of experience, best practice and lessons learnt - To achieve regional integration between member countries - To ensure interaction between Western Asia and other regions of the world, familiarizing the outside world with the circumstances and needs of the countries of the region.	- Assessment of gender inequality in agriculture and agro-food processing industries in Lebanon. - Informing policy development in this area and identify areas for future policy-relevant research. - Assisting in the socio-economic development of the post-occupied areas in the South.- Establishment of two development centres in Marjeyoun and Kfar Kila	Grants and Studies	Energy, water resources, productive sectors, social development, economic development and globalization, statistics, and emerging and conflict-related issues.

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
15	Embassy of Germany	Operating	Maghzal Building close to Jesus-and-Mary-School Rabieh, Lebanon Tel: +9614935000 Fax: +9614935001 info@beirut.diplo.de www.beirut.diplo.de	Economic cooperation is part of the bilateral relations between Germany and Lebanon. However, there is no bilateral framework agreement between the governments of Germany and Lebanon in the field of economic cooperation and development; financial protocols in this field have not been signed.	To promote bilateral relations between Germany and Lebanon.	Germany's bilateral assistance until summer 2006 comprised €42.3 million for financial cooperation (loans) and approximately €23.2 million (grants) for technical cooperation. This does not include Germany's substantial contribution to the EU program. In addition, an amount of approximately €132 million has been disbursed since 1990 for general development cooperation and humanitarian aid, mainly via German NGOs and autonomous institutions like churches, universities and relief agencies	Grants/ Loans. The Embassy has a yearly budget of app. 40.000 Euro for projects within the framework of the small grants programme. During a year, approximately five projects can be supported. Social institutions, authorities, churches, associations or other non-governmental organisations can be granted a fund for a specific project. Project proposals should be handed in at the Economics Section of the Embassy.	Socio-economic multiplier-effects and capacity building
16	Embassy of Norway	Operating	Embassy Complex, Serail Hill. P.O. Box 113.7001, Hamra 1103-2150 Beirut, Lebanon Tel: +9611960 000 Fax: +9611960 099 emb.bey@mfa.no			- US$ 1.05 million to Mines Advisory Group (MAG) - US$ 0.54 to UNDP-Lebanon to contribute to free, fair & transparent elections, promote democracy and enhance citizens' participation in the decision making process	Grants	

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			www.norway-lebanon.org			in Lebanon - US$ 0.85 to meet a shortfall in the budget for humanitarian purposes in Nahr El Bared		
17	European Commission (EC)	Operating	490 Harbour Drive bldg., Charles Helou Ave., Saifi - Beirut P.O.Box 11-4008 Riad el Solh, Beirut 11072150 Tel : + 961-1- 569 400 Fax: + 961-1- 569 415 delegation-lebanon@eeas.europa.eu http://ec.europa.eu/delegations/lebanon	The Commission is both the institution and the 'college' of commissioners. There is currently one commissioner from each EU country.	Avoiding the emergence of new dividing lines between the enlarged EU and its neighbours and instead strengthening the prosperity, stability and security of all. The Association Agreement Article 51 states that the Parties encourage industrial cooperation centred on developing agricultural water resources.	€105 million grants being executed for the recovery and reconstruction. In the context of the European Neighbourhood Agreement, €46 million worth of projects signed including support to socio-economic and political reforms, traffic control, support to municipalities, scholarship fund for Palestinian refugees in Lebanon, facilitating access to credit and demining	- 2011-2013: An indicative ENPI envelope of €150 million announced by the Commission/ EU-Lebanon action plan. - The EU's financial assistance will be provided under the European Neighbourhood Partnership Instrument (ENPI), planned for 2007-13. - The maximum rate of co-financing will be up to 75% of the total eligible costs in most regions.	The main goal of EU – Lebanon long standing partnership is to promote the development of Lebanon as a democratic, politically open and economically strong neighbour of the EU - Develop the transport, energy, water and information society sectors and networks through sector liberalization, investment in infrastructures and interconnection with EU networks. - Protect surface and ground water resources from all sources of pollution.

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18	European Investment Bank (EIB)	Operating	98-100, Boulevard Konrad Adenauer L-2950 Luxembourg Tel: +35243791 Fax: +352437704 press@eib.org www.eib.org	The EIB furthers the objectives of the European Union by making long-term finance available for sound investment. The European Investment Bank's operations in the Mediterranean partner countries have been brought together under the Facility for Euro-Mediterranean Investment and Partnership (FEMIP)	- To finance viable capital projects which further EU objectives - To borrow on the capital markets to finance these projects	Existing projects in the water & wastewater sector, ports and roads amounting to US$260 million.	- It is part of the EIB pledge to lend €960 million in the next five years following the Paris III conference (2007) on the reconstruction and development of Lebanon. - The Technical Assistance Support Fund utilises non-repayable aid granted by the European Commission in support of EIB investment activities in the southern Mediterranean countries - Forms of technical assistance include pre-feasibility or feasibility studies for investment projects relating to the private sector, water and wastewater, the environment, transport and communications, education and health	Water, wastewater, the environment, transport and communications, education, health, and road infrastructure

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							- EIB loans are available for public and private sector bodies and enterprises. The EIB will finance up to 50% of the total project cost.	
19	Fares Foundation (Lebanon)	Operating	Fares Foundation bldg. Maameltein Highway Jounieh - Lebanon Tel: +9619639987/8 Fax: +9619639991 ffinfo@fares.org.lb www.fares.org.lb	The Fares Foundation is a private, non-profit institution active in the fields of human and social development in Lebanon. It pays particular attention to underprivileged groups, communities and regions.	To pay particular attention to underprivileged groups, communities and regions	Programmes and services in health, education, humanitarian aid, culture, infrastructure, research, and conferences	Executing projects, Grants	Health, education, social, cultural, infrastructure, research, conferences
20	Food and Agriculture Organisation of the United Nations (FAO)	Operating	Rayess Bldg. Rayess Street Tallet El-Rayess Baabda Tel: +9615924007 Fax: +9615922128 fao-lb@fao.org www.fao.org	The Food and Agriculture organisation of the United Nations leads international efforts to defeat hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information.	- To put information within reach - To share policy expertise - To provide a meeting place for nations - To bring knowledge to the field	Some of the financed projects are: - Development of a GCP-project proposal for a national reforestation programme in Lebanon - Promoting Mountain Quality Products - Modernisation of Irrigation Systems - Recovery and Rehabilitation of Dairy Sector in Bekaa Valley and Hermel-Akkar Uplands - Re-use of treated effluent and sludge at Iaat WWTP - Regional Initiative for	Grants under the technical cooperation programme, trust funds, government cooperative programme, unilateral trust fund, and telefood programme activities.	Agriculture, forestry and fisheries

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						Obsolete Pesticide Management - Rehabilitation of a poultry house in Jrabta		
21	Friedrich-Ebert-Stiftung (FES)	Operating	Friedrich Ebert Stiftung Beirut, Lebanon Tel/Fax: +9611320080 feslb@feslb.org www.feslb.org	With its presence in Lebanon the FES focuses on contributing to the development of socio-economic policies and improving environmental awareness	- Promoting the integration of civil society in the context of a local, regional and international socio-political dialogue. - Implementing principles of good governance within the field of municipal politics. - Improving the work and supporting the rights of trade unions.	Supporting NGOs	- Organising conferences, seminars, workshops and training courses; - Supporting research projects and publications; - Financing short-term experts as well as visiting and consulting programmes.	Consulting, training and advanced training courses, information and resources.
22	Global Environment Facility (GEF)	Operating	Lebanese Environment Forum, Ain El Rummanah, El Arid Road, Najjar Building, 2nd floor, Beirut, Lebanon Tel: +9611382332 Fax: +9611386570 gefweb@thegef.org www.thegef.org	The Global Environment Facility (GEF) unites 182 member governments - in partnership with international institutions, nongovernmental organisations, and the private sector - to address global environmental issues. Established in 1991, the GEF is today the largest funder of projects to improve the global environment. The GEF has allocated US$9.2	- Improve the sustainability of protected area systems; - Mainstream biodiversity conservation and sustainable use into production landscapes/ seascapes and sectors; - Build capacity to implement the Cartagena Protocol on Biosafety; - Build capacity on access to genetic resources and benefit-sharing; - Integrate CBD obligations into national planning processes	Land use and environment, Small Grants Programme	The GEF Small Grants Programme (SGP) provides support for community-level initiatives that contribute to conserving global biodiversity, mitigating climate change, protecting international waters, reducing impacts of persistent organic pollutants and preventing land degradation while generating	Biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants

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				billion, supplemented by more than US$40 billion in co-financing, for more than 2,700 projects in more than 165 developing countries and countries with economies in transition. Through its Small Grants Programme (SGP), the GEF has also made more than 12,000 small grants directly to nongovernmental and community organisations, totalling US$495 million.	through enabling activities.		sustainable livelihoods. The Scientific and Technical Advisory Panel provides technical and scientific advice on the GEF's policies and projects.	
23	Hariri Foundation for Sustainable Human Development	Operating	2nd floor. Soubra Bldg., Verdun P.O.Box 13-5742 Chouran, Beirut - Lebanon Tel: +9611792300 +9611803320 Fax: +9611793300 info@hariri-foundation.org www.hariri-foundation.org	The Hariri Foundation also serves as an umbrella organisation for many NGOs where it provides resources to smaller more specialised organisations.	Raising the Lebanese citizens' economic, social and cultural situation, through reinforcing the citizens' role in achieving sustainable human development.	Over the past thirty years, the foundation has implemented around 70 projects with more than 30 local, regional, and international partners	Executing projects with international and local partners	Education, Information Technology, Civic Engagement and Governance, Cultural Heritage and Tourism, Women Empowerment, Agriculture, Environment, and Relief Services

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24	International Fund for Agricultural Development (IFAD)	Operating	International Fund for Agricultural Development Via Paolo di Dono, 44 00142 Rome, Italy Tel: +390654591 Fax +39065043463 ifad@ifad.org www.ifad.org	The International Fund for Agricultural Development (IFAD), a specialized agency of the United Nations, was established as an international financial institution in 1977 as one of the major outcomes of the 1974 World Food Conference.	To ensure that poor rural people have better access to, and the skills and organisation they need to take advantage of: - Natural resources, especially secure access to land and water, and improved natural resource management and conservation practices - Improved agricultural technologies and effective production services - A broad range of financial services - Transparent and competitive markets for agricultural inputs and produce - Opportunities for rural off-farm employment and enterprise development - Local and national policy and programming processes	Agriculture and irrigation projects	Loans and grants. The Fund is committed to financing technical assistance in undertaking special studies or pre-investment projects in problem areas, e.g. in rain fed agriculture areas or drought-prone areas that hold prospects for future investment (among others).	Agriculture/ Increasing rural poor peoples' access to financial services, markets, technology, land and other natural resources.

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25	International Islamic Trade Finance Corporation (ITFC)	Operating	ITFC Islamic Development Bank Headquarters P.O. Box 55335, Jeddah 21534 Kingdom of Saudi Arabia Tel: +96626361400 Fax: +96626371064 info@itfc-idb.org itfc@isdb.org www.itfc-idb.org	The International Islamic Trade Finance Corporation (ITFC) is advancing trade to improve the economic situation and livelihoods of people across the Islamic world. As an autonomous entity within the Islamic Development Bank Group, the ITFC was formed to consolidate the trade finance business that was formerly undertaken by various windows within the IDB Group.	The ITFC helps businesses in Islamic countries gain better access to trade finance and provides them with the necessary education and training to compete successfully in the global marketplace. Its efforts are geared to building stronger trade relations between member countries and giving individuals opportunities to grow and prosper.	Power and education projects	Financial	Trade finance
26	International Monetary Fund (IMF)	Operating	Bourie Building, Abdullah Beyhum Street Downtown - Beirut Central District Tel: +9611972320 Fax: +9611972429 rr-lbn@imf.org www.imf.org	The International Monetary Fund (IMF) is an organisation of 187 countries, working to foster global monetary cooperation, secure financial stability, facilitate international trade, promote high employment and sustainable economic growth, and reduce poverty around the world.	- Emergency lending to emerging markets - Helping low-income countries fight the crisis - Advocating global fiscal stimulus - Reforming the international financial system	- US$76.8 million in Emergency Post-Conflict Assistance (EPCA) to Lebanon in support of the authorities' economic program for 2007 - US$ 37.6 million in Emergency Post-Conflict Assistance (EPCA) to Lebanon in support of the authorities' economic program for 2008-09.	Concessionary loans	

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27	International Union for Conservation of Nature (IUCN) / Regional Office for West Asia (ROWA)	Operating	Um Uthaina - Tohama Str. No. 6P.O. Box 94223011194 AmmanJordan Lebanon Project Office c/o Ministry of Environment, Beirut, Lebanon Tel: +96265546912 +96265546913 +96265546914 Fax: +96265546915 westasia@iucn.org www.iucn.org/westasia	The IUCN Regional Office for West Asia (ROWA) covers the region of West Asia including the countries of Bahrain, Iran, Iraq, Syria, Jordan, Palestine, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, UAE and Yemen.	- Understand, respect and improve the environment in its widest sense, including its natural, social, economic and cultural aspects - Support and secure the abundance and diversity of nature - Ensure that people have secure rights and equitable access to natural resources, decent living conditions on a sustainable basis - Understand the interdependence of poverty and environmental protection - Recognise the importance of sustainable natural resource use in meeting people's aspirations	- Supporting an integrated strategy for managing forest fires - Providing technical assistance for a Marine Protected Area monitoring programme - Capacity building for the development of a representative network of Mediterraneanmarine protected areas	Grants/ Calls for proposals are posted on the organisation's website.	Land degradation, protected areas, environmental legislation, aridity, desertification, unsustainable water extraction and use, biodiversity, habitat loss, species extinction, threats to sensitive marine ecosystems through pollution, habitat destruction, introduction of invasive alien species, and unplanned coastal development.
28	Islamic Corporation for the Development of the Private Sector (ICD)	Operating	Le Chateau Centre, South West Entrance, First Floor, Office No. 102, P.O.Box 54069, Jeddah, Zip Code: 21514 Jeddah Tel: +96622611370 Fax: +96622611375 info@idbgroupbf.com ukhoujali@isdb.org.sa www.idbgrouponline.com	The Islamic Corporation for the Development of the Private Sector (ICD) is a multilateral organisation, affiliated with the Islamic Development Bank (IDB) Group. Its shareholders are the IDB, 45 Islamic member countries,	Encouraging: - Transfer of technical know-how - Exchange of expertise and resources - Transfer and redeployment of funds - Innovative and cluster projects - Locally demanded projects	Power, transportation, health, and education projects	Provision of finance to private sector projects in accordance with principles of the Sharia, and advice to governments and private organisations	Education, health care, mining, financial, services, oil and gas, real estate and housing, information technology, agriculture, infrastructure, and industrial

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				and 5 public financial institutions from member countries				
29	Islamic Republic of Iran	Operating	Bir Hassan PO Box 5030 Beirut - Lebanon Tel: +9611821224 +9611865558 +9611865559			600 construction projects, including academic, religious and medical centres, bridges, rural infrastructure facilities, and power stations, 70% of which are already completed		
30	Italian Cooperation in Lebanon	Operating	Rue du Palais Presidentiel 2902 2633 - Baabda P.O. Box 57 Baabda Lebanon Tel: +961 5 954955 Fax: +961 5 959616 amba.beirut@esteri.it www.utlbeirut.org	The Italian presence in Lebanon stands on two priority pillars: a significant emergency initiative and a broad development programme.	To support decentralisation and local development	- Wastewater treatment plant in Zahlé - Rehabilitation of Baalbeck irrigation perimeter - Wastewater treatment and water supply for the district of Jbeil - Water supply network in Danniyeh - Water supply in the city of Koura and surrounding areas (Qalamoun and Al-Fawar villages)	- Grants, soft loans, low cost loans: granted to finance the risk capital of Italian firms embarking on joint-venture initiatives in developing countries. Loans cover assets in cash and/or in kind, including technical assistance and copyrights. - Agriculture and health fall under the eligible initiatives. - Italy pledged €120 million, of which €75 million as soft loans and the remaining €45 million as a "gift"	Agriculture, water, cultural heritage, health and social services.

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							that Rome wished to give to Beirut as a token of its commitment to promote peace in the Middle East, which is one of the top priorities of Italian foreign policy.	
31	Kreditanstalt für Wiederaufbau (KfW)	Operating	KfW Bankengruppe Palmengartenstrasse 5-9 60325 Frankfurt am Main Tel: +406974314260 Fax: +406974313363 info@kfw-entwicklungsbank.de www.kfw.de	As a promotional bank, KfW Bankengruppe supports change and encourages forward-looking ideas – in Germany, Europe and throughout the world.	Carrying out Financial Cooperation (FC) on behalf of the German Government. FC is one of the most important instruments of German bilateral cooperation.	- KfW Entwicklungsbank, on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), provided €3 million for the reconstruction of vocational schools in Lebanon. - Completion of the sewage pre-treatment plant of Al Ghadir in southern Beirut €7.43 million	Financial	FC activities contribute to reducing poverty, making globalization fair, conserving natural resources and ensuring peace. KfW's involvement is in line with the principles of the German Government, which has made an international commitment to help achieve the goals set forth in the UN Declaration, in the Monterrey Consensus and in the Paris Declaration.
32	Kuwait Fund For Arab Economic	Operating	Kuwait Fund for Arab Economic Development Mirqab	Kuwait Fund For Arab Economic Development is the first institution in the	To assist Arab and other developing countries in developing their economies.	- 2010: Lending US$18 million to Lebanon for construction of a dam and water tank in	- Direct loans or the provision of guarantees. - Joint or parallel	Agriculture, irrigation, transport, communications, energy, water

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	Development (KFAED)		Mubarak Al-Kabeer St. Kuwait City P.O. Box 2921 Safat 13030 Kuwait State of Kuwait Tel: +96522999000 Fax: +96522999090 Lebanon Office (Temporary) Clemenceau Street Wafers Center - 10th floor Beirut Lebanon Tel: +961369995 Fax: +961379994 www.kuwait-fund.org	Middle East that took an active role in the international development efforts.		Falougha - 55.5 million KWD for various water and sewage projects since 1993	financing with other international, regional or national development finance institutions. - Making of grants-in-aid to finance technical, economic and financial studies whether in relation to projects financed by the Fund or otherwise. Studies may be of such types as pre-investment surveys, studies for the identification of investment opportunities and projects, feasibility studies, project preparation, sectoral studies and the like. - Advisory services in relation to technical, financial, economic and legal aspects of projects or programmes or development	supply, sewage, industry, education and health.

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							policies, or in relation to institution building in the field of development. - Subscription to the capital or contribution to the resources of development finance institutions. - Subscription to the capital of eligible developmental enterprises.	
33	Mercy Corps Internatio nal (Lebanon)	Operating	Mercy Corps PO Box 2669, Dept. W Portland OR 97208-2669 USA Tel: +9611611586 Fax: +9611611585 mci@sodetel.net.lb www.mercycorps.org	Mercy Corps has worked in Lebanon since 1993, providing development assistance to thousands of disadvantaged citizens around the country	Helping to build secure, productive, and just communities	During and after the war of summer 2006, Mercy Corps ran a large-scale relief and recovery programme to aid those most affected by the conflict. In addition to providing emergency food items and relief supplies to tens of thousands of people, Mercy Corps worked to rehabilitate more than 60 war-affected schools, provided psychosocial support to over 70,000 children and youth, and assisted hundreds of small farmers to preserve their livelihoods.	Projects' implementation	Rural and agricultural development, environmental protection, community-based economic development, and infrastructure repair activities

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34	Overseas Private Investment Corporation (OPIC)	Operating	Romen Mathieu Managing Director EuroMena FMC C/O Capital Trust S.A. Luxembourg Representative Office Starco Center Bloc C, 8th floor Beirut, PO Box 11-439 Lebanon Tel: +9611368 968 Fax: +9611683 24 info@opic.gov www.opic.gov	OPIC is America's development finance institution, solving critical world challenges by delivering finance innovations that help ambitious U.S. businesses successfully enter, grow and compete in emerging markets	- To solve critical world challenges by catalysing markets in developing nations	OPIC partnered with Citigroup to provide a US$120 million loan facility that will mobilise up to US$160 million in private capital for home reconstruction, mortgage financing and small and medium-sized enterprises.	Financial/Loans	Infrastructure, telecommunications, power, water, housing, airports, hotels, high-tech, financial services, and natural resource extraction industries
35	Qatar Foundation (State of Qatar)	Operating	Chouran, Deebs Bldg., 1st Floor PO Box 14/6502-11/6717 Beirut - Lebanon Tel: +9611804256 +9611804258 +9611865271 Fax: +9611810460 beirut@mofa.gov.qa www.mofa.gov.qa			- US$300 million pledged for the reconstruction of Lebanon at the Stockholm donors' conference - US$12,000 per family for home repairs - Emergency Relief & Humanitarian Assistance	Grants	

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36	Relief International (RI)	Operating	First Floor, Bldg. Khoury & Abou Rjeily, Mar Takla area, Officers street, Hazmieh, Lebanon Tel/Fax:+9615955516 info@ri.org www.ri.org	Relief International is a humanitarian non-profit agency that provides emergency relief, rehabilitation, development assistance, and programme services to vulnerable communities worldwide. Relief International is solely dedicated to reducing human suffering and is non-political and non-sectarian in its mission.	- Serve the needs of the most vulnerable - particularly women and children, victims of natural disasters & civil conflicts, and the poor - with a specific focus on neglected groups and cases. - Provide holistic, multi-sectoral, sustainable, and pro-poor programmes that bridge emergency relief and long-term development at the grassroots level. - Empower communities by building capacity and by maximising local resources in both programme design and implementation. - Promote self-reliance, peaceful coexistence, and reintegration of marginalized communities. - Protect lives from physical injury or death and/or psychological trauma where present. - Uphold the highest professional norms in programme delivery, including accountability to beneficiaries and donors alike.	- Three-year programme: Empowering Municipalities through Local Economic Development (EMLED), which provides youth forums, leadership workshops, microfinance loans, and a knowledge-sharing Internet portal - Three-year, Rural Enterprise Development for Information Technology (CREDIT) programme that aims at supporting new ICT entrepreneurs in rural areas. - Providing urgently needed food, water and sanitation supplies to individuals suffering from displacement after the 2006 conflict.	Technical assistance, Grants	Emergency, health, sanitation, food, agriculture, education, empowerment, infrastructure and human rights

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37	René Moawad Foundation (RMF)	Operating	844, rue Alfred Naccache Achrafieh, Beirut, Lebanon BP: 468 - Hazmieh Tel: +9611613 367/8/9 Fax: +9611613 370 rmf@rmf.org.lb www.rmf.org.lb	The RMF provides medical care to the poor; develops agriculture and rural enterprises; conducts literacy campaigns and vocational training; encourages public political participation; promotes democratic values; and protects the environment.	- To promote social, economic, and rural development - To contribute in building a responsible civil society that strengthens national unity and promotes democratic values and social justice.	- Clustering for economic development and revitalisation of industry sectors programme to support and promote the agribusiness industries in rural areas of Lebanon with the highest growth potential. - Implementation of the following activities at the Pilot Animal Farm: Conferences and trainings on intensive breeding of cattle and goats, a technical assistance service composed of agricultural engineers and veterinarians, a research centre for professors and students	Grants, medical activities, education programmes and economic development projects.	Education, human rights, agriculture, economy, and health
38	Saudi Fund For Development (SFD)	Operating	Tel : +96612794000 Fax: +96614647450 info@sfd.gov.sa www.sfd.gov.sa	SFD extends concessional loans for financing projects that contribute to the social and economic well-being of the beneficiary countries. Funds should contribute to the host government's priority development projects.	To participate in financing the development projects in developing countries, in addition to supporting the national exports other than oil.	- Arab Highway (Beirut-Damascus road): 187.5 Million SAR - Building the Lebanese University premises in Tripoli - Transportation, health, education, water, and sovereignty services projects	Concessionary loans. Proposed projects should be applied to other donors to cover 50% of the project cost.	

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39	Spanish Agency for International Development Cooperation - Kingdom of Spain	Operating	Palais Chehab, Hadath Antounie B.P.: 11/3039 Tel: +9615464120 Fax: +9611464030 +9611467454 embesplb@mail.maec.es www.maec.es	The environment is a priority strategic sector for Spanish cooperation.	Contributing to the fight against poverty, the promotion and defence of human rights, environmental conservation, gender equality and respect for cultural diversity; in short, promoting sustainable development.	Medical waste treatment plant in Saida	Grants	Projects related to environmental protection
40	Swedish International Development Cooperation Agency (SIDA)	Operating	Stockholm - headquarters Valhallavägen 199 105 25 Stockholm SWEDEN Tel: +4686985000 Fax: +468208864 sida@sida.se www.sida.se	SIDA works according to directives of the Swedish Parliament and Government to reduce poverty in the world. Sweden works with both short-term humanitarian assistance and long-term development cooperation. Short-term assistance is used primarily to provide relief in situations of great hardship, such as natural disasters or conflicts. In development cooperation, Sweden works on a long-term basis with partner countries in order to contribute to these countries' development.	To contribute to making it possible for poor people to improve their living conditions	Land use and environment, health, transportation, and solid waste projects	Grants	Democracy, Human Rights and Gender Equality, Economic Opportunities, Knowledge, Health and Social Development, Environmentally Sustainable Development, and Peace and Security

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41	The Islamic Development Bank (IDB)	Operating	PO. Box. 5925 Jeddah 21432 Kingdom of Saudi Arabia Tel: +96626361400 Fax: +96626366871 idbarchives@isdb.org www.isdb.org	The IDB is the financial arm of the Jeddah-based organisation of the Islamic Conference (OIC), which comprises 56 Muslim countries. The OIC has extended numerous loans to many countries in the past few years.	The purpose of the Bank is to foster the economic development and social progress of member countries and Muslim communities individually as well as jointly in accordance with the principles of Islamic Law.	- US$32.4 million for the construction of a section of the southern coastal highway - US$12.5 million of the loan for furnishing three hospitals and three other health centres in the South - US$7 million funding the construction of a new road in the northern region of Becharré - US$23.5 million for the wastewater collection and treatment project in Joub Jannine, Saghbine and neighbouring villages	Financial	The functions of the Bank are to participate in equity capital and grant loans for productive projects and enterprises besides providing financial assistance to member countries in other forms of economic and social development. The Bank is also required to establish and operate special funds for specific purposes including a fund for assistance to Muslim communities in non-member countries, in addition to setting up trust funds.

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
42	The OPEC Fund for International Development (OFID)	Operating	Parkring 8, A-1010 Vienna, Austria Tel: +431515640 Fax: +4315139238 info@ofid.org www.ofid.org	OFID's key aim is to foster social and economic progress in the developing world through the provision of concessional financing for developing countries.	To aspire to a world where sustainable development, centred on human capacity-building, is a reality for all. One of its central aims has always been to advance 'South-South' solidarity in every way available to it. It does this by promoting cooperation in many spheres among countries of the developing world. It also does what it can to champion the cause of the developing world in the international arena. In this regard, OFID has been closely associated with two multilateral institutions of great relevance in the developing world: IFAD and the Common Fund for Commodities (CFC).	- US$5 million for the reconstruction of Nahr El Bared camp	The methods of funding include public sector loans for development projects and programs, balance of payments support and debt relief under the Heavily Indebted Poor Countries (HIPC) Initiative	Trade financing; support to private enterprises; grants for technical assistance, food aid, research and humanitarian relief work; and contributing to the resources of other development organisations whose activities benefit developing countries.
43	The Overseas Economic Cooperation Fund (OECF) through JICA, JCIB	Operating	4-1, Otemachi 1-chome, Chiyoda-ku, Tokyo 100-0004, Japan Tel: +81332151304 Fax: + 81332151307 www.mofa.go.jp	The Overseas Economic Cooperation Fund (OECF) is the implementing agency for loan aid furnished by the Japanese government.	To achieve economic independence and alleviate poverty in the long run	- Waste water treatment plant and sewage networks in Saida; - Drinking water supply to the coast of Kesrouan	Low-interest, long-term funds	Irrigation and other projects in the agriculture sector, the development of sewerage and water supply systems and reforestation projects in the environmental sector

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
44	The World Bank / International Bank for Development & Reconstruction (IBRD), International Development Association (IDA), International Finance Corporation (IFC)	Operating	Mona Ziadé Communications Officer Allenby St, Down Town, Beirut, Lebanon Tel: +9611987800 Fax: +9611986800 mziade@worldbank.org www.worldbank.org/lb	The World Bank is a vital source of financial and technical assistance to developing countries around the world. Its mission is to fight poverty with passion and professionalism for lasting results and to help people help themselves and their environment by providing resources, sharing knowledge, building capacity and forging partnerships in the public and private sectors.	- Alleviate poverty and offer debt relief - Creating infrastructure - Develop financial systems - Protect individual and property rights - Implement legal systems that encourage business	- 2010: Greater Beirut Water Supply - 2007: Bekaa emergency water supply project - 2002: Baalbeck Water and Wastewater project - 2000: First municipal infrastructure project - 1997: Coastal pollution control and wastewater project *1995: Solid waste/environmental management project	Low-interest loans, interest-free credit and grants. In August 2010 the World Bank Group and the Republic of Lebanon finalized a Partnership Strategy that enables the Government to borrow between US$375 million and US$550 million over four years to finance its economic and social development programme	Education, health, public administration, infrastructure, financial and private sector development, agriculture and environmental and natural resource management.
45	U.S. Agency for International Development (USAID)	Operating	Jim Barnhart Mission Director US Embassy Tel: +9614542600 +9614543600 Fax: +9614544254 usaidbeirut@state.gov www.usaid.gov/lb	USAID works alongside the Government of Lebanon to improve the lives of the Lebanese people through development projects that foster stability and democracy. USAID helps to build a better future for Lebanese citizens through cross-cutting programmes focusing on youth,	USAID/Lebanon programmes focus on four specific objectives: - Strengthening governing institutions, support for the rule of law and development of the capacity of civil society organisations to be more responsive to Lebanese citizens; - Job creation and income generation; - Improving student achievement through support for basic	- 2010: US$27.5 million Memorandum of Understanding for Assistance to Water Sector (Litani River Basin Management Support and Lebanon Water and Wastewater Sector Support) - 2009: Completing Oil Spill Clean-up along a 60-km stretch of the northern seashore from Tabarja to Enfeh - On 21 December 2005 the Lebanese	All USAID programmes and contracts are predominantly awarded on a competitive basis and are posted on the USAID Business & Procurement website (http://www.usaid.gov/business/). Interested parties are encouraged to apply and USAID selects	- Support for basic and higher education - Small and medium enterprise development and increasing income revenue - Improving the health of the Litani River and strengthening capacity to manage water resources - Support for the rule

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
				reconciliation throughout Lebanese society, and opportunities for women through targeted microfinance and education programs.	education in all public schools; - Improved water management.	Government and the USAID signed a memorandum of understanding to cooperate towards the provision of small village wastewater treatment systems to alleviate pollution in the Upper Litani River and the Qaraaoun Lake. According to this memorandum, new waste water treatment plants were constructed in Ferzol, Aaytanit, Rachayya, and Bakka. Another plant is under construction in Ablah.	potential applicants based on a competitive process in line with the U.S. Government's procurement policy. However, in some instances, USAID accepts unsolicited proposals that are defined as unique, innovative and fit USAID-Lebanon's strategic objectives	of law and for democratic systems - Support to municipalities to streamline and strengthen operations and citizen services - Strengthen the role of civil society to be more effective advocates for the people of Lebanon
46	United Nations Development Programme (UNDP)	Operating	Arab African International Bank Bldg., Riad El Solh Street, Nejmeh, Beirut 2011 5211 Lebanon Tel: +9611962500 Fax: + 9611962491 registry.lb@undp.org www.undp.org.lb	UNDP is the UN's global development network, an organisation advocating change and connecting countries to knowledge, experience and resources to help people build a better life.	To help countries build and share solutions to the challenges of: - Achieving the MDGs and reducing poverty - Fostering democratic governance - Energy and environment for sustainable development - Crisis prevention and recovery - Responding to HIV/AIDS	Some projects: - Support to The Regional Development Programme For Baalbeck-Hermel - Flood Risk Management and Water Harvesting for Livelihood Recovery in Baalbeck-Hermel - Phase I and II - Integrated Solid Waste Management of Baalbeck District - Integrated Waste Management for the Olive Oil Pressing Industries in Lebanon, Syria & Jordan - Groundwater	Grants and technical assistance	Millennium development goals, democratic governance, social and local development, environment and energy, crisis prevention and recovery.

	Donor	**In-Country Donor Status**	**Contact Details**	**General**	**Objectives**	**Recent contributions to Lebanon**	**Type of assistance / Programming Phase / Budget Allocation**	**Stated Donor Intervention Areas**
						Assessment and Database		
47	United Nations Industrial Development Organisation (UNIDO)	Operating	UNIDO Headquarters Vienna International Centre Wagramerstr. 5 P.O. Box 300 A-1400 Vienna - Austria Tel: +431260260 Fax: +4312692669 unido@unido.org www.unido.org	UNIDO is the specialised agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalisation and environmental sustainability	To promote and accelerate sustainable industrial development in developing countries and economies in transition, and work towards improving living conditions in the world's poorest countries by drawing on its combined global resources and expertise	- 2006: US$4.5 million project to revitalize over 150 small enterprises in the south of the country, the Bekaa Valley, and in southern Beirut - 2009: Lebanon Agro-Industrial Support and Economic Recovery, or LAISER, project that helped increase the number of employees in these enterprises from just over 100 to over 650. - Training of more than 300 people on food safety management, occupational health and safety and ISO standards.	Provision of essential equipment, assistance to rehabilitation of civil works (excluding major structural works or building shells), and capacity development for general and market-specific skills.	Agro-industrial sectors such as: food and beverage, olive oil, textiles, woodwork and leather

	Donor	In-Country Donor Status	Contact Details	General	Objectives	Recent contributions to Lebanon	Type of assistance / Programming Phase / Budget Allocation	Stated Donor Intervention Areas
48	Young Men's Christian Association (YMCA)	Operating	Delta Center, Third Floor Horsh Tabet, Sin el Fil, Beirut Tel: +9611490 40 +9611490685 ymca@ymca-leb.org.lb www.ymca-leb.org.lb	The organisation works with communities to identify local needs and solutions. This methodology assures that programme beneficiaries are receiving the assistance that they need and want to improve their overall quality of life. By serving communities with the projects that they value, the YMCA creates a sense of ownership and gains the trust of beneficiaries, partners and counterparts in the region.	- To ensure that all programmes and activities of YMCA are consistent with the Christian character of the association. - To equip staff, members and volunteers of YMCA in Christian life and ministry. - To reinforce Christian principles and values in the workplace and community. - To engage and involve more Christians as members of YMCA in the execution and participation of programmes and activities. - To partner with churches and other organisations in YMCA's Christian outreach and ministries.	- Introduced solid waste treatment facilities that serve all 56 villages of the district of Tyre (300,000 inhabitants), which provide sorting of recyclable materials and processing of organic waste into compost. - Developed secondary level water treatment centres in nine locations in South Lebanon and the Bekaa Valley: Wadi Jezzine, Haytoura, Shayyah, Aychiyyeh, Ghabbatieh, Rachayya, Al Hosh, and two in Bakka - Developed Agricultural Extension Centres in South Lebanon to, improve and develop the management of the centres by activating partnerships between them and the local community, helped reduce the agricultural cost of production by training farmers on new techniques of production, and helped improve the production of olive oil and honey quantitatively and the qualitatively	Financial, projects and activities	Agriculture, child rights, environment, good governance, health and youth

Sources: Websites of donors mentioned in the 3rd column of **Error! Reference source not found.**.

APPENDIX J – COST CALCULATIONS

Table J-1. Cost Breakdown for the 50 t/d Sanitary Landfill in Joub Jannine – Zone 1

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Preparatory works				
Mobilization and insurance	LS	1	15,000	15,000
Land clearing	m^2	15,000	1	15,000
Soil analysis (bearing capacity, etc)	unit	10	100	1,000
Excavation				
Excavation to reshape the bottom of the landfill	m^3	8,000	3	24,000
Access roads construction	m^2	1,000	38	38,000
Cells preparation				
Bottom preparation and grading	m^2	10,000	2	20,000
Supply and install clay liner (1 m)	m^3	10,000	12	120,000
Supply and install geomembrane (HDPE-2mm)	m^2	12,000	10	120,000
Supply and install geotextile	m^2	12,000	3	36,000
Supply and install fine protective layer of soil (30cm)	m^3	3,000	9	27,000
Leachate Drainage				
Supply and install drainage collection pipes (HDPE-150mm)	m	150	20	3,000
Gravel drainage layers around pipes	m^3	100	10	1,000
Leachate collection points	unit	2	5,000	10,000
Leachate collection towers	unit	2	10,000	20,000
Submersible pumps	unit	2	4,000	8,000
Leachate treatment station	unit	0	100,000	0
Gas collection				
Gas extraction wells	unit	40	500	20,000
Gas collection pipes (perforated HDPE or GRP)	m	400	30	12,000
Non perforated lateral collection pipes	m	900	25	22,500
Equipment required during exploitation	unit	13	350	4,550
Suction Pumps	unit	1	10,000	10,000
Flaring unit	unit	1	75,000	75,000
Equipment for biogas measurement	unit	1	15,000	15,000
Peripheral drainage				
Construction of peripheral drainage channels (40x50cm)	m^3	250	120	30,000
Equipment for landfill operation				
Wheel Loader	unit	1	180,000	180,000
Excavator	unit	1	200,000	200,000
Landfill compactor	unit	1	300,000	300,000

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Truck	unit	1	70,000	70,000
Complementing structures				
Guard room	unit	1	10,000	10,000
Service station	LS	1	10,000	10,000
Workshop	LS	1	25,000	25,000
Truck Washing area	LS	1	15,000	15,000
Water supply reservoir (50 m^3)	LS	1	15,000	15,000
Water distribution network, pumps	LS	1	15,000	15,000
Safety equipment	LS	1	5,000	5,000
Fire protection equipment	LS	1	10,000	10,000
Supervision Services	LS	1	100,000	100,000
Miscellaneous	LS	1	50,000	50,000
TOTAL				**1,652,050**

Table J-2. Cost Breakdown for Qaraaoun Storage for Processing of Recyclables – Zone 1

Bins needed	**in 2018**		**in 2023**	
Village	**Number of 240 liters GREEN bins**	**Number of 240 liters BLUE bins**	**Additional GREEN bins**	**Additional BLUE bins**
Qaraaoun	183	462	15	39
Saghbine	73	184	6	15
Khirbet Qanafar	135	191	11	16
Lala	139	245	12	21
Sohmor	183	446	16	37
TOTAL	**713**	**1528**	**60**	**128**
Total investment ($)	**24,955**	**53,480**	**2,100**	**4,480**
	78,435 $			

Trucks needed

Village	**Pick up (8 m³)**	**Investment ($)**
Qaraaoun	1	30,000
Saghbine	1	30,000
Khirbet Qanafar	1	30,000
Lala	2	60,000
Sohmor	2	60,000
TOTAL ($)	**7**	**210,000**

Setting up 2 x 200 m² storage centers in Qaraaoun and in Sohmor*

Equipment and set up	**Cost ($)**
Baler	15,000
Skid steer loader	30,000
Generator	15,000
Steel Structure	25,000
Civil works	25,000
Total Investment/center ($)	**110,000**

TOTAL Project Costs

Village	**Bins**	**Pick up (8 m³)**	**Storage/ Processing centers**	**Total investment / village ($)**
Qaraaoun	22,575	30,000	110,000	162,575
Saghbine	8,995	30,000	0	38,995
Khirbet Qanafar	11,410	30,000	0	41,410
Lala	13,440	60,000	0	73,440
Sohmor	22,015	60,000	110,000	192,015
TOTAL ($)	**78,435**	**210,000**	**220,000**	**508,435**

*Sohmor storage center has been cancelled

Table J-3. Cost Breakdown for the Closure of the Ain El Tineh Dump – Zone 1

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
Option 1: Group with other dumps and transfer to sanitary landfill				
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,500	2	3,000
2.2 - Transfer waste to sanitary landfill	trucks	75	65	4,875
2.3 - Gate fee at sanitary landfill	tonne	750	10	7,500
TOTAL COST ($)				**19,375**
AVERAGE COST ($/m³)				**12.9**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,500	2	3,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	250	14	3,500
2.2.1-Install a geomembrane liner and geotextile	m^2	500	13	6,500
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	750	2	1,500
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	250	14	3,500

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	150	40	6,000
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	150	15	2,250
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	500	4	2,000
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**36,000**
AVERAGE COST ($/m³)				**24.0**

Table J-4. Cost Breakdown for the Closure of the Sohmor Dump – Zone 1

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	250	2	500
2.2 - Transfer waste to sanitary landfill	trucks	13	65	813
2.3 - Gate fee at sanitary landfill	tonne	125	10	1,250
TOTAL COST ($)				**5,563**
AVERAGE COST ($/m³)				**22.3**

Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	250	2	500
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	83	14	1,167
2.2.1-Install a geomembrane liner and geotextile	m^2	167	13	2,167
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	125	2	250
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	83	14	1,167

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	50	40	2,000
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	50	15	750
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	167	4	667
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	25	15	375
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**13,042**
AVERAGE COST ($/m³)				**52.2**

Table J-5. Cost Breakdown for the Closure of the Majdel Balhis Dump – Zone 1

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	500	2	1,000
2.2 - Transfer waste to sanitary landfill	trucks	25	65	1,625
2.3 - Gate fee at sanitary landfill	tonne	250	10	2,500
TOTAL COST ($)				**8,125**
AVERAGE COST ($/m³)				**16.3**

Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	500	2	1,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	83	14	1,167
2.2.1-Install a geomembrane liner and geotextile	m^2	167	13	2,167
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	250	2	500
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	83	14	1,167

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	50	40	2,000
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	50	15	750
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	167	4	667
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	25	15	375
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**13,792**
AVERAGE COST ($/m³)				**27.6**

Table J-6. Cost Breakdown for the Closure of the Rihane Jezzine Dump – Zone 2

Option 1: Group with other dumps and transfer to sanitary landfill

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	560	2	1,120
2.2 - Transfer waste to sanitary landfill	trucks	28	65	1,820
2.3 - Gate fee at sanitary landfill	tonne	280	10	2,800
TOTAL COST ($)				**8,740**
AVERAGE COST ($/m³)				**15.6**

Option 2: Excavate, line, grade and cap

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	560	2	1,120
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	117	14	1,633
2.2.1-Install a geomembrane liner and geotextile	m^2	233	13	3,033
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	280	2	560
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	117	14	1,633

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	70	40	2,800
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	70	15	1,050
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	233	4	933
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	25	15	375
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**17,138**
AVERAGE COST ($/m³)				**30.6**

Table J-7. Cost Breakdown for the Opening of the 75 t/d Nabatiye Sanitary Landfill – Zones 3 & 4

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Landfill design				
Topographic survey	LS	1	10,000	10,000
Landfill design	LS	1	35,000	35,000
Tender documents preparation	LS	1	10,000	10,000
Preparatory works				
Mobilization and insurance	LS	1	20,000	20,000
Land clearing	m^2	20,000	1	20,000
Soil analysis (bearing capacity, etc.)	unit	10	100	1,000
Excavation				
Excavation to reshape the bottom of the landfill (in rocks)	m^3	10,000	7	70,000
Access roads construction	m^2	3,000	38	114,000
Cells preparation				
Bottom preparation and grading	m^2	15,000	2	30,000
Supply and install clay liner (1 m)	m^3	15,000	12	180,000
Supply and install geomembrane (HDPE-2mm)	m^2	17,000	10	170,000
Supply and install geotextile	m^2	17,000	3	51,000
Supply and install fine protective layer of soil (30 cm)	m^3	4,500	9	40,500
Leachate Drainage				
Supply and install drainage collection pipes (HDPE-150mm)	m	200	20	4,000
Gravel drainage layers around pipes	m^3	150	10	1,500
Leachate collection points	unit	3	5,000	15,000
Leachate collection towers	unit	3	10,000	30,000
Submersible pumps	unit	3	4,000	12,000
Leachate treatment station	unit	1	100,000	100,000
Gas collection				
Gas extraction wells	unit	60	500	30,000
Gas collection pipes (perforated HDPE or GRP)	m	550	30	16,500
Non perforated lateral collection pipes	m	1,300	25	32,500
Equipment required during exploitation	unit	16	350	5,600
Suction Pumps	unit	2	10,000	20,000
Flaring unit	unit	1	75,000	75,000
Equipment for biogas measurement	unit	1	15,000	15,000
Peripheral drainage				
Construction of peripheral drainage channels (40x50cm)	m^3	320	120	38,400
Equipment for landfill operation*				
Wheel Loader	unit	1	180,000	180,000
Excavator	unit	1	200,000	200,000
Landfill compactor	unit	1	300,000	300,000
Truck	unit	1	70,000	70,000
Complementing structures				
Guard room	unit	1	10,000	10,000
Service station	LS	1	10,000	10,000

Workshop	LS	1	25,000	25,000
Truck Washing area	LS	1	15,000	15,000
Water supply reservoir (50 m^3)	LS	1	15,000	15,000
Water distribution network, pumps	LS	1	15,000	15,000
Safety equipment	LS	1	5,000	5,000
Fire protection equipment	LS	1	10,000	10,000
Supervision Services	LS	1	125,000	125,000
Miscellaneous	LS	1	50,000	50,000
TOTAL				**2,177,000**
*Could be provided as part of the landfill operator contract				

Table J-8. Cost Breakdown for the Opening of 250 t/d Sorting and Composting Facility for Bent Jbayl and Marjaayoun – Zones 3 & 4

Description	Quantity	Unit	Unit Price (euro)	Total Price (euro)
EIA preparation	1	LS	30,000	30,000
Design of the facility	1	LS	40,000	40,000
Construction				
General requirements (insurance, mobilization, demobilization, offices, signboard, etc)	1	LS	50,000	50,000
Site clearance and excavations (clearing and Grubbing, Rough grading, excavation, backfill, drainage, road pavements, etc)	1	LS	100,000	100,000
Civil Works (concrete works, masonry, metals, wood and plastics, thermal and moisture protection, doors and windows, finishes, etc)	1	LS	600,000	600,000
Steel structure	1	LS	220,000	220,000
Electrical Works including conduits, earthing, wires and cables, cable trays, outlets, disconnecting switches, generator, panel boards, lighting fixtures, etc	1	LS	50,000	50,000
Mechanical Works including sanitary works (pipes, valves, drainage, manholes, collection tanks, pumps, plumbing, etc) and HVAC (AC units, ducts, fans, etc)	1	LS	100,000	100,000
Equipment				
Weighbridge	1	unit	45,000	45,000
Sorting lines (horizontal and inclined conveyors)	1	unit	100,000	100,000
Hoppers, shredder, Trommel Screen, magnetic separator, ballistic separator	1	unit	350,000	350,000
Biofilter	1	unit	70,000	70,000
Compost turning machine	1	unit	350,000	350,000
Compost refining equipment	1	unit	50,000	50,000
Supervision services	1	LS	50,000	50,000
TOTAL				**2,135,000**

Table J-9. Cost Breakdown for the Opening of the 100 t/d Bent Jbayl Sanitary Landfill – Zone 3 & 4

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Landfill design				
Topographic survey	LS	1	15,000	15,000
Landfill design	LS	1	35,000	35,000
Tender documents preparation	LS	1	10,000	10,000
Preparatory works				
Mobilization and insurance	LS	1	20,000	20,000
Land clearing	m^2	25,000	1	25,000
Soil analysis (bearing capacity, etc.)	unit	10	100	1,000
Excavation				
Excavation to reshape the bottom of the landfill	m^3	8,000	3	24,000
Access roads construction	m^2	1,000	38	38,000
Cells preparation				
Bottom preparation and grading	m^2	20,000	2	40,000
Supply and install clay liner (1 m)	m^3	20,000	12	240,000
Supply and install geomembrane (HDPE-2mm)	m^2	24,000	10	240,000
Supply and install geotextile	m^2	24,000	3	72,000
Supply and install fine protective layer of soil (30cm)	m^3	6,000	9	54,000
Leachate Drainage				
Supply and install drainage collection pipes (HDPE-150mm)	m	300	20	6,000
Gravel drainage layers around pipes	m^3	200	10	2,000
Leachate collection points	unit	4	5,000	20,000
Leachate collection towers	unit	4	10,000	40,000
Submersible pumps	unit	4	4,000	16,000
Leachate treatment station	unit	1	200,000	200,000
Gas collection				
Gas extraction wells	unit	80	500	40,000
Gas collection pipes (perforated HDPE or GRP)	m	800	30	24,000
Non perforated lateral collection pipes	m	1,800	25	45,000
Equipment required during exploitation	unit	26	350	9,100
Suction Pumps	unit	2	10,000	20,000
Flaring unit	unit	2	75,000	150,000
Equipment for biogas measurement	unit	2	15,000	30,000
Peripheral drainage				
Construction of peripheral drainage channels (40x50cm)	m^3	500	120	60,000
Equipment for landfill operation*				
Wheel Loader	unit	1	180,000	180,000
Excavator	unit	1	200,000	200,000
Landfill compactor	unit	1	300,000	300,000
Truck	unit	1	70,000	70,000
Complementing structures				
Guard room	unit	1	10,000	10,000
Service station	LS	1	10,000	10,000

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Workshop	LS	1	25,000	25,000
Truck Washing area	LS	1	15,000	15,000
Water supply reservoir (50 m^3)	LS	1	15,000	15,000
Water distribution network, pumps	LS	1	15,000	15,000
Safety equipment	LS	1	5,000	5,000
Fire protection equipment	LS	1	10,000	10,000
Supervision Services	LS	1	150,000	150,000
Miscellaneous	LS	1	50,000	50,000
TOTAL				**2,471,100**
*Could be provided as part of the landfill operator contract				

Table J-10. Cost Breakdown for the Closing of the Yohmor En Nabatiye Dump – Zone 3

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	500	2	1,000
2.2 - Transfer waste to sanitary landfill	trucks	25	65	1,625
2.3 - Gate fee at sanitary landfill	tonne	250	10	2,500
TOTAL COST ($)				**8,125**
AVERAGE COST ($/m³)				**16.3**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	500	2	1,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	83	14	1,167
2.2.1-Install a geomembrane liner and geotextile	m^2	167	13	2,167
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	250	2	500
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	83	14	1,167

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	50	40	2,000
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	50	15	750
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	167	4	667
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	25	15	375
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**13,792**
AVERAGE COST ($/m³)				**27.6**

Table J-11. Cost Breakdown for the Closing of the Aadchit El Qoussair Dump – Zone 4

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,500	2	3,000
2.2 - Transfer waste to sanitary landfill	trucks	75	65	4,875
2.3 - Gate fee at sanitary landfill	tonne	750	10	7,500
TOTAL COST ($)				**19,375**
AVERAGE COST ($/m³)				**12.9**

Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,500	2	3,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	83	14	1,167
2.2.1-Install a geomembrane liner and geotextile	m^2	167	13	2,167
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	750	2	1,500
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	83	14	1,167

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m³	50	40	2,000
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m³	50	15	750
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m²	167	4	667
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	lm	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**20,167**
AVERAGE COST ($/m³)				**13.4**

Table J-12. Cost Breakdown for the Closing of the Bani Haiyane Dump – Zone 4

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	500	500
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	1,000	1,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	50	2	100
2.2 - Transfer waste to sanitary landfill	trucks	3	65	163
2.3 - Gate fee at sanitary landfill	tonne	25	10	250
TOTAL COST ($)				**2,013**
AVERAGE COST ($/m³)				**40.3**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	500	500
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	1,000	1,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	50	2	100
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	17	14	233
2.2.1-Install a geomembrane liner and geotextile	m^2	33	13	433
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	25	2	50
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	17	14	233

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	10	40	400
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	10	15	150
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	33	4	133
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	12	15	180
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	500	500
TOTAL COST ($)				**3,913**
AVERAGE COST ($/$m^3$)				**78.3**

Table J-13. Cost Breakdown for the Closing of the Kounine Dump – Zone 4

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,000	2	2,000
2.2 - Transfer waste to sanitary landfill	trucks	50	65	3,250
2.3 - Gate fee at sanitary landfill	tonne	500	10	5,000
TOTAL COST ($)				**14,250**
AVERAGE COST ($/m³)				**14.3**

Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,000	2	2,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	167	14	2,333
2.2.1-Install a geomembrane liner and geotextile	m^2	333	13	4,333
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	500	2	1,000
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	167	14	2,333
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	100	40	4,000

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	100	15	1,500
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	333	4	1,333
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**26,583**
AVERAGE COST ($/m³)				**26.6**

Table J-14. Cost Breakdown for the Closing of the Deir Siriane Dump – Zone 4

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,100	2	2,200
2.2 - Transfer waste to sanitary landfill	trucks	55	65	3,575
2.3 - Gate fee at sanitary landfill	tonne	550	10	5,500
TOTAL COST ($)				**15,275**
AVERAGE COST ($/m³)				**13.9**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,100	2	2,200
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	92	14	1,283
2.2.1-Install a geomembrane liner and geotextile	m^2	183	13	2,383
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	550	2	1,100
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	92	14	1,283
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	55	40	2,200

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	55	15	825
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	183	4	733
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**19,758**
AVERAGE COST ($/m³)				**18.0**

Table J-15. Cost Breakdown for the Closing of the Houla Dump – Zone 4

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,000	2	2,000
2.2 - Transfer waste to sanitary landfill	trucks	50	65	3,250
2.3 - Gate fee at sanitary landfill	tonne	500	10	5,000
TOTAL COST ($)				**14,250**
AVERAGE COST ($/m³)				**14.3**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,000	2	2,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	167	14	2,333
2.2.1 - Install a geomembrane liner and geotextile	m^2	333	13	4,333
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	500	2	1,000
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	167	14	2,333
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	100	40	4,000

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	100	15	1,500
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	333	4	1,333
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**26,583**
AVERAGE COST ($/m³)				**26.6**

Table J-16. Cost Breakdown for the Closing of the Rabb ET-Talatine Dump – Zone 4

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,500	2	3,000
2.2 - Transfer waste to sanitary landfill	trucks	75	65	4,875
2.3 - Gate fee at sanitary landfill	tonne	750	10	7,500
TOTAL COST ($)				**19,375**
AVERAGE COST ($/m^3)				**12.9**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,500	2	3,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	250	14	3,500
2.2.1-Install a geomembrane liner and geotextile	m^2	500	13	6,500
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	750	2	1,500
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	250	14	3,500
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	150	40	6,000

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	150	15	2,250
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	500	4	2,000
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**36,000**
AVERAGE COST ($/m³)				**24.0**

Table J-17. Cost Breakdown for the Ras El Ain Rehabilitation and Conversion to Sanitary Landfill – Zone 5

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	25,000	25,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, design of the new landfill, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	25,000	25,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of treatment/sorting and earth movement	m^3	300,000	4	1,200,000
2.2 - Sorting of waste: Segregation of waste into hazardous and non-hazardous materials, organic material, soil material and recovery of recyclables using sieving techniques (rotating trommel screen, sorting platform, magnets, or any other separation technology suitable for this large quantity of waste)	m^3	300,000	8	2,400,000
3. Construction of the first two cells of the sanitary landfill				
3.1 -Bottom sealing works. Including soil shaping, subbase, sealing layer, geomembrane, geotextile, drainage and sand layer (Area 10,000 m^2)				
Subbase	m^3	2,500	10	25,000
Sealing layer 0,50 m (clay)	m^3	5,000	12	60,000
Geomembrane HDPE 2mm	m^2	12,000	10	120,000
Separation geotextile (500g/m^2)	m^2	12,000	3	36,000
Drainage layer 0,50 m (gravel)	m^3	5,000	40	200,000
Sand layer	m^3	1,250	20	25,000
3.2 - Construction of the sealing surface of the two cells including a leveling layer, gas drainage layer, a separation geotextile, a sealing layer, a drainage layer, a separation geotextile, soil and a cultivation layer (Cells 1-2)				
Leveling layer 0,30 m	m^3	3,000	12	36,000
Gas drainage layer 0,30 m (gravel)	m^3	3,000	40	120,000
Separation geotextile (500g/m^2)	m^2	10,000	3	30,000
Sealing layer 0,50 m (clay)	m^3	5,000	12	60,000
Drainage layer 0,50 m (gravel)	m^3	5,000	40	200,000
Separation geotextile (500g/m^2)	m^2	10,000	3	30,000
Soil 0,70 m	m^3	7,000	20	140,000
Cultivation layer 0,30 m	m^3	3,000	15	45,000
3.3 - Leachate collection network for the proposed two cells				0

Leachate collection network	m	1,250	110	137,500
Leachate collection - transfer pipe	m	200	150	30,000
Leachate collection shaft	item	2	5,000	10,000
Excavation of trench for the installation of the main leachate collection network, sand and backfilling	m^3	200	15	3,000
Leachate pumping station	unit	1	40,000	40,000
3.4 - Biogas management including construction of LFG vertical wells and conveyance network and biogas flaring unit				0
Construction of gas wells within a Radius of influence of 15 and 20 m.	m	16	125	2,000
Supply and install gravel (silica-based) inside gas wells: - The gravel size should vary between 5 mm and 5 cm. Preferably gravel should be of basalt nature, otherwise it should be properly and extensively washed before usage.	m^3	10	50	508
Supply and install HDPE Pipes in gas wells (slotted and non-slotted) complete including all accessories. Pipes thickness to be 5 mm minimum.	m	240	130	31,200
Supply and install connection headers including main venting header and sub venting header, complete including all accessories. Pipes to be made of 150 to 200 mm HDPE. Accessories include T-junction, 90 degrees curves, m enlarger, reducer, caps, monitoring ports, gate valves, flexible hose, etc.	m	600	150	90,000
Supply and install blower and flaring unit: including flare, blowers, connections, fittings, and accessories. Minimum flow to be 50 m^3/hr	unit	1	90,000	90,000
Supply and install soil backfill material, Bentonite clay and grout for sealing the gas wells, complete including all accessories	unit	16	50	800
4. Control and Monitoring				
4.1 - Control and Monitoring of works	LS	1	250,000	250,000
TOTAL COST ($)				**5,462,008**
AVERAGE COST ($/$m^3$)				**18.2**

Table J-18. Cost Breakdown for the Proposed 100 t/d Tyre Sanitary Landfill – Zone 5

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Landfill design				
Topographic survey	LS	1	15,000	15,000
Landfill design	LS	1	40,000	40,000
Tender documents preparation	LS	1	15,000	15,000
Preparatory works				
Mobilization and insurance	LS	1	20,000	20,000
Land clearing	m^2	30,000	1	30,000
Soil analysis (bearing capacity, etc)	unit	20	100	2,000
Excavation				
Excavation to reshape the bottom of the landfill (in rocks)	m^3	20,000	7	140,000
Access roads construction	m^2	6,000	38	228,000
Cells preparation				
Bottom preparation and grading	m^2	30,000	2	60,000
Supply and install clay liner (1 m)	m^3	25,000	12	300,000
Supply and install geomembrane (HDPE-2mm)	m^2	30,000	10	300,000
Supply and install geotextile	m^2	30,000	3	90,000
Supply and install fine protective layer of soil (30cm)	m^3	12,000	9	108,000
Leachate Drainage				
Supply and install drainage collection pipes (HDPE-150mm)	m	500	20	10,000
Gravel drainage layers around pipes	m^3	300	10	3,000
Leachate collection points	unit	5	5,000	25,000
Leachate collection towers	unit	5	10,000	50,000
Submersible pumps	unit	5	4,000	20,000
Leachate treatment station	unit	1	300,000	300,000
Gas collection				
Gas extraction wells	unit	100	500	30,000
Gas collection pipes (perforated HDPE or GRP)	m	750	30	22,500
Non perforated lateral collection pipes	m	1,650	25	41,250
Equipment required during exploitation	unit	20	350	7,000
Suction Pumps	unit	5	10,000	50,000
Flaring unit	unit	1	150,000	150,000
Equipment for biogas measurement	unit	2	15,000	30,000
Peripheral drainage				
Construction of peripheral drainage channels (40x50cm)	m^3	400	120	48,000
Equipment for landfill operation*				
Wheel Loader	unit	2	180,000	360,000
Excavator	unit	1	200,000	200,000
Landfill compactor	unit	1	300,000	300,000
Truck	unit	2	70,000	140,000
Complementing structures				
Guard room	unit	1	15,000	15,000

Service station	LS	1	15,000	15,000
Workshop	LS	1	25,000	25,000
Truck Washing area	LS	1	20,000	20,000
Water supply reservoir (100 m^3)	LS	1	20,000	20,000
Water distribution network, pumps	LS	1	20,000	20,000
Safety equipment	LS	1	10,000	10,000
Fire protection equipment	LS	1	20,000	20,000
Supervision Services	LS	1	125,000	125,000
Miscellaneous	LS	1	50,000	50,000
TOTAL				**3,474,750**
*Could be provided as part of the landfill operator contract				

Table J-19. Cost Breakdown for the Proposed 150 t/d Sorting and Composting Facility for Sahel El Zahrani

Description	Quantity	Unit	Unit Price (euro)	Total Price (euro)
EIA preparation	1	LS	30,000	30,000
Design of the facility	1	LS	35,000	35,000
Construction				
General requirements (insurance, mobilization, demobilization, offices, signboard, etc)	1	LS	40,000	40,000
Site clearance and excavations (clearing and Grubbing, Rough grading, excavation, backfill, drainage, road pavements, etc)	1	LS	80,000	80,000
Civil Works (concrete works, masonry, metals, wood and plastics, thermal and moisture protection, doors and windows, finishes, etc)	1	LS	500,000	500,000
Steel structure	1	LS	190,000	190,000
Electrical Works including conduits, earthing, wires and cables, cable trays, outlets, disconnecting switches, generator, panel boards, lighting fixtures, etc	1	LS	40,000	40,000
Mechanical Works including sanitary works (pipes, valves, drainage, manholes, collection tanks, pumps, plumbing, etc) and HVAC (AC units, ducts, fans, etc)	1	LS	80,000	80,000
Equipment				
Weighbridge	1	unit	45,000	45,000
Sorting lines (horizontal and inclined conveyors)	1	unit	80,000	80,000
Hoppers, shredder, Trommel Screen, magnetic separator, ballistic separator	1	unit	325,000	325,000
Biofilter	1	unit	60,000	60,000
Compost turning machine	1	unit	350,000	350,000
Compost refining equipment	1	unit	50,000	50,000
Supervision services	1	LS	50,000	50,000
TOTAL				**1,890,000**

Table J-20. Cost Breakdown for the Proposed 75 t/d Sahel El Zahrani Sanitary Landfill

Description	Unit	Quantity	Unit price (euro)	Total price (euro)
Landfill design				
Topographic survey	LS	1	10,000	10,000
Landfill design	LS	1	35,000	35,000
Tender documents preparation	LS	1	10,000	10,000
Preparatory works				
Mobilization and insurance	LS	1	20,000	20,000
Land clearing	m^2	20,000	1	20,000
Soil analysis (bearing capacity, etc)	unit	10	100	1,000
Excavation				
Excavation to reshape the bottom of the landfill (in rocks)	m^3	10,000	7	70,000
Access roads construction	m^2	3,000	38	114,000
Cells preparation				
Bottom preparation and grading	m^2	15,000	2	30,000
Supply and install clay liner (1 m)	m^3	15,000	12	180,000
Supply and install geomembrane (HDPE-2mm)	m^2	17,000	10	170,000
Supply and install geotextile	m^2	17,000	3	51,000
Supply and install fine protective layer of soil (30cm)	m^3	4,500	9	40,500
Leachate Drainage				
Supply and install drainage collection pipes (HDPE-150mm)	m	200	20	4,000
Gravel drainage layers around pipes	m^3	150	10	1,500
Leachate collection points	unit	3	5,000	15,000
Leachate collection towers	unit	3	10,000	30,000
Submersible pumps	unit	3	4,000	12,000
Leachate treatment station	unit	1	100,000	100,000
Gas collection				
Gas extraction wells	unit	60	500	30,000
Gas collection pipes (perforated HDPE or GRP)	m	550	30	16,500
Non perforated lateral collection pipes	m	1,300	25	32,500
Equipment required during exploitation	unit	16	350	5,600
Suction Pumps	unit	2	10,000	20,000
Flaring unit	unit	1	75,000	75,000
Equipment for biogas measurement	unit	1	15,000	15,000
Peripheral drainage				
Construction of peripheral drainage channels (40x50cm)	m^3	320	120	38,400
Equipment for landfill operation*				
Wheel Loader	unit	1	180,000	180,000
Excavator	unit	1	200,000	200,000
Landfill compactor	unit	1	300,000	300,000
Truck	unit	1	70,000	70,000
Complementing structures				
Guard room	unit	1	10,000	10,000

Service station	LS	1	10,000	10,000
Workshop	LS	1	25,000	25,000
Truck Washing area	LS	1	15,000	15,000
Water supply reservoir (50 m^3)	LS	1	15,000	15,000
Water distribution network, pumps	LS	1	15,000	15,000
Safety equipment	LS	1	5,000	5,000
Fire protection equipment	LS	1	10,000	10,000
Supervision Services	LS	1	125,000	125,000
Miscellaneous	LS	1	50,000	50,000
TOTAL				**2,177,000**
*Could be provided as part of the landfill operator contract				

Table J-21. Cost Breakdown for the Closing of the Borj Rahhal Dump – Zone 5

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,800	2	3,600
2.2 - Transfer waste to sanitary landfill	trucks	90	65	5,850
2.3 - Gate fee at sanitary landfill	tonne	900	10	9,000
TOTAL COST ($)				**22,450**
AVERAGE COST ($/m³)				**12.5**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,800	2	3,600
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	100	14	1,400
2.2.1-Install a geomembrane liner and geotextile	m^2	200	13	2,600
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	900	2	1,800
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	100	14	1,400
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	60	40	2,400

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	60	15	900
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	200	4	800
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**22,650**
AVERAGE COST ($/$m^3$)				**12.6**

Table J-22. Cost Breakdown for the Closing of the Bedias Dump – Zone 4

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	500	500
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	1,000	1,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	50	2	100
2.2 - Transfer waste to sanitary landfill	trucks	3	65	163
2.3 - Gate fee at sanitary landfill	tonne	25	10	250
TOTAL COST ($)				**2,013**
AVERAGE COST ($/m³)				**40.3**

Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	500	500
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	1,000	1,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	50	2	100
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	17	14	233
2.2.1-Install a geomembrane liner and geotextile	m^2	33	13	433
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	25	2	50
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	17	14	233
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	10	40	400

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	10	15	150
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	33	4	133
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	lm	12	15	180
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	500	500
TOTAL COST ($)				**3,913**
AVERAGE COST ($/m³)				**78.3**

Table J-23. Cost Breakdown for the Closing of Deir Qanoun En Nahr Dump – Zone 5

Option 1: Group with other dumps and transfer to sanitary landfill

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,500	1,500
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	4,000	4,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	4,500	2	9,000
2.2 - Transfer waste to sanitary landfill	trucks	225	65	14,625
2.3 - Gate fee at sanitary landfill	tonne	2,250	10	22,500
TOTAL COST ($)				**51,625**
AVERAGE COST ($/m³)				**11.5**

Option 2: Excavate, line, grade and cap

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	4,000	4,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	4,500	2	9,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (half the original area)	m^3	375	14	5,250
2.2.1-Install a geomembrane liner and geotextile	m^2	750	13	9,750
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	2,250	2	4,500
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	375	14	5,250
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	225	40	9,000

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	225	15	3,375
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	750	4	3,000
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,500	1,500
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**58,375**
AVERAGE COST ($/m³)				**13.0**

Table J-24. Cost Breakdown for Closing of the Maaroub Dump – Zone 5

Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	600	2	1,200
2.2 - Transfer waste to sanitary landfill	trucks	30	65	1,950
2.3 - Gate fee at sanitary landfill	tonne	300	10	3,000
TOTAL COST ($)				**9,150**
AVERAGE COST ($/m³)				**15.3**

Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	600	2	1,200
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	100	14	1,400
2.2.1-Install a geomembrane liner and geotextile	m^2	200	13	2,600
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	300	2	600
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	100	14	1,400
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	60	40	2,400

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	60	15	900
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	200	4	800
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	25	15	375
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**15,675**
AVERAGE COST ($/m³)				**26.1**

Table J-25. Cost Breakdown for the Closing of Hmairi Sour Dump – Zone 5

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
Option 1: Group with other dumps and transfer to sanitary landfill				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	600	2	1,200
2.2 - Transfer waste to sanitary landfill	trucks	30	65	1,950
2.3 - Gate fee at sanitary landfill	tonne	300	10	3,000
TOTAL COST ($)				**9,150**
AVERAGE COST ($/m³)				**15.3**
Option 2: Excavate, line, grade and cap				
Description	**Unit**	**Quantity**	**Unit price (US$)**	**Total price (US$)**
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	600	2	1,200
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	33	14	467
2.2.1-Install a geomembrane liner and geotextile	m^2	67	13	867
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	300	2	600
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	33	14	467
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	20	40	800

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	20	15	300
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	67	4	267
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	0	500	0
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit	unit	0	500	0
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	10	15	150
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**9,117**
AVERAGE COST ($/m³)				**15.2**

Table J-26. Cost Breakdown for the Closing of the Sir El Gharbiyeh Dump – Zone 5

Option 1: Group with other dumps and transfer to sanitary landfill

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	1,000	2	2,000
2.2 - Transfer waste to sanitary landfill	trucks	50	65	3,250
2.3 - Gate fee at sanitary landfill	tonne	500	10	5,000
TOTAL COST ($)				**14,250**
AVERAGE COST ($/m³)				**14.3**

Option 2: Excavate, line, grade and cap

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	3,000	3,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	1,000	2	2,000
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	167	14	2,333
2.2.1-Install a geomembrane liner and geotextile	m^2	333	13	4,333
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	500	2	1,000
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	167	14	2,333
3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	100	40	4,000

3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	100	15	1,500
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	333	4	1,333
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**26,583**
AVERAGE COST ($/m³)				**26.6**

Table J-27. Cost Breakdown for the Closing of the Srifa Dump – Zone 5

Option 1: Group with other dumps and transfer to sanitary landfill

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to an available sanitary landfill	m^3	630	2	1,260
2.2 - Transfer waste to sanitary landfill	trucks	32	65	2,048
2.3 - Gate fee at sanitary landfill	tonne	315	10	3,150
TOTAL COST ($)				**9,458**
AVERAGE COST ($/m³)				**15.0**

Option 2: Excavate, line, grade and cap

Description	Unit	Quantity	Unit price (US$)	Total price (US$)
1. Preparatory Works				
1.1 - Mobilization and Demobilization: Mobilization to the site and demobilization after completion of all the required tasks including machineries and equipment needed for the completion of the works.	LS	1	1,000	1,000
1.2 - Site Assessment: including visual inspection, topographic survey, initial assessment study and research, sampling, waste characterization, shop drawings, as built drawings and all necessary work needed to assess conditions of the dump.	LS	1	2,000	2,000
2. Earth Movement Works				
2.1 - Excavate the waste dump for the purpose of transfer its components to another location in the same plot.	m^3	630	2	1,260
2.2-Prepare bottom layer surface in new location within the site by placement and compaction of a 50 cm clay layer (one third the original area)	m^3	67	14	933
2.2.1-Install a geomembrane liner and geotextile	m^2	133	13	1,733
2.3 - Surface preparation and re-shaping: including movement of waste within the dump for the purpose of grading, compaction and stabilization of waste	m^3	315	2	630
3. Capping Works				
3.1 - Supply and install a well compacted low permeability clay liner (50 cm thickness)	m^3	67	14	933

3.2 - Supply and install a gravel drainage layer (30 cm thickness)	m^3	40	40	1,600
3.3 - Supply and install fine protective layer of soil (30 cm thickness)	m^3	40	15	600
3.4 -Supply and install a geotextile protective membrane between the clay liner and the gravel drainage layer	m^2	133	4	533
4. Gas Management Works				
4.1 - Supply and install a passive venting system complete including all accessories. The venting system includes the necessary gravel, piping, metallic funnel shaped structure, activated carbon, geotextile, and wood ships or compost.	LS	1	1,000	1,000
5. Leachate Management Works				
5.1 - Construction of a concrete leachate collection pit.	unit	1	1,000	1,000
5.2 - Construction of peripheral drainage channels to collect leachate and divert rain away from the dump. Drainage channel to be 80 cm x 80 cm x 80 cm min.	m	50	15	750
6. Control and Monitoring				
6.1 - Control and Monitoring of works	LS	1	1,000	1,000
TOTAL COST ($)				**14,973**
AVERAGE COST ($/m³)				**23.8**

Table J-28. Breakdown for the Previous and Recent Municipal Solid Waste Management Costs – Zone 1

Name of Village	Quantity generated (t/day)	Previous WM system		Recent WM system*	
		Current costs	Cost per ton	Total cost**	Cost per year
		2017 (L.L.)	$/tonne	$/tonne	LL
Yohmor (B-G)	2	16,200,000	14.79	50	54,750,000
Maydoun	2	20,000,000	18.26	50	54,750,000
Machghara	4	170,000,000	77.63	50	109,500,000
Ain Et Tineh (B-G)	2.5	36,000,000	26.30	50	68,437,500
Sohmor	5	100,000,000	36.53	50	136,875,000
Zilaya	1	8,000,000	14.61	50	27,375,000
Qelaya	1	20,000,000	36.53	50	27,375,000
Majdel Balhis	3	21,000,000	12.79	50	82,125,000
Kfar Michki	1	17,000,000	31.05	50	27,375,000
Kaoukaba Bou Aarab	2	24,000,000	21.92	50	54,750,000
Qaraaoun	8	79,995,000	18.26	50	219,000,000
Libbaya	3	40,000,000	24.35	50	82,125,000
TOTAL	**35.4**	**552,195,000**	**29.23**	**50**	**944,437,500**
				Additional funds needed (LL/year)	**392,242,500**

*after the Joub Jannine SWM complex started operation
**Includes collection at 10$/tonne, treatment at 25$/tonne and landfilling at 15$/tonne

Quantities of MSW generated in Aaytanit are not reported due to Municipality's non-cooperation to fill the survey questionnaire despite official communication and repeated attempts to follow-up.

Table J-29. Breakdown for the Current and Proposed Municipal Solid Waste Management Costs – Zone 2

Name of Village	Quantity generated (t/day)	Current WM system		Proposed WM system	
		Current costs	Cost per ton	Total cost*	Cost per year
		2017 (L.L.)	$/tonne	$/tonne	LL
Kfar Roummane	12	100,000,000	15.22	50	328,500,000
Aaramta	2	25,000,000	22.83	50	54,750,000
Kaoukaba (Hasbaiya)	1	11,000,000	20.09	50	27,375,000
Dibbine	2	80,000,000	73.06	50	54,750,000
Blat (Marjaayoun)	0.5	60,000,000	219.18	50	13,687,500
Jdaideh (Marjaayoun)	4.5	152,000,000	61.69	50	123,187,500
Jarmaq	0.05	6,000,000	219.18	50	1,368,750
Aaychiyeh	0.3	12,000,000	73.06	50	8,212,500
Dellafi	0.5	5,000,000	18.26	50	13,687,500
Srayri**	0.143	-	-	50	3,914,625
Qatrani*	0.5	-	-	50	13,687,500
Bouyada***	0.3	-	-	50	8,212,500
TOTAL	**23.79**	**451,000,000**	**36.05**	**50**	**651,333,375**
				Additional funds needed (LL/year)	**200,333,375**

*Includes collection at 10$/tonne, treatment at 25$/tonne and landfilling at 15$/tonne

Quantities of MSW generated in Rihane and Sejoud are not reported due to Municipalities' non-cooperation to fill the survey questionnaires despite official communication and repeated attempts to follow-up.
*** Union of Municipalities of Jabal El Rihane collects the waste*
**** No waste collection and management services.*

Table J-30. Breakdown for the Current and Proposed Municipal Solid Waste Management Costs – Zone 3

Name of Village	Current WM system			Proposed WM system	
	Quantity generated (t/day)	Current costs	Cost per ton	Total cost*	Cost per year
		2017 (L.L.)	$/tonne	$/tonne	LL
Kfar Kila	18	100,000,000	10.15	50	492,750,000
Borj El Mlouk	0.4	30,000,000	136.99	50	10,950,000
Deir Mimas	0.5	24,000,000	87.67	50	13,687,500
Deir Siriane	1	7,200,000	13.15	50	27,375,000
Aadaysseh	3.865	21,881,000	10.34	50	105,804,375
Arnoun	1	-	-	50	27,375,000
Zaoutar Ech-Charqiyeh	3	-	-	50	82,125,000
Yohmor (Nabatiye)	1	-	-	50	27,375,000
Aalmane	0.01	-	-	50	273,750
Kfar Tibnit	3	-	-	50	82,125,000
Qlaiaa	5	-	-	50	136,875,000
Zaoutar El Gharbiyeh	-	-	-	50	
TOTAL	**36.78**	**183,081,000**	**14.07**	**50**	**1,006,715,625**
				Additional funds needed (LL/year)	**823,634,625**

*Includes collection at 10$/tonne, treatment at 25$/tonne and landfilling at 15$/tonne

Table J-31. Breakdown for the Current and Proposed Municipal Solid Waste Management Costs – Zone 4

Name of Village	Current WM system			Proposed WM system	
	Quantity generated (t/day)	Current costs	Cost per ton	Total cost*	Cost per year
		2017 (L.L.)	$/tonne	$/tonne	LL
Taybeh	6	110,000,000	33.49	50	164,250,000
Rabb Et Talatine	0.3	27,000,000	164.38	50	8,212,500
Aadchit (Qoussair)	1.5	100,000,000	121.77	50	41,062,500
Markaba	1.5	48,000,000	58.45	50	41,062,500
Khirbet Selm	2	120,000,000	109.59	50	54,750,000
Aaytaroun	10	200,000,000	36.53	50	273,750,000
Jmaijmeh	2	30,000,000	27.40	50	54,750,000
Maroun Er Ras	1	60,000,000	109.59	50	27,375,000
Aaynata (Bent Jbayl)	5	70,000,000	25.57	50	136,875,000
Kfar Dounine	1.6	39,000,000	44.52	50	43,800,000
Chaqra	10	162,000,000	29.59	50	273,750,000
Beit Yahoun	3.5	52,526,000	27.41	50	95,812,500
Majdel Selm	4	100,000,000	45.66	50	109,500,000
Bani Haiyane	1.25	14,000,000	20.46	50	34,218,750
Borj Qalaouiyeh	2	54,000,000	49.32	50	54,750,000
Blida	1.3	54,000,000	75.87	50	35,587,500
Soultaniyeh	5	61,200,000	22.36	50	136,875,000
Kounine	0.8	28,000,000	63.93	50	21,900,000
Talloussa	1	25,000,000	45.66	50	27,375,000
Tiri	0.8	50,000,000	114.16	50	21,900,000
Ghandouriyeh	3	12,000,000	7.31	50	82,125,000
Souaneh	1.5	23,500,000	28.61	50	41,062,500
Qantara	0.2	13,200,000	120.55	50	5,475,000
Qabrikha	1	50,000,000	91.32	50	27,375,000
Qalaouiyeh	2	30,000,000	27.40	50	54,750,000
Meiss Ej Jabal	5	240,000,000	87.67	50	136,875,000
Touline	5	50,000,000	18.26	50	136,875,000
Mhaibib	0.25	-	-	50	6,843,750
Houla	6	40,000,000	12.18	50	164,250,000
TOTAL	**84.50**	**1,863,426,000**	**40.28**	**50**	**2,313,187,500**
				Additional funds needed (LL/year)	**449,761,500**

*Includes collection at 10$/tonne, treatment at 25$/tonne and landfilling at 15$/tonne

Table J-32. Breakdown for the Current and Proposed Municipal Solid Waste Management Costs – Zone 5

Name of Village	Quantity generated (t/day)	Current WM system		Proposed WM system	
		Current costs	Cost per ton	Total cost*	Cost per year
		2017 (L.L.)	$/tonne	$/tonne	LL
Arzai	5.5	54,000,000	17.93	50	150,562,500
Sir El Gharbiyeh	3	45,000,000	27.40	50	82,125,000
Qsaibeh (Nabatiye)	4	60,000,000	27.40	50	109,500,000
Kfar Sir	4	120,000,000	54.79	50	109,500,000
Deir Qanoun En-Nahr	8	95,000,000	21.69	50	219,000,000
Braiqeaa	2	40,000,000	36.53	50	54,750,000
Srifa	3	126,000,000	76.71	50	82,125,000
Bestiyat	0.1	4,200,000	76.71	50	2,737,500
Borj Rahhal	14	250,000,000	32.62	50	383,250,000
Chehour	2.75	100,000,000	66.42	50	75,281,250
Maaroub	12	70,000,000	10.65	50	328,500,000
Tayr Falsay	18.5	60,000,000	5.92	50	506,437,500
Jennata	0.5	30,000,000	109.59	50	13,687,500
Arzoun	3	20,000,000	12.18	50	82,125,000
Bedias	3.5	45,000,000	23.48	50	95,812,500
Halloussiyeh	1.5	24,000,000	29.22	50	41,062,500
Kharayeb (Saida)	14	100,000,000	13.05	50	383,250,000
Zrariyeh	6	300,000,000	91.32	50	164,250,000
Derdaghaiya	1.5	18,000,000	21.92	50	41,062,500
Hmairi	1	-	-	50	27,375,000
Qaaqaaiyet Ej Jisr	6	25,000,000	7.61	50	164,250,000
Froun	3	25,000,000	15.22	50	82,125,000
TOTAL	**116.85**	**1,611,200,000**	**25.40**	**50**	**3,198,768,750**
Additional funds needed (LL/year)					**1,587,568,750**

*Includes collection at 10$/tonne, treatment at 25$/tonne and landfilling at 15$/tonne

Table J-33. Cost Breakdown for the Pre-Treatment of Effluents of Priority Industries – Zone 1

	ID	Village	Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
Priority 1	A023	Kaoukaba	Rock Cutting	30	TSS, Turbidity	Screening, Gravity thickener, Filter press	55,000	8,250	5,000
	A027	Sohmor	Olive Mill	6	BOD, COD, oil and grease, TSS	Combine the effluents of the 5 industries into a single treatment facility: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	200,000	30,000	20,000
	A029	Sohmor	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A034	Sohmor	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A038	Yohmor	Olive Mill	9	BOD, COD, oil and grease, TSS				
	A028	Sohmor	Olive Mill	9	BOD, COD, oil and grease, TSS				
	A024	Machghara	Olive Mill	9	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	75,000	11,250	5,000
Priority 2	A026	Majdel Balhis	Olive Mill	9	BOD, COD, oil and grease, TSS	Combine the effluents into a single facility: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	125,000	18,750	15,000
	A031	Majdel Balhis	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A043	Zilaya	Olive Mill	12	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	90,000	13,500	7,000

	ID	Village	Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
	A048	Dellafi	Rock Cutting	30	TSS, Turbidity	Screening, Gravity thickener, Filter press	55,000	8,250	5,000
					SUB-TOTAL		**600,000**	**90,000**	**57,000**
					TOTAL		**747,000**		

Table J-34. Cost Breakdown for the Pre-Treatment of Effluents of Priority Industries – Zone 2

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
Priority 1	A066	Kfar Tibnit	Dairy Products	20	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, Dissolved Air Flotation, followed by biological treatment and sludge dewatering	60,000	9,000	5,000
					SUB-TOTAL		**60,000**	**9,000**	**5,000**
					TOTAL		**74,000**		

Table J-35. Cost Breakdown for the Pre-Treatment of Effluents of Priority Industries – Zone 3

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
Priority 1	A118	Deir Mimas	Olive Mill	6	BOD, COD, oil and grease, TSS	Combine the effluents into a single facility: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	90,000	13,500	7,000
	A119	Deir Mimas	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A091	Yohmor (Nabatiye)	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
Priority 2	A145	Kfar Kila	Olive Mill	9	BOD, COD, oil and grease, TSS	Build a treatment facility for all the olive mills in Kfar kila: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	300,000	45,000	25,000
	A147	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A148	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A156	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A160	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A144	Kfar Kila	Olive Mill	9	BOD, COD, oil and grease, TSS				
	A146	Kfar Kila	Olive Mill	6	BOD, COD, oil and grease, TSS				
	A165	Aadaysseh	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
					SUB-TOTAL		**520,000**	**78,000**	**42,000**
					TOTAL		**640,000**		

Table J-36. Cost Breakdown for the Pre-Treatment of Effluents of Priority Industries – Zone 4

	ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
Priority 1	A201	Jmaijmeh	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
Priority 2	A140	Taybeh	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
	A167	Borj Qalaouiyeh	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
	A169	Borj Qalaouiyeh	Rock Cutting	30	TSS, Turbidity	Screening, Gravity thickener, Filter press	55,000	8,250	5,000
	A200	Houla	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
	A213	Kounine	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	65,000	9,750	5,000
	A218	Aaytaroun	Olive Mill	6	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological	75,000	11,250	6,000

ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
A222	Aaytaroun	Olive Mill	15	BOD, COD, oil and grease, TSS	treatment and sludge dewatering			
A220	Aaytaroun	Dairy Products	15	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, Dissolved Air Flotation, followed by biological treatment and sludge dewatering	60,000	9,000	5,000
				SUB-TOTAL		**515,000**	**77,250**	**41,000**
				TOTAL		**633,250**		

Table J-37. Cost Breakdown for the Pre-Treatment of effluents of Priority Industries – Zone 5

<table>
<tr><th></th><th>ID</th><th>Village</th><th>Type of Activity</th><th>Estimated WW volume (m³/d)</th><th>Effluent Characteristics</th><th>Pre-treatment needed</th><th>Pre-treatment Cost (US$)</th><th>O&M Cost (US$)</th><th>Studies' Cost (US$)</th></tr>
<tr><td rowspan="10">Priority 1</td><td>A068</td><td>Kharayeb (Saida)</td><td>Rock Cutting</td><td>30</td><td>TSS, Turbidity</td><td>Screening, Gravity thickener, Filter press</td><td>55,000</td><td>8,250</td><td>5,000</td></tr>
<tr><td>A072</td><td>Kharayeb (Saida)</td><td>Olive Mill</td><td>6</td><td>BOD, COD, oil and grease, TSS</td><td>Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering</td><td>65,000</td><td>9,750</td><td>5,000</td></tr>
<tr><td>A079</td><td>Zrariyeh</td><td>Olive Mill</td><td>6</td><td>BOD, COD, oil and grease, TSS</td><td rowspan="2">Combine the effluents into a single facility: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering</td><td rowspan="2">90,000</td><td rowspan="2">13,500</td><td rowspan="2">7,000</td></tr>
<tr><td>A082</td><td>Zrariyeh</td><td>Olive Mill</td><td>6</td><td>BOD, COD, oil and grease, TSS</td></tr>
<tr><td>A104</td><td>Bedias</td><td>Rock Cutting</td><td>30</td><td>TSS, Turbidity</td><td>Screening, Gravity thickener, Filter press</td><td>55,000</td><td>8,250</td><td>5,000</td></tr>
<tr><td>A116</td><td>Deir Qanoun En-Nahr</td><td>Rock Cutting</td><td>30</td><td>TSS, Turbidity</td><td>Screening, Gravity thickener, Filter press</td><td>55,000</td><td>8,250</td><td>5,000</td></tr>
<tr><td>A130</td><td>Deir Qanoun En-Nahr</td><td>Olive Mill</td><td>12</td><td>BOD, COD, oil and grease, TSS</td><td rowspan="3">Combine the effluents from the 3 facilities into a single treatment facility: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering</td><td rowspan="3">200,000</td><td rowspan="3">30,000</td><td rowspan="3">20,000</td></tr>
<tr><td>A131</td><td>Deir Qanoun En-Nahr</td><td>Olive Mill</td><td>12</td><td>BOD, COD, oil and grease, TSS</td></tr>
<tr><td>A124</td><td>Deir Qanoun En-Nahr</td><td>Olive Mill</td><td>9</td><td>BOD, COD, oil and grease, TSS</td></tr>
<tr><td>Priority 2</td><td>A094</td><td>Kfar Sir</td><td>Chocolate</td><td>10</td><td>BOD, COD, oil and grease, TSS</td><td>Screening, Equalization and neutralization, Dissolved Air Flotation and sludge dewatering</td><td>65,000</td><td>9,750</td><td>5,000</td></tr>
</table>

ID	Village	Type of Activity	Estimated WW volume (m^3/d)	Effluent Characteristics	Pre-treatment needed	Pre-treatment Cost (US$)	O&M Cost (US$)	Studies' Cost (US$)
A089	Qsaibeh	Olive Mill	9	BOD, COD, oil and grease, TSS	Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	75,000	11,250	6,000
A101	Tayr Falsay	Rock Cutting	30	TSS, Turbidity	Screening, Gravity thickener, Filter press	55,000	8,250	5,000
A102	Tayr Falsay	Olive Mill	6	BOD, COD, oil and grease, TSS	Combine the effluents into a single facility: Screening, Equalization and neutralization, lime treatment followed by biological treatment and sludge dewatering	90,000	13,500	9,000
A106	Tayr Falsay	Olive Mill	6	BOD, COD, oil and grease, TSS				
				SUB-TOTAL		**805,000**	**120,750**	**72,000**
				TOTAL		**997,750**		

Table J-38. Cost Breakdown of the Proposed Measures to Combat Agricultural Pollution

Proposed Measures	Cost Breakdown (USD)
Build and strengthen capacity on IPM	
1- Development of IPM curricula of important crops in the region (e.g. Olives, Tobacco, Wheat, Grapes) with the help of extension agents and local experts	108,000 (6 Months*6 crops*1500 USD/months*2 people)
2- Collection of preliminary baseline information on current practices for the selected crops (proper pruning, fertilization, pest control...)	72,000 (6 Months*1500 USD/months*2 people*4 regions (Sour/Saida; West Bekaa + Rachayya + Hasbaiya; Marjaayoun; Nabatiye/BentJbayl)
3- Introduction of new varieties/cultivars that are resistant to diseases and pathogens	Already Budgeted in Law No. 63/2016
4- Surveying of present pests and natural enemies of selected crops	Along with #2 above
1- Training on proper agrochemical handling, application and storage	12,000 (6 sessions*4 regions*500 per day)
2- Creation of farmer discussion groups through equipping demonstration plots in 3-4 regions to solve their problems individually and collectively whenever applicable based on their experience and expert consultation.	148,000 (4 fields*10,000 per field for equipment and rental + 1,500 USD/Month*6 Months*3 people*4 regions)
3- Establishment of liaisons between farmers, extension service agents and experts in research stations and universities for the identification of proper IPM techniques and their dissemination	36,000 (4 regions * 1 person * 1,500USD/Mo * 6Mo)
4- Familiarization of farmers with the different techniques and tools used in IPM (insects attractants, traps, natural enemies, use of climatic parameters)	72,000 (4 regions *3 people * 4 months * 1,500 USD/Mo)
1-Mandating and enforcing the use of buffer zones for maximum pesticide trapping efficiency	Already Budgeted in Law No. 63/2016
2- Create incentives in favour of IPM and organic products through removal of direct or indirect subsidies for pesticide use, and tax exemption for environmentally friendly pesticides	Already Budgeted in Law No. 63/2016
Management costs for "building and strengthening capacity on IPM" component	*96,000 (1 project Manager * 2,500 USD/ month *24 months and 1 Assistant * 1,500 USD/month * 24 months)*

Proposed Measures	Cost Breakdown (USD)
Identify technical problems and constraints of production and export of selected crops	
Promotion of produce cultivated using IPM techniques (agricultural trade fairs, TV awareness, international exhibitions…)	Already Budgeted in Law No. 63/2016
1- Training sessions on traceability and certification: Protocol of production following the characteristics of the agricultural products (varieties, form, colour, etc.), region of production, localization of the field where crops are cultivated (name/ producer/ certificates), cultural techniques used	17,000 (4 regions * 5 days * 500USD/day + 20 expert days*350USD)
2- Training sessions on labelling, packaging, storage, current safety standards and quality, crop specific quarantine requirements in the targeted markets	17,000 (4 regions * 5 days * 500USD/day + 20 expert days*350USD)
Performance of regular pesticide residue tests on certified IPM products throughout the production season	116,000 (4 regions * 20 crops * 20 samples/crop * 50USD/sample + 12 Mo * 1,500 USD * 2 for salaries)
Management costs for "Identifying problems and constraints of production and export of selected crops" component	*48,000 (1 project Manager * 2,500 USD/ month *12 months and 1 Assistant * 1,500 USD/month * 12 months)*
Monitor Water and Soil Quality	
1- Training Sessions on water quality for irrigation	7,000 (4 regions * 2 days * 500USD/day + 8 expert days*350USD)
2- Training Sessions on water analysis for irrigation	7,000 (4 regions * 2 days * 500USD/day + 8 expert days*350USD)
3- Training Sessions on agricultural soil pollutants	7,000 (4 regions * 2 days * 500USD/day + 8 expert days*350USD)
4- Training Sessions on soil sampling and analysis for pollutant accumulation	7,000 (4 regions * 2 days * 500USD/day + 8 expert days*350USD)
1- Estimation of pollution loads by frequent soil sampling and analysis	54,000 (1sample/Mo*12Mo* 10 samples from 5 zones*50$/sample+1000*5*12 for personnel)
2- Estimation of pollution loads by frequent sampling of water to determine if the irrigation water quality standards are met for fertilizers and pesticides	78,000 (2sample/Mo*12Mo* 15 samples from 5 zones*50$/sample+1000*5*12 for personnel)
Management costs for "Monitoring water and soil quality" component	*48,000 (1 project Manager * 2,500 USD/ month *12 months and 1 Assistant * 1,500 USD/month * 12 months)*

Proposed Measures	Cost Breakdown (USD)
Support the installation and use of efficient Irrigation methods and technologies to avoid excessive leaching and salinization	
1- Field training on drip irrigation: Existing and new equipment features and benefits	20,000 (4 regions * 10 days * 500 USD/day)
2- Field training on water management, water budgeting and scheduling, and use of agro-meteorological data	20,000 (4 regions * 10 days * 500 USD/day)
3- Field training on methods to enhance the use of filtration techniques (improve water quality, impact on irrigation systems, use of sand, screen, disc, etc.)	20,000 (4 regions * 10 days * 500 USD/day)
4- Field training on methods in field drainage (planning of drainage improvements, operation & maintenance of drainage system)	135,000 (4 regions *3 people * 6 months * 1,500 USD/Mo + 20 Expert days *350USD/day + 20,000 travel and other expenses)
Management costs for "Supporting the installation and use of efficient Irrigation methods and technologies to avoiding excessive leaching and salinization" component	*24,000 (1 project Manager * 2,500 USD/ month *6 months and 1 Assistant * 1,500 USD/month * 6 months)*
Support integrated Plant nutrition systems and soil conservation at farming community level	
1- Educate farmers on the use of soil organic matter and appropriate mechanical and conservation tillage practices	20,000 (4 regions * 10 days * 500 USD/day)
2- Awareness raising on the negative environmental impacts of traditional fertilization (Overuse of fertilisers and impacts, suggested alternatives to traditional practices)	Already Budgeted in Law No. 63/2016
3 Training to improve understanding of basic plant nutrient requirements (crops' needs for production)	20,000 (4 regions * 10 days * 500 USD/day)
4- Training on proper fertilization and fertigation (Basics of fertilization and techniques of fertigation)	20,000 (4 regions * 10 days * 500 USD/day)
Management costs for "Supporting integrated Plant nutrition systems and soil conservation at farming community level" component	*48,000 (1 project Manager * 2,500 USD/ month *12 months and 1 Assistant * 1,500 USD/month * 12 months)*
Creation of Nitrate Vulnerable Zones (NVZs)	
Identification of potentially susceptible areas known as Nitrate Vulnerable Zones (NVZs)	80,000 (4 experts * 6 Months * 2500USD/Month + 20 Expert days * 1000USD)

Proposed Measures	Cost Breakdown (USD)
Restricting farms within an NVZ with regard to how much nitrogen fertilizer can be applied to the land	60,000 (5000 USD/month * 12)
Management costs for "Creation of Nitrate Vulnerable Zones" component	*48,000 (1 project Manager * 2,500 USD/ month *12 months and 1 Assistant * 1,500 USD/month * 12 months)*
Ecological and Land Rehabilitation	
1- Estimation of land use – land cover changes between two base maps or satellite images (e.g., 2005 and 2020); net primary productivity (NPP) and soil organic Carbon (SOC).	60,000 (1 senior expert * 3 months * 2,500USD/month + 2 experts * 12 Months * 1,500 USD/Month + 16,500 USD cost of acquiring satellite imagery)
2- Multiseasonal ecological assessment based on tactical sampling (core and edge quadrates and transects) over up to 3 years	30,000 (10,000 USD/year * 3 years)
3- Land degradation assessment including establishment of a corridor	50,000 (Biodiversity Expert 90 man-days * 300 USD/month +Agriculture Expert 60 man-days * 300 USD/month + 5,000 USD field expenses)
4- Topographic surveys of quarries and engineering studies to determine rehabilitation requirements of quarries using construction and demolition waste, and related Environmental Impact Assessments (EIAs).	500,000 (333,000 USD for implementing Com Decision 45/2019 (Policy brief) on the Integrated Management of the Quarries and Crushers Sector + 167,000 USD for related EIAs)
Management costs for "building and strengthening capacity on IPM" component	*96,000 (1 project Manager * 2,500 USD/ month *24 months and 1 Assistant * 1,500 USD/month * 24 months)*