

WATER SUPPLY AND WASTEWATER SYSTEMS MASTER PLAN FOR THE BEKAA WATER ESTABLISHMENT

INCEPTION REPORT

THIS DOCUMENT IS PREPARED BY DAI/KREDO UNDER THE LEBANON WATER AND WASTEWATER SECTOR SUPPORT PROGRAM (LWWSS) FUNDED BY USAID



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TABLE OF CONTENTS

1-	INTRODUCTION AND SCOPE OF WORK			
2-	POPULATION PROJECTIONS			
	2.1	POPULATION ESTIMATES		
	2.2	POPULATION GROWTH		
3-	WA	FER MANAGEMENT		
	3.1	WATER SOURCES		
	3.2	WATER NEEDS		
	3.3	EXISTING FACILITIES		
	3.4	ADDITIONAL EXISTING STUDIES9		
	3.5	WATER STORAGE		
4-	WAS	STEWATER MANAGEMENT		
	4.1	WASTEWATER FLOW		
	4.2	EXISTING AND PLANNED WASTEWATER TREATMENT PLANTS		
	4.3	ADDITIONAL EXISTING STUDIES		
5-	- IRRIGATION			
	5.1	IRRIGATION PROJECTS		
	5.2	WASTEWATER EFFLUENT REUSE IN IRRIGATION		
	5.3	PREPARATION OF THE SCOPE OF WORK		
6-	EXIS	STING BWE FACILITIES: ASSETS DATABASE		
7-	GEC	OGRAPHICAL INFORMATION SYSTEM		
	7.1	IMPROVING GIS FUNCTIONALITY AND UPDATING DATABASE		
	7.2	SUPPORT TO THE BWE		
8-	ADD	DITIONAL INFORMATION GATHERED TO DATE		
9-	wo	RK ORGANISATION		

LIST OF TABLES

TABLE 2.1: BEKAA POPULATION ACCORDING TO DIFF	FERENT SOU
TABLE 2.2: BEKAA POPULATION CALCULATED BASED	ON CAS 200
TABLE 2.3: NUMBER OF BEKAA VOTERS	
TABLE 3.1: AVERAGE FLOWS IN THE BEKAA SURFAC	E WATER CC
TABLE 3.2: GROUNDWATER USE IN THE BEKAA	
TABLE 3.3: SUMMARY OF BWE ASSETS	
TABLE 3.4: DISTRIBUTION OF ASSETS PER ZONE (AS	DEFINED BY
TABLE 3.5: PLANS RECEIVED FROM MEW CONCERNI	NG POTABLE
TABLE 3.6: COMPLETED AND ONGOING WATER SUPP	VLY PROJEC
TABLE 3.7: SURFACE WATER POTENTIAL FOR THE BI	ΞΚΑΑ
TABLE 4.1: STATUS OF THE BEKAA TREATMENT PLAN	NTS PLANNE
TABLE 4.2: WASTEWATER TREATMENT PLANTS FUNI	DED BY USAI
TABLE 4.3: WASTEWATER TREATMENT PLANTS ACCO	ORDING TO 1
TABLE 4.4: WASTEWATER TREATMENT PLANTS AC	CORDING T
DATABASE	
TABLE 4.5: COMPLETED AND ONGOING WASTEWATE	R PROJECTS
TABLE 4.6: PLANS RECEIVED FROM MEW CONCERNI	NG SEWER N
TABLE 5.1: LAND AND CROP INVENTORY FROM "REC	ENSEMENT (
(FAO 1999)	

LIST OF FIGURES

FIGURE 3.1: FACILITIES DISTRIBUTION
FIGURE 3.2: WELLS AND SPRINGS CONDITION
FIGURE 3.3: WATER TREATMENT FACILITIES
FIGURE 3.4: PUMPING STATIONS AND CHLORINATORS CONDITION
FIGURE 3.5: WATER SUPPLY COMPLETED & ONGOING PROJECT
FIGURE 3.6: WATER SUPPLY PROJECTS UNDER PREPARATION I
FIGURE 4.1: WASTEWATER TREATMENT PLANTS ACCORDING TO
FIGURE 4.2: WASTEWATER COMPLETED, ONGOING & UNDER PF
PROGRESS REPORT – 2012



RCES	4
94 BUILDING CENSUS	4
	5
URSES	6
	6
	8
BWE)	8
WATER PROJECTS	9
IS IN THE BEKAA (CDB)	9
	10
	10
	17
	/ ۱ ۱۰
HE BWE 2012-2016 BUSINESS PLAN	10
J THE BWE ASSETS ASSESSMENT	
	19
S IN THE BEKAA (CDR)	21
IETWORK PROJECTS	22
GÉNÉRAL DE L'AGRICULTURE"	
	26

	. 11
	. 12
	. 13
Ν	. 14
FROM CDR PROGESS REPORT - 2012	. 15
ROM CDR PROGESS REPORT - 2012	. 15
THE BWE ASSESSMENT DATABASE	. 23
PARATION PROJECTS FROM CDR	
	.24

INCEPTION REPORT

PAGE 1 OF 67

PROPOSED TIMELINE

APPENDIX A:

- A.1 POPULATION ESTIMATES FROM PREVIOUS STUDIES
- A.2 NUMBER OF TOWNS AND VILLAGES IN THE BEKAA ACCORDING TO DIFFERENT SOURCES
- A.3 TOWNS AND VILLAGES NAMES ACCORDING TO CDR & DGA
- A.4 TOWNS AND VILLAGES NAMES ACCORDING TO CAS
- A.5 POPULATION SURVEY QUESTIONNAIRE
- A.6 WATER NEEDS IN THE BEKAA REGION FROM "ANALYSE DES STRATEGIES ET PROSPECTIVES DE L'EAU AU LIBAN" - (PLAN BLEU-UNEP 2001)
- A.7 WASTEWATER TREATMENT PLANTS FOR IN THE NORTH & SOUTH OF BEKAA FROM SIU-MRHE (2000)
- A.8 WASTEWATER TREATMENT PLANT LOCATIONS FROM "MASTER PLAN STUDY TO LOCATE WASTE WATER TREATMENT PLANTS IN BEKAA" (DAHNT 1994 - MINISTRY OF HOUSING AND COOPERATIVE)

APPENDIX B:

- B.1 ROAD NETWORKS, SDATL, 2002
- B.2 RAINFALL DISTRIBUTION MAP, PLASSARD, 1:200,000, 1971
- B.3 GEOLOGICAL MAP, L. DUBERTRET, 1:50,000, 1945
- B.4 HYDROLOGICAL MAP, TOPOGRAPHIC MAP DGA, 1:50,000, 1945
- B.5 INDUSTRIES DISTRIBUTION IN THE BEKAA, SDATL, 2002
- B.6 LAND USE, MOA, 1:20,000, 2001
- B.7 SOIL MAP, GEZE, 1954

LIST OF ACRONYMS

BWE	BEKAA WATER ESTABLISHMENT
CAS	CENTRAL ADMINISTRATION OF STATIST
CDM	CAMP DRESSER & MCKEE
CDR	COUNCIL FOR DEVELOPMENT AND REC
DAI	DEVELOPMENT ALTERNATIVES, INC.
DAHNT	DAR AL HANDASAH NAZIH TALEB AND P
DGA	DIRECTORATE GENERAL OF THE ARMY
GIS	GEOGRAPHIC INFORMATION SYSTEM
GIZ	GERMAN AGENCY FOR INTERNATIONAL
IFES	INTERNATIONAL FOUNDATION FOR ELE
K&A	KHATIB & ALAMI
LCWMC	LEBANESE CENTER FOR WATER MANAG
LRA	LITANI RIVER AUTHORITY
LWWSS	LEBANON WATER AND WASTEWATER S
MEW	MINISTRY OF ENERGY AND WATER
MOA	MINISTRY OF AGRICULTURE
USAID	UNITED STATES AGENCY FOR INTERNA



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TIONAL DEVELOPMENT

INCEPTION REPORT

PAGE 2 OF 67

1 INTRODUCTION AND SCOPE OF WORK

On December 1st, 2012 KREDO has been commissioned by DAI to carry out the project entitled "Development of a Water Supply and Wastewater Systems Master Plan within the Service Area of the Bekaa Water Establishment" as part of the USAID – Lebanon Water Wastewater Sector Support Program (LWWSS). The project duration is sixteen months and it includes 9 major deliverables spread between Month 2 and Month 16, in addition to brief monthly reports. The present report is the Inception Report which is the first scheduled deliverable

The scope of the current study is to establish water supply and wastewater master plans in order to support the Bekaa Water Establishment (BWE) decision-makers in the preparation of a rational infrastructure development and capital investment plan for water supply, water distribution, wastewater collection and wastewater treatment systems, as well as elements of an irrigation system.

More specifically, the following activities are required:

- Review population projections used in different studies.
- Forecast population sizes and distribution. The number of inhabitants, residences, schools, and industries will be included in the region covered in order to determine the average population size for the year 2035 planning horizon.
- Collect existing water sources information springs, rivers, wells, etc.
- Collect existing studies concerning the water supply and distribution network in the project area, as well as any existing master plans. Focus will be on recent and relevant studies.
- Collect information concerning water supply projects already executed in the last 20 years.
- Determine current and future water needs based on population projections for the year 2035.
- Make recommendations to improve the water supply system in accordance with the National Water Strategy and the BWE 2012-2016 Business Plan and present these improvements in a schedule of CAPE and OPEX along with their timing.
- Assess CAPEX needs for deploying water metering across BWE service area and recommend implementation plan.
- Collect existing studies concerning wastewater treatment plants, sewer networks, and proposed discharge points as well as any existing master plans. Focus will be on recent and relevant studies.
- Collect information concerning wastewater treatment plants and sewer networks already executed.
- Determine current and future wastewater flow quantities based on population projections for the year 2035. The projected volumes of wastewater for every village and by region shall be calculated.

- Make recommendations for improvements to the sewage system and wastewater treatment plants according with the National Water Sector Strategy and the BWE 2012-2016 Business Plan, and present these recommendations in a schedule of CAPE and OPEX along with their timing.
- Evaluate funding mechanisms for all recommended actions.
- Collect existing irrigation water system information and prepare a detailed scope of work and cost estimate for an Irrigation Water Master Plan.
- Improve the existing BWE GIS functionality, update the GIS database, and support the BWE in the preparation of its annual business plan 2014 update. The present report summarizes the information gathered and inception work to date and establishes the framework to be adopted in the next phase in order to complete the required master plan.



2 POPULATION PROJECTIONS

2.1 Population Estimates

Population estimates are one of the essential elements in a successful master plan. Erroneous population estimates will lead to inaccurate projections of water quantity needs and generated wastewater flows which in turn will lead to a flawed solution scheme. Unfortunately, no population census has been conducted in Lebanon since 1932. That has caused the government to rely on estimates for any design or any project, albeit these estimates are sometimes based on some local baseline information such as electrical connections, number of registered voters, some limited population counts, etc. This has resulted in widely varying estimates from one study to the next. For example, a study carried out by Dar Al Handasah Nazih Taleb and Partners (DAHNT) for the Ministry of Housing and Cooperative in 1994 and entitled "Master Plan Study to Locate Waste Water Treatment Plants in Bekaa" has estimated (based on data from literature and a field survey) the population of the Bekaa to be 536,638 in 1980 and 873,972 in 1994 (Table A1); while the National Waste Management Plan produced by Camp Dresser & McKee Inc. (CDM) in association with Khatib & Alami in 1982 has estimated the Bekaa population in 1980 to be 480,447 and the update of the Master Plan by Khatib & Alami (K&A) in 1994 estimated that year's population to be 477,897. The K&A number is half the estimate of the DAHNT study but would still be, if projected to 2011, considerably higher than the number used in the Terms of Reference of this current project which specifies the current population of the Bekaa to be around 516,000. It is understood that the current population estimate given in the TOR is projected from the estimates of the CAS (Central Administration of Statistics), which places the population of the Bekaa at about 489.865 in 2007 and uses a fixed 1.3% population growth factor for all of Lebanon.

TABLE 2.1: BEKAA POPULATION ACCORDING TO DIFFERENT SOURCES

Population	DAHNT Master Plan	CDM/K&A Master Plan	Master Plan TOR	Calculated from CAS Building Census (compounded values per caza)	Calculated from Voters' Turnout	Calculated from Registered Voters
1980	536,638	480,447				
1994	873,972	477,897				
2004				609,173		
2007			489,865			
2009					479,870	908,694
2011			516,000			940,817

At a meeting held with the CAS Director General Dr. Maral Tutelian and her team, it was confirmed that no population census exists for the Bekaa region, and that the figure estimated in 2007 was obtained from an approximation at the level of the Mohafaza and hence there is no breakdown of this estimate by caza or village. On the other hand, the CAS conducted a building census for all of Lebanon in 2004 and the results published by caza. This census covered the number of buildings, dwellings, and commercial facilities along with a host of other information among which building type, use, status, construction date, unit surface area distribution, and type of occupancy. The following table lists the number of dwellings (units) used for housing purposes (excluding units used solely for other purposes, empty units, closed units, and units under construction) for each caza in the Bekaa. Also according to a 2004 CAS population characteristics survey, the average household size in the Bekaa was 4.58 (unfortunately, there is no specific number per caza). By multiplying the number of housing units with the average household size, a rough estimate of the population by caza can be obtained (Table 2.2). According to the literature accompanying the results of this census, the field work was collected on the basis of geographical or cadastral units which sometimes coincide with the administrative limits of a municipality or a town. Efforts are currently under way to obtain the information from the CAS by geographical unit as population estimates per caza are of very limited use in the current master plan.

TABLE 2.2: BEKAA F	POPULATION CALCUL	ATED BASED ON CAS
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Cozo	Nb of housing units	Population	
Gaza	2004	2004	
Zahle	41,729	191,119	
West Bekaa	17,525	80,265	
Baalbeck	57,732	264,413	
Hermel	8202	37,565	
Rachaya	7819	35,811	
TOTAL	133,007	609,173	

CAS has informed the Consultant that a study is currently underway to conduct a building census for a handful of localities in the caza of Zahle. Similarly to the 2004 census, it will gather information on: the number of buildings, the number of dwellings, water connections, sewer connections, and source of water. An official letter has been sent to the CAS by the BWE authorizing that this information be released to this Consultant.

It is important to note that there is no consensus on the number of towns and villages in the Bekaa. Indeed different sources give widely varying numbers: the DAHNT study mentioned above lists 258; the official CDR list 304; the CAS 212; the USAID 251 (however, this list contains some omissions, errors villages listed twice, misplaced villages misplaced-, and a large number of "disputed" villages); and the TOR of the current study mention 330 (without listing them) out of which 240 are said to be connected



2004 BUILDING CENSUS

to the BWE public water supply network (Tables A1 and A2 in Appendix A). In this study, the towns/villages considered are based on the official cadastral map issued by the DGA. Moreover, there is no consensus on the spelling of the towns/villages/localities names as they are translated from Arabic. The spelling adopted in this study is that used by USAID for all its projects in Lebanon. However, for information purposes, the different spellings used by the various Lebanese Authorities (CDR, DGA, CAS) are listed in tables A3 and A4 and can be referred to in case any confusion concerning the name of a village occurs.

The 2011 Electoral Districts in Lebanon report published by the IFES (International Foundation for Electoral Districts) lists the following number of voters for the Bekaa, provided by the Ministry of Interior and Municipalities:

TABLE 2.3: NUMBER OF BEKAA VOTERS

District	Number of voters (2011)	Number of voters (2009)	Turnout (2009)	Turnout % (2009)
Baalbeck-Hermel	268,457	255,637	126,038	49.3
Zahle	160,091	158,005	91,848	58.1
West Bekaa -Rachaya	126,534	122,487	65,237	53.3
Total	555,082	536,129	283,123	52.8

The UNDP, in their report entitled "Selected Characteristics of the Population in Bekaa - 2004" has listed the following population distribution by age:

<u>Age</u>	Percentage of total population
Less than 15 years	28.1
15 – 24 years	21.1
25 – 44 years	29.6
45 – 64 years	15.7
Above 65 years	8.5

Accordingly, about 41% of the Bekaa population is not eligible to vote (the minimum age for voters' eligibility in Lebanon is 21 years), and hence the total number of voters in principle would represent 59% of the population only. Knowing that a large number of registered voters do not actually live in the Bekaa (having emigrated or living in another area in Lebanon), it is believed that the turnout number is more indicative of the actual population, or at least the population still having residential ties in the Bekaa. Hence assuming the turnout number represents 59% of the resident population would bring the



2.2 Population Growth

In the absence of relevant information that can be used to realistically predict population estimates taking into account population movements and emigration as well as natural population growth, the following rates have been used for other studies in Lebanon:

Population	<u>1</u>	<u>Annu</u>
<1000		2.0%
1,000 to 5,0	000	2.15%
5,000 to 10	,000	2.25%
>10,000		2.35%

These values are however higher than the flat rate of 1.75% adopted by the NWSS, and the BWE Business Plan. In order to stay in line with the NWSS and the BWE, this growth rate value will be adopted at this stage. However, once the results of the limited population survey and the additional information requested from the CAS become available, this value will be reassessed and, if needed, a new growth rate value adopted, in agreement with the BWE. A report including all the population data gathered, projections, and recommended population estimates will be issued at the end of May and submitted for approval.



INCEPTION REPORT

al Growth Rate

3 WATER MANAGEMENT

3.1 Water sources

The present master plan aims at presenting a scheme where a reliable water supply is provided to residents within the BWE service area. To do so, all surface and ground water sources have to be taken into account and their current exploitation scheme re-evaluated. A master plan that incorporates already existing potable water systems and allocates water from appropriate surface or groundwater sources to un-serviced or under-serviced areas will then be devised. Provisions shall be made in the master plan to ensure that in each area an untapped water resource is still available after potable water allocation to meet the irrigation water requirements that will be specified in the terms of reference of the irrigation water master plan to be drafted as part of the current contract.

Information on water sources in Lebanon is scarce and inaccurate. According to the National Water Sector Strategy (NWSS) prepared by the MEW in 2010-2011 the total flow in water courses is equal to about 3,400 MCM for an average year, including the flow from both national and transboundary rivers. The NWSS lists the following average flows in the Bekaa water courses:

TABLE 3.1: AVERAGE FLOWS IN THE BEKAA SURFACE WATER COURSES

Period	Average flows in water courses (in MCM)				
	North Bekaa	Central/South Bekaa			
Entire year	480	830			
May – October	240	240			
July – October	155	115			
September	38	27			

The origin of these figures is unknown however it is worthwhile to note that the State and Trends of the Lebanese Environment 2010 report gives an average annual volume of 275.54 MCM and 167.83 MCM for the El-Assi and Litani rivers respectively, based on primary data obtained from the Litani River Authority (LRA) from 2005 to 2009. These figures translate into a combined average annual volume of 443.37 MCM which is only about a third of the total average flow estimated by the MEW in its strategy. Knowing that El-Assi and Litani rivers are by far the two main rivers in the Bekaa, a question mark regarding the validity of all these figures has to be raised.

With the scarcity of surface water, the use of groundwater for water supply and irrigation has soared in the last 20 years. Irrigation is the largest consumer of groundwater with about half the irrigation water needs coming from wells. There are three types of wells in the Bekaa: public (registered wells under the responsibility of the BWE); licensed private wells whose number keeps increasing continuously; and

illegal (undeclared) wells whose number is completely unknown, but thought to be in the several thousands. The MEW Strategy lists the following values for the Bekaa:

TABLE 3.2: GROUNDWATER USE IN THE BEKAA

Туре	Number	Water supply (MCM/year)	Total yield (MCM/year)		
Licensed private	2678	1.47	19.55	1.47	22.49
lllegal	4500	2.46	32.85	2.46	37.77
Public (registered)	135				55

A list of 140 wells owned by the BWE and 14 others owned by municipalities (or private) has been provided, along with information regarding their coordinates, depth (varying from 20 to 670 m), pump capacity, energy source, and status. Unfortunately, aside from a one-time reading for 20 of the 154 wells, no water flow information was provided.

A current project funded by UNDP entitled "Groundwater Assessment and Database" is being carried out by the consortium ELARD-BURGEAP-IGIP-RIBEKA for the benefit of the MEW. It aims at quantifying the national groundwater resources through a data collection and field assessment campaign of groundwater resources across Lebanon. Both the LCWMC (Lebanese Center for Water Management and Conservation) within the MEW and the ELARD have been contacted to obtain the information collected to date for the Bekaa region. It was made clear though that the survey does not cover illegal wells, and that the coverage of the registered private wells is not completely reliable as it was very dependent on the well owner's willingness to participate in the survey. The major springs of the Bekaa are shown on the assets map in Figure 3.2 and on the Hydrological Map in Appendix B. Information regarding flow rates is scarce, sporadic, and highly unreliable. Lately, some information was obtained from the LRA regarding spring and river flows. The data is currently being analysed and reduced.

A study entitled "Analyse des Stratégies et Prospectives de L'Eau au Liban" carried out for the UNEP-Plan Bleu by Sélim Catafago and Bassam Jaber in 2001 gives the following figures for the available quantities of water (excluding the Qaraoun lake):



Lebanon - Average year	4.4 Billion m ³ /year
Lebanon – Average year	1.13 Billion m ³ for July to October
Bekaa – Average year	1.1 Billion m ³ /year
Bekaa – Average year	463.3 Million m ³ for July to October
Lebanon – 10-yr drought year	2.7 Billion m ³ /year
Lebanon – 10-yr drought year	0.7 Billion m ³ /year for July to October
Bekaa - 10-yr drought year	405 Million m ³
Bekaa - 10-yr drought year	286.6 Million m ³ for July to October

* The source of this information is not included in the report.

The available quantity of water was described as the sum of the water from the springs exploited by the administration, the river flows, and the groundwater pumped from public and private wells. It is noteworthy that the figure for an average year in the Bekaa (1.1 Billion m³/year) is lower than the figure provided by the NWSS as the flow in the Bekaa water courses alone (1.3 Billion m³/year).

The purpose of the Plan Bleu was to describe the prevailing situation, evaluate the steps carried out by the Lebanese Government to address the problems and elaborate a new water strategy. It is not known how much (or if any) of this study and its recommendations were taken into account by the recent NWSS. For the purpose of this master plan, any data included in the report will be taken into consideration. However, the strategy included in the report is considered to be superseded by the NWSS.

3.2 Water needs

According to the 1982 National Waste Management Plan (CDM) water consumption rates were projected to be equal to 320, 250, and 100L/capita per day for Beirut, Urban Areas, and Rural Areas, respectively in 2000, and 350, 250, and 150 L/capita per day for Beirut, Urban Areas, and Rural Areas, respectively in 2040. The MEW National Water Sector Strategy (NWSS) uses the following figures for a moderate demand scenario in 2010:

- 160 L/capita/day for rural domestic demand;
- 180 L/capita/day for urban domestic demand;
- 30% of domestic demand for industrial demand (or 51 L/cap/d on average).
- 400 L/person/day for tourism demand;
- 9000 m3/ha/year for agriculture demand.

Their resulting total water demand forecasts for the moderate demand scenario (based on a moderate population growth scenario) are as follows for the Bekaa:

493 MCM/yr for 2010 of which 405 MCM/yr for irrigation purposes (based on 45000 ha of irrigated areas); and 612 MCM/yr for 2035.

In terms of water supply, it is listed at 409 MCM/yr for 2010, which results in a shortage of 84 MCM/yr. About 50.3% of the 409 MCM/yr is supplied by surface water sources, 47.2% by groundwater sources, and 2.5% by existing water storage.

The Plan Bleu (2001) gives different values for the Bekaa water shortages than the NWSS. According to this report, the total yearly demand for the Bekaa is approximately 466 million m³ including potable water, irrigation, and industry demands. The monthly distribution for water demand is tabulated (Table A5), and the total demand for the dry months (July to October) adds up to 293 million m³. The water demand was calculated based on the following assumptions: population of the Bekaa equal to 580000: water consumption of 216 L/cap/day; total irrigated area equal to 33000 ha; irrigation water demand equal to 8500 m³/ha/year; potable water system efficiency of 75%; and agricultural yield of 70%. Comparing with the figures listed for the available water (which for the Bekaa apparently include the yield from 4500 wells), the authors conclude that there is no shortage during a regular year and a 6.4 million m³ deficit only for the 10-year drought year. They acknowledge that the deficit is actually higher since the potable water system efficiency is closer to 50% in reality. However since potable water in the Bekaa only accounts for a small percentage of the water demand, their water shortages figures remain much smaller than the ones currently listed by the MEW in their NWSS. Another discrepancy between the two documents relates to the Bekaa total irrigated area: the Plan Bleu assumes there are 33000 ha of irrigated land, while the NWSS bases its calculations on 45000 ha. This 12000 ha difference cannot be explained by an extension of irrigated areas between 2001 and 2010. In view of all these discrepancies, the water availability and demand figures will have to be validated during the next phase of the study based on the population estimates, water demand, and actual irrigated surface areas agreed upon with USAID and BWE. At this point, it is proposed to stay in line with the recommendations of the latest BWE Business Plan. The latter gives the following range of values for metered water usage in areas similar to those in Lebanon:

> Household Commercial Institutional Industrial **Total**

Based on the above mentioned data, the BWE decided to apply an aggregate norm for water demand (i.e., no separate consideration is made for the different types of consumers), once connections are metered and billed, of 180 l/c/d, which is the middle range of total values found in other similar countries, but lower than the aggregate value of the NWSS which comes up to 221L/cap/day (domestic and industrial). One of the reasons for this lower value being that the Business Plan aims at remaining



90 – 120 L/cap/day 25 – 30 L/cap/day 15 – 20 L/cap/day 30 – 40 L/cap/day **160 – 210 L/cap/day** conservative in terms of profitability and hence is concerned with not overstating sales once meters are installed and billing is based on metered consumption.

Regarding irrigation, the current need will be evaluated based on the data collection and limited stakeholders' interviews that will be conducted as part of the present project. It is believed that once meters are installed, farmers will not be using potable water for irrigation (as has been the case sometimes so far) because of the prohibitive cost that would be incurred.

Concerning the projected urban domestic water demand over 25 years, the NWSS moderate scenario gives the following values:

Year	2010	2015	2020	2025	2030	2035
Demand (L/cap/day)	180	174	167	176	185	195

The dip in the forecasted demand is a projected result of the water conservation measures to be introduced (plumbing retrofits, high-efficiency toilets and showerheads, dual flush toilets, high-efficiency cloth washers, complete retrofit of large commercial and industrial consumers, public awareness campaigns, etc.) and a more conscious use of the water by the consumer after meters are installed. Accordingly, in the present study the aggregate value for water demand for the year 2035 will be taken as 195 L/cap/day at this stage, and corrected as needed based on the final adopted current water demand figure.

Existing facilities 3.3

In 2010, the BWE has commissioned Liban Consult to undertake a complete inventory and field evaluation of the assets under its jurisdiction (water transmission lines, pumping stations, water treatment plants, chlorination systems, reservoirs, springs, and public wells) in view of preparing a state of the art documentation of the water supply infrastructure including its valuation. The project, funded by GIZ (German Agency for International Cooperation) covered 3000 km² in surface area, 565 km of pipes, and 461 facilities distributed as listed in Tables 3.3 and 3.4 below. In late February this database was handed over to the Consultant who is currently assessing it as discussed in Chapter 6 of this report.

TABLE 3.3 SUMMARY OF BWE ASSETS

No.	Designation	Description	Quantity
1	Ground water reservoirs	Capacity from 25 to 6000 m ³	215
2	Elevated tanks	Capacity from 25 to 750 m ³	27
3	Wells	Depth from 20 to 500 m	150
4	Surface pumping stations	Horizontal and VTP pumps	16
5	Transmission pipelines	Ductile iron pipes DN 100 to 300 (in Km)	564.6
6	Water treatment plants	Zahle and Falaoui	2
7	Water springs	Natural springs	28
8	Chlorination systems	10 - 1000 g/h chlorinators	23

TABLE 3.4 DISTRIBUTION OF ASSETS PER ZONE (AS DEFINED BY BWE)

Location	Divisions	Wells	Springs	Water treatment plants	Chlorination units	Pumping stations	Reservoirs	Elevated tanks	Total
Zahle	Zahle	8	3	1	1	2	11	0	26
	Rayak	9	0	0	1	1	1	2	14
	Chtoura	4	1	0	1	1	7	2	16
	Baalbeck	36	10	0	14	1	36	3	100
Baalbeck	Deir Al Ahmar	6	5	0	1	1	29	0	42
	Chmistar	9	0	1	0	2	32	1	45
North	Laboue	16	1	0	3	1	21	2	44
Bekaa	Hermel	10	2	0	0	2	30	4	48
	Rachaya	21	0	0	0	0	14	4	39
West Bekaa	Joub Jennine	16	5	0	0	2	14	6	43
	Machghara	15	1	0	2	3	20	3	44
		150	28	2	23	16	215	27	461

The information taken from the geodatabase is plotted on the Bekaa map in Figures 3.1 to 3.4. In order to produce these figures, the BWE/GIZ database had to be reworked as the data was scattered and not properly linked. The steps undertaken included: creating attribute tables by selecting fields of interest, data classification, merging and verification of common data, appropriate linking of data to each other, building templates, introducing symbology and shapefiles for all fields, etc.. Figure 3.1 shows the locations of the various facilities, Figure 3.2 shows the conditions of the civil works for the wells and springs as reported by BWE based on the field assessment, Figure 3.3 shows the water treatment facilities along with the area of influence of the two existing water treatment plants, and Figure 3.4 shows the conditions of the civil works of the pumping stations and the chlorinators, also as reported by



INCEPTION REPORT

BWE based on the field assessment. The conditions were classified as either A (good), B (No data), C (Worn), or D (Out of service). More details about the field assessment are included in Chapter 6.

Field visits to some of the facilities have been initiated (the two water treatment plants of Zahle and Falaoui). The Consultant plans to select a few facilities of each type (wells, springs, reservoirs, elevated tanks, chlorination units, and pumping stations) to visit. The selection will be based on criteria set once the thorough review and evaluation of the BWE assets database, and especially the field reports for each facility submitted by Liban Consult, are completed. For facilities that will not be visited, attempts will be made to obtain any information missing in the database field report from the facility operator.

3.4 Additional existing studies

During the second week of March, the Consultant was able to secure from the MEW a set of plans containing information about potable water networks in the Bekaa (Table 3.5). These plans, in either pdf or AutoCad formats, however are not accompanied by any written documentation. Moreover, they are not as-built drawings, but rather design drawings, and hence the actual status for these networks is not known at this point. Efforts are currently underway to transform the information contained in these plans into a format usable for this master plan, and to combine them into a single, coherent, and comprehensive database. This task is expected to consume a substantial amount of time. Once completed, validation of the contained information will have to be undertaken with the help of the BWE in order to assess the status of each network (already built, planned to be built, or design abandoned).

TABLE 3.5: PLANS RECEIVED FROM MEW CONCERNING POTABLE WATER PROJECTS

Project Description	Consultant
ETUDES DES SYSTEMES D'EAU POTABLE CAZAS DE BAALBECK - EL HERMEL Included villages: information not processed yet	Dar Al Handasah N.T. (1999)
ALIMENTATION EN EAU POTABLE DE LA BEKAA OUEST: Included villages: Er Rafid, Er Raouda, Khirbet Rouha, Saghbine, Saghbine - Kefraya, Saouiri, Sohmor, Soultane Yaacoub Et Tahta - Haouch El Harime, Sultane Yaacoub El Faouqa - Aazze, Sultane Yaacoub El Faouqa - Sultane Yaacoub El Faouqa, Aazze - Joubb Jannine, Soultan Yaacoub El Faouqa, Deir Tahnich , Dahr El Ahmar, Yohmor El Beqaa, Ain Ez Zarka-Dahr Miri, Zillaya, Tell Znoub, Aana- Ammiq, Aana-Kefraya, Ammiq, Aana, Aanjar- El Khiara, Aazze, Aazze - Dahr El Ahmar, Dahr El Ahmar, Ain Et Tine, Aita El Foukhar, Pompage Aitanit -Regional Aitanit, Regional Aitanit -Regional Saghbine, Aanjar - El Marj, Ain Aarab, Baaloul, El Bire, Ed Dakoue, De Lala, Majdel Aanjar, Es Salamiye - Er Rachidiye, Tell Ez Zezea, Chamsine - Aanjar, Chamsine - Aanjar, El Khiara, Soultan Yaacoub El Tahta, Deir Ain Ej Jaouze, Kamed El Loz, Kefraya, Kfardenis, Libbaya, Machghara - Maidoun, Aanjar - Manara, Manara - Sultan Yaaqoub El Faoqa, El Marj, Mdouka, Bab Marea, El Mhaidthe, Dahr Miri - Aitanit, Dahr Miri - Machghara, Dahr Miri - Qelia, Dahr Miri - El Qaraaoun Aintanit, El Manara, Mazraat Souairi, Majdel Aanjar - Tell Ez Zaazea, Khribet Qanafar, El Qaraaoun, El Qaraaoun - Lala, El Qaraaoun - El Qaraaoun, Qelia	BTD (1997)

Efforts are currently underway to obtain information regarding the completed or ongoing projects carried out by the CDR listed in Table 3.6 and shown in Figures 3.5 and 3.6. Once obtained, a cross-reference between these projects and the plans obtained from the MEW (Table 3.5) will be carried out.

TABLE 3.6 COMPLETED AND ONGOING WATER SUPPLY PROJECTS IN THE BEKAA (CDR)

Project Name	Contract Amount (USD)	Funded By	Execution Starting Date	Completion Date
Operation and Maintenance of water and wastewater establishments of Bekaa Water Authority	12,000,000	IBRD	May 2008	N.A
Completion of Systems in Bekaa	5,000,000	IRAN	March 2008	N.A
Zahle Water Network	10,146,250	Local fund	January 2008	N.A
Rehabilitation of water systems served by Luci Wells	4,780,500	KFAED	June 2008	N.A
Rehabilitation & expansion of water systems in West Bekaa and villages east Zahle district - first phase	15,000,000	World Bank	October 2009	October 2011
Work execution project of potable water network in Jrebta in Baalback	1,322,982	Local fund	August 2009	October 2010
Rehabilitation of water supply systems in West Bekaa and villages in east Zahle (first lot)	13,707,783	World Bank	September 2009	August 2011
Rehabilitation and expansion of potable water systems inWest Bekaa and villages east Zahle district – second and third phases	37,000,000	Kuwait Fund	December 2010	December 2014
Potable water supply to Zahle	8,000,000	Kuwait Fund	September 2010	May 2012
Execution of potable water transmission lines, networks and reservoirs in some regions of Bekaa	1,120,000	Arab Fund		Completed
Baalbeck - Nabi Shit domestic connections and additional distribution lines	1,250,000	World Bank		
Construction of wastewater and additional potable water distribution pipes in 17 villages in Baalbeck	12,200,000	World Bank		



PAGE 9 OF 67

Project Name	Contract Amount (USD)	Funded By	Execution Starting Date	Completion Date
Construction of wastewater and additional potable water distribution pipes in Baalebeck and Aaamshki	11,700,000	World Bank		Completed
North Baalbeck + potable water supply - lot I & II	13,000,000	Local fund		
Drilling and Equipping of water wells in Bekaa, South, Douier and Qlaile				
Water supply for Yammouneh: dam + water supply pipes + water distribution pipes + 23 reservoirs + 2 artesian wells	11,900,000	IDB		
Water supply for Oyoun Orghoch: water supply pipes + water distribution pipes + 18 reservoirs	7,800,000	IDB		Completed
Baalbeck- Nabi Shit potable water supply & Baalbeck wastewater network	32,000,000	World Bank		Completed
Execution of distribution lines and additional potable networks and domestic connections in Baalbeck, khodr , nabi shit and kherbe	4,900,000	IBC		
Domestic Connections for regions covered by Yammouneh – Ouyoun orghosh potable water systems	6,500,000	Local fund		Completed
Shmistar potable water supply	4,500,000	Local fund		
Al- Yammouneh infrastructure: This project includes the construction of potable water supply and wastewater networks, in addition to a wastewater treatment plant.	3,960,000	IDB		
Execution of irrigation works in Hermel region	1,000,000	Kuwait Fund		
Installation of Potable water conveyer lines to Al-Bustan and Al- Harf	2,000,000	Kuwait Fund		
Habilitation and expansion of potable water systems in Bekaa governorate (North- West Bekaa)	13,400,000	Local fund		
Rehabilitation of Water Networks in West Bekaa & villages in the East of Zahle and Rashaya Lot B & C	37,000,000	Kuwait Fund	Planned	Unknown

3.5 Water Storage

In order to limit water shortages, the water distribution network has to be upgraded to limit losses as much as possible. However, even with a well-performing water network, shortages will still occur, and hence the Lebanese Government has developed a plan to mobilize surface water through the construction of dams and hill lakes. According to the NWSS the following surface water potential exists for the Bekaa:

Designation of dam	Capacit	ty (MCM)	CAPEX	OPEX
	Total	Irrigation	(MUSD)	(MUSD)
Yammouneh	1.5	1.5	Under construction	0.1
Younine	5.8	0.0	66.0	1.5
Assi Phase I	63.0	63.0	50.0	1.3
Assi Phase II	15.0	15.0	141.0	0.8
Barhacha	2.5	0.0	37.0	0.6
Ain Aarab	2.0	0.0	21.0	0.5
Salaa	2.5	0.0	36.0	0.6
Massa	7.0	5.0	35.0	0.8
TOTAL	99.8	84.5	386.0	6.0

TABLE 3.7 SURFACE WATER POTENTIAL FOR THE BEKAA

The SDATL project ("Schéma Directeur d'Aménagement du Territoire Libanais" - 2004) listed two additional artificial lakes under consideration in the caza of Baalbeck not included in the MEW list: Sbat and Jriban, each having a capacity of 0.7 to 1 MCM and taking their water from the sources by the same names. SDATL proposed a prioritization scheme for these dams and lakes based on four criteria: how much the facility fulfills the domestic water demand (the weight of this criterion is double that of the others); the extent of improvement the facility brings to land irrigation; the improvement potential the facility might bring to other sectors such as tourism and flood prevention; and the status of the feasibility studies and execution of the project. Based on these criteria, the projects were classified as follows: Younine, Massa, and Yammouneh as high priority; and Aassi, Smat, and Jriban as medium priority. Barhacha, Ain Aarab, and Salaa were not included in the SDATL list of projects. The planned water storage reservoirs will be taken into account in the water allocation schemes to be proposed by the master plan.





FIGURE 3.1: FACILITIES DISTRIBUTION







FIGURE 3.2: WELLS AND SPRINGS CONDITION



PAGE 12 OF 67



FIGURE 3.3: WATER TREATMENT FACILITIES



INCEPTION REPORT

PAGE 13 OF 67



FIGURE 3.4: PUMPING STATIONS AND CHLORINATORS CONDITION



PAGE 14 OF 67





4 WASTEWATER MANAGEMENT

4.1 Wastewater Flow

In the absence of measurements concerning the exact quantities of sewage flows which vary substantially with the time of the day, of the week, and of the year the estimation of the sewage flow to be adopted in the current study for the 2035 horizon year will be based on estimates of water consumptions, as has been the case for previous similar studies in Lebanon. Usually, the amount of generated wastewater is considered to be 85% of the domestic water consumption, with 10% added to account for infiltration, and the total population used to calculate it is the actual population (household and institutional) multiplied by a population equivalent factor in order to take into account commercial and light industrial activities. Hence the wastewater generation rate proposed at this stage is 115 L/capita per day (based on an average domestic and institutional water demand rate of 123 L/capita per day). If the final adopted water demand value is modified, this value will be modified accordingly. It is worth noting that according to the list provided by the BWE regarding their existing or planned wastewater treatment plants (Section 4.2 and Table 4.4), the value used for design varied between 68 and 182 L/capita per day.

4.2 Existing and Planned Wastewater Treatment Plants

In 1982, Camp Dresser & McKee Inc. (CDM) prepared the National Waste Management Plan for CDR, which included a master plan for wastewater management for the entire country. The recommended plan involved a staged approach aimed at achieving improvements to existing wastewater collection systems and construction of collection systems for selected unsewered communities in order to reduce environmental pollution and protecting watersheds. The recommended works included seven regional coastal systems providing wastewater disposal through sea outfalls and 65 inland systems providing secondary treatment.

In 1994, a pre-feasibility study entitled "Lebanon's Staged Wastewater Program" was conducted by Khatib & Alami for the Ministry of Environment with the aim of preparing a phased program for the development of wastewater facilities throughout Lebanon. The treatment requirements were set out as follows. For coastal areas, preliminary treatment should be provided with disposal of the pretreated effluent through long sea outfalls. For inland areas, a number of possible treatment processes depending on the size of the community to be served are identified. In effect, this study was an update of the 1982 Master Plan, and aside from an updated population estimate, the most significant change

from the 1982 Master Plan was the higher priority given to the design and construction of sea outfalls in order to protect the coastal area.

As part of its ongoing effort to plan for wastewater treatment plants, the Sector Implementation Unit (SIU) which was part of the Ministry of Hydraulic and Electrical Resources (MRHE later changed to MEW) issued in June 2000 a list of all the wastewater treatment plants planned, designed, or executed in Lebanon along with its population equivalents, capacity, design horizon, projected cost, design firm, and status of the project. The lists for the Bekaa are included in Appendix A. The DAHNT study mentioned in section 2.1 above developed a scheme for wastewater collection and conveyance and for plant locations for all the Bekaa regions. The study proposed two solutions: the first consisted of providing a treatment plant for each village or for a number of neighboring villages; and the second grouped an important number of villages in one plant. This scenario led to a decrease in the number of treatment plants but to an increase in the network lengths. Both scenarios used either stabilization ponds or extended aeration in terms of treatment method. The tables listing both proposals are included in Appendix A.

For the last 19 years, the CDR and MEW have largely been following the recommendations of the 1982 and 1994 master plans as well as the SIU list and hence implementing wastewater treatment and disposal projects according to the established schemes.

An extensive data collection campaign has been initiated to gather all information regarding the past, current and planned wastewater treatment and sewer network projects in the Bekaa. The main sources of information were the Council for Development and Reconstruction (CDR), the Ministry of Energy and Water (MEW), and the Bekaa Water Establishment (BWE) who concentrate most of the wastewater projects. Other entities involved in the field include a few nonprofit organizations, who are working in collaboration with local municipalities to design and construct small to medium wastewater treatment plants using international funding.

According to the National Strategy for the Wastewater Sector issued by the MEW in October 2012, seven treatment plants have obtained partial funding in the Bekaa and hence are at various stages of completion, while two plants require complete funding. These are listed in Table 4.1 below. The total cost of each plant is the sum of the available funds and the additional required funds, and includes the cost of the treatment plant, as well as that of the corresponding sewer network and house connections.



Treatment Plant	Equivalent Population	Capacity m ³ /d	Process	Status	Available Funds (Million USD)	Treatment Plant Cost (MUSD)	Network + House Connections Cost (MUSD)	Additional Funds Required (Million USD)
Baalbeck	100,000	12,000	Activated Sludge	OP	17.0	6.3	19.7	9.0
Yammouneh	6,000			OP	2.6	1.0	2.6	1.0
Zahle	150,000	18,000	Trickling Filter	UC	35.4	32.0	20.5	17.1
West Bekaa (Joub Jannine + Saghbine)	100,000	11,030	Extended Aeration Activated Sludge	UC	37.0	12.0	35.0	10.0
Aanjar	300,000	44.500	Activated Sludge	UD	36.2	30.0	66.0	59.8
Laboua	47,000	7,000	Activated Sludge	UD	4.6	7.0	17.0	19.4
Timnine El Tahta	100,000	25,000	Activated Sludge	UD	8.9	10.0	36.0	37.1
Hermel	96,000				0.0	9.6	21.0	30.6
Rachaya	22,000				0.0	8.0	12.4	20.4
Total	803,000			2	141.7	115.9	230.2	204.4

TABLE 4.1: STATUS OF THE BEKAA TREATMENT PLANTS PLANNED BY THE CDR/MEW (MEW)

OP: Operational; UC: Under Construction; UD: Under Design

In addition, the National Strategy lists 18 treatment plants funded by USAID as shown in Table 4.2 below.

TABLE 4.2 WASTEWATER TREATMENT PLANTS FUNDED BY USAID (MEW)

Plant	Population Served	Capacity	Completion Date	Investment (USD)
Bakka 1	1.000	160	1998	87000
Bakka2	6.000	160	2002	55000
Rachava	6,000	600	2005	240000
FI Housh	1 000	100	2005	126000
Aitopit	25 700	5000	2000	600000
Farral	35,700	5000	2009	600000
Forzoi	7,500	1000	2009	400000
Ablah	15,000	2000	2012	4000000
Jabbouleh	1,000	80	2001	39900
Deir El Ahmar	3,000	300	2002	93000
Chouaia	700	50	2007	117000
Al Fardis	1,200	120	2007	414500
Hebbaria	9,200	920	2007	350000
Kfar Hamam	1,700	115	2007	128000
EL Mari	1,300	220	2007	131000
Kawkaba	2,000	135	2007	225000
Yanta 1 &2	3,000	300	2002	160000
Mimes 1 &2	3,000	120	2002	160000
Ain Harcha	1,200	120	2002	145000
TOTAL	99,500	11500		16,471,400

The State and Trends of the Lebanese Environment 2010 Report published by the UNDP gives a slightly diverging picture of the situation. It lists 11 wastewater treatment plants in the Bekaa along with the population they serve, their capacity, the process utilized, and their status. Information taken from this report has been incorporated in Table 4.2 above. Comparing the listed information, it is noticed that many treatment plants do not appear on the UNDP report list, most markedly the one at Yammouneh listed as being operational by MEW, Hermel and Rachaya, which are only in the planning phase, as well as all of the USAID funded plants except for Aitanit, Forzol, and Ablah. On the other hand, a Chmistar plant listed by UNDP as being under construction (with a capacity of 1,800 m³/d and serving a population of 13,200) does not appear on any of the two MEW lists. Except for the Aitanit, Forzol, and Ablah plants which are operational (constructed by Camp Dresser and McKee), the real status of the other USAID funded plants is not known. Many of them are believed to be un-operational or malfunctioning due to poor design and construction as well as the inability of municipalities to sustain



the financial and technical requirements of operation and maintenance (USAID- Comprehensive Sector Analysis Report, 2011).

Two additional official sources of information regarding wastewater treatment plants obtained lately, namely the 2012-2016 BWE Business Plan and the BWE Assets Assessment Database list the following (Table 4.3 and 4.4):

Area	Size (Population Equivalent)	Design capacity (m3/day)	Status
Baalbeck	89,000	12,000	Construction Completed and Partial Operation and maintenance (CDR). Hand-over to BWE expected in June 2012 ¹⁾
Aitanit	35,700	5,000	Construction Completed and Handed Over to Municipality (funding from USAID)
Fourzol	7,400	1,000	Construction Completed and Handed Over to Municipality (funding from USAID)
Joubb Jannine	77,000	10,500	Under Construction/Take Over CDR 2014
Zahle	120,000	18,000	Under Construction
Saqhbin	4,100	530	Under Construction/Take Over CDR 2014
Majdal/Anjar	275,000	44,500	Planning stage, four systems
Laboueh	53,000	7,000	Under Construction
Rachaya	6,000	600	Under Construction
Chmistar	13,200	1,800	Under Construction
Ablah	14,630	2,000	Under Construction/Take Over 2014 (funding from USAID)
Yammouneh	mmouneh < 5,000 <500 Construction maintenance Outsourcing MEW between		Construction Completed and outsourcing of operation and maintenance (CDR) until March 2011 Outsourcing of operation and maintenance with funding by MEW between March 2011 and June 2012
Total	700,030	103,430	

TABLE 4.3: WASTEWATER TREATMENT PLANTS ACCORDING TO THE BWE 2012-2016 BUSINESS PLAN



INCEPTION REPORT

INCEPTION REPORT

PAGE 18 OF 67

TABLE 4 4. WASTEWATED TREATMENT DI ANTS ACCORDING TO THE DWE ASSETS ASSESSMENT DATADASS

TABLE 4.4: WAS	IEWAIER IREAIN	IENI PLANIS A	CCORDING TO TH	E BWE ASSETS A	SSESSMENT DATABASI	E	-				
Treatment Plant	Population Served	Capacity (m ³ /day)	Wastewater flow (I/cap/d)	Completion Date	Funded	Type of treatment	Status	Cost \$	Effluent disposal	Power required	Sludge disposal
Bakka 1 (Eastern)	1,000	100	100	2005	USAID	Anaerobic Digestion + Extended Aeration Non-electromechanical system: Anaerobic fermentation (closed reactor), aerobic treatment (open ponds), and extended aeration channels	Operational	87K	disposed in nearby water stream		
Bakka 2 (Western)	600	60	100	2005	USAID	Anaerobic Digestion + Extended Aeration Non-electromechanical system: Anaerobic fermentation (closed reactor), aerobic treatment (open ponds), and extended aeration channels	Network 62400 m	55K	disposed in nearby water stream		
Rachaya	6,000	600	100	2005	USAID	Non-electromechanical system: Aerobic treatment + Trickling filter reservoirs + Extended Aeration	Operational - Network 11288 m	240K	disposed in nearby water stream		Sludge Drying Beds
El Housh	1,000	100	100	2005	USAID	Non-electromechanical system: Anaerobic fermentation (closed reactor), aerobic treatment (open ponds), and extended aeration channels	Operational - Network 4416 m	126K			
Mashghara (Aitanit, Baaloula, Machghara & Qaroun)	35,700	5000	140	2009	USAID	Trickling Filters + primary and final clarifiers + chlorination of final effluent	Operational/ Machghara has a network and is connected to the plant, but networks needs rehabilitation - Qaraoun is still not connected but has a partial network. Aitanit does not have a network. Balloul has a partial network but not connected yet	6M	Disposed in Litani River	2600 KW Hrs/day Standby Generator available	Sludge Drying Beds 1578 Kg/day
Forzol	75,000	1000	134	2009	USAID	Trickling Filters + primary and final clarifiers + chlorination of final effluent	Operational/ Connected to networks Forzol has a network and is connected, but network needs rehabilitation	4M	Disposed in Litani River	780 Kw Hrs/Day Standby Generator available	Sludge Drying Beds 316Kg/day
Ablah	15,000	2000	134	2012	USAID	Trickling Filters + primary and final clarifiers + chlorination of final effluent	Under construction Ablah and Nabi Aila have networks. Niha has a partial network	4M	Disposed in Litani River	960 KW Hrs/Day	Sludge Drying Beds 632Kg/day
Jabbouleh	1,000	80	80	2001	USAID	Tertiary treatment	Operational	40K			
Deir El Ahmar	3,000	300	100	2002	USAID		Constructed but not commissioned & 2 incomplete	93K			
Kawkaba	2000	135	68	2007	USAID	Extended aeration		225K			
Yanta 1 & 2	3,000	300	100	2002	USAID	Extended aeration & Activated sludge (Hans Reactor)	Not operational	160K			
Ain Harcha	1,200	120	100	2002	USAID	Anaerobic fermentation (closed reactor), aerobic treatment (open ponds), and extended aeration channels	Operational - Network 5340 m	145K	Disposed in river		In Digester
laat	90,000	12000	134	2008	World Bank		Operational- contains 2 lanes each can receive 6000 m3/day now they are operating just one				
Zahle	205,000	37300	182	2012 (February)	Italian Cooperation	Secondary treatment	Under construction/ Zahle WWTP including 12 km sewer				



INCEPTION REPORT

PAGE 19 OF 67

Treatment Plant	Population Served	Capacity (m ³ /day)	Wastewater flow (I/cap/d)	Completion Date	Funded	Type of treatment	Status	Cost \$	Effluent disposal	Power required	Sludge disposal
Saghbine	4400	530	120	2005	IDB		Operational				
Joubb Jannine	87000	10500	120	2005	IDB		Operational				
Aanjar	275000	44500	162	2006	Italian Protocol Phase 1		Operational				
Laboue	52300	7800	149	2005	Iranian Protocol		Operational				
Hermel	50000	8100	162	2006	Italian Protocol Phase 2		Operational				
Yammouneh	5836	788	135			Aerobic fermentation	Operational				
Total	914,036	131,313									



Figure 4.1 shows the location of the wastewater treatment plants listed in the BWE database. Although both tables 4.3 and 4.4 are issued by the BWE within the same time frame, the following discrepancies are noted:

Bakka, El Housh, Jabbouleh, Deir El Ahmar, Kawkaba, Yanta, Ain Harcha, Hermel	Not mentioned in the Business Plan
Rachaya, Saghbine, Joubb Jannine, Laboue	Completion date: Plan: Under Construction Database: 2005
Zahle	Population served: Plan: 120,000 Database: 205,000 Capacity: Plan: 18,000 m ³ /day Database: 37,300 m ³ /day
Forzol:	Population served: Plan: 7,400 (equivalent) Database: 75,000
Chmistar:	Not mentioned in Database
Anjar	Completion date: Plan: Under Planning Database: 2006

As part of the current project, site visits have already been conducted by a KREDO engineer (accompanied by the plant operator) at a number of wastewater treatment plants, namely Forzol, laat, Ablah, Machghara, Saghbine, Joubb Jannine, Rachaya, Bakka (1 & 2), and Yanta (1 & 2). For each plant collected information is summarized in a table and pictures are taken. This information along with an evaluation of the plants will be included in the next report entitled "Wastewater System Assessment Report". Current efforts are concentrated on obtaining the design reports for all recent plants funded by USAID and designed by CDM as well as all the documentation regarding the wastewater treatment projects (completed or ongoing) carried out by the CDR (Table 4.5 and Figure 4.2). Partial information, in the form of economic feasibility studies or environmental impact analysis studies, regarding some of these projects, namely the Western Bekaa, Anjar, Qaraoun, and Hermel, has already been secured and is currently under evaluation.

TABLE 4.5 COMPLETED AND ONGOING WASTEWATER PROJECTS IN THE BEKAA (CDR)

Project Name	Contract Amount (Million USD)		Execution Starting Date	Completion Date
Construction of treatment plant and wastewater networks in central and northern Bekaa in the Litani basin	10.50	AFESD	October 2013	December 2015
Construction of treatment plant and wastewater networks in Anjar, Majdal Anjar, Bar Elias, Mraijet, Marj, Chtoura and neighboring areas	41	Italian Protocol	December 2015	December 2018
Completion of wastewater project in West Bekaa region	27	IBD	December 2012	December 2014
Construction of treatment plant and wastewater networks in Rachaya and neighboring areas	30	Kuwait Fund	May 2015	December 2018
Construction of treatment plant and wastewater networks in Laboue and neighboring areas	4.50	Iranian Protocol	January 2012	August 2014
Construction of treatment plant and collector networks in Hermel and neighboring areas	20	Italian Protocol	December 2013	June 2016



INCEPTION REPORT

PAGE 21 OF 67

4.3 Additional existing studies

During the third week of March, the Consultant was able to secure from the MEW a set of plans containing information about sewer networks in the Bekaa (Table 4.6). These plans, in either pdf or AutoCAD formats, however are not accompanied by any written documentation. Moreover, they are not as-built drawings, but rather design drawings, and hence the actual status for these networks is not known at this point. Efforts are currently underway to transform the information contained in these plans into a format usable for this master plan, and to combine them into a single, coherent, and comprehensive database. This task is expected to consume a substantial amount of time. Once completed, validation of the contained information will have to be undertaken with the help of the BWE in order to assess the status of each network (already built, planned to be built, or design abandoned).

TABLE 4.6: PLANS RECEIVED FROM MEW CONCERNING SEWER NETWORK PROJECTS

Project Description	Lot	Consultant
ETUDES DES SYSTEMES D'EAU POTABLE ET DES EAUX USEES CAZAS DE BAALBECK - EL HERMEL		Dar Al Handasah
Included villages:		N.T. (1997)
BednayelBeit-Chama, El-Aaquiyeh Et Haouch-Er-Rafqa, Kfar-Dabach, Qsarnaba, Temnine-El-Faouqa, Temnine-El-Tahta	1	
Boudai, El-Hadet, Kfardane Et Jebaa, Nabi-Rchadeh Et Tleileh, El-Aallaiq , Ras- En-Nabaa Et Saaideh, Taraya, Mazraat-Beit-Slim , Mrah-El-Jamal Mrah-Bou- Brahim Et Mrah-El	2	
Mrah-El-Aouja, Baalbeck, Bechouat, Blaiqa, Bessailet-El-Faouqa Et Bessailet-Et- Tahta, Btedaai, Mazraat-Beit-El-Ghoussain, Chaat Et Es-Soueidiyeh, Chlifa, Deir- El-Ahmar, Ez-Zarayeb, Flaoui, El-Hafir Et Karm-El-Hafir, Mchaitiyeh, Mrah- Maroun Et Qornet-Beit-Habchi, Mrah-Es-Saiyed Et Mazraat-Beit-Matar, Mrah- Semaane, Qalileh, El-Qerrami, Rasm-El-Hadeth Et Es-Soueid, Mrah-Soukkar, Mrah-El-Aassi Et Barqa, Ez-Zrazir	3	
Amhaz, Aarsal, El-Ain, Halbata, Harbata, Jdaideh, El-Moqraq, En-Nabi-Osmane - Caza De Baalbeck, En-Nouqra, El-Qaa, Ras-Baalbeck, Taoufiqiyeh, Zabboud , El- Kharayeb Et Ouadi-El-Aaoss,	4	
El-Hermel, El-Kouakh, El-Mansoura, Qanafez , Haouchariyeh , Mrah-Ed-Dallil Et Ez-Zekbi, El Qasr Et Sahlat-El-May, Ouadi-Er-Ratl	5	
Kfardane and Jebaa, Nabi-Rchadeh, Tleileh, Taraya	1&2	
WEST BEKAA REGION - WATER AND WASTEWATER PROJECT Note: master plan without any detail regarding networks inside villages		BTD (1997)



INCEPTION REPORT

PAGE 22 OF 67



FIGURE 4.1: WASTEWATER TREATMENT PLANTS ACCORDING TO THE BWE ASSESTS ASSESSMENT DATABASE



INCEPTION REPORT

PAGE 23 OF 67



FIGURE 4.2: WASTEWATER COMPLETED, ONGOING &UNDER PREPARATION PROJECTS FROM CDR PROGRESS REPORT – 2012



INCEPTION REPORT

PAGE 24 OF 67

5 **IRRIGATION**

Irrigation projects 5.1

The area under the jurisdiction of the BWE in terms of irrigation lies north of the Litani river basin, namely the northern part of the caza of Baalbeck and the caza of Hermel. All the other Bekaa areas located within the Litani river basin are under the responsibility of the Litani River Authority. Efforts are currently underway to identify studies that have been completed or are ongoing concerning the irrigation water sector in that area mainly from the CDR and the Ministry of Agriculture. The information obtained to date from the BWE is sketchy and incomplete. It includes a set of plans either in Autocad or pdf format, or as a hard copy. While these maps include the layout of the irrigation canals or transmission pipes, they lack crucial information such as the flowrate, and in some instances the water sources.

- 1- Yammouneh irrigation scheme (Autocad): This project is completed and as-built drawings are provided for the network in the following villages: Flawi, Harika, Jaafar, Mrah El Kach, Mrah El Sayed, Zarayeb, Bsaily, and Chlifa. The plans show a large water reservoir. The total length is 12,767m.
- 2- Laboue irrigation scheme (pdf): Plans lack details. Only position of canals is provided. The status of the project is not known but it was apparently executed in 2003.
- 3- Ras El Ain irrigation scheme (Autocad): The project is complete and as-built drawings are provided for three main canals in Kallout, Westani, and Shimali, along with the size of the area irrigated by each canal in hectares. However the data is incomplete as no details for the canals are included. The project was executed in 2011.
- 4- Jroud El Hermel (hardcopy): The project was executed in 1996, with irrigation canals from the following water sources: Ain Deleb, Ain Houda, Ain Alhawzalani, Ain Al Bahsat, Ain Kaykab, Nabaa Jourat Touton, Ouadi Al Jouze, Ain Al Bakhourat, and Ain Obeid for the villages of: Almaabour, Ain El Jaouzeh, Kaykab, Al Safsaf, Al Wardat, Al Maaboura, Al Hmaira, Ain Al Bakhourat, Wahiba, Al Njassa, Maabour, Ain Al Wadi, Mazraat Aln Obeid, Karm Sbait, Maabour, Ain Al Sawda, Nabaa Aldibat, Ain Al Jarfat, Aaroubat Al Naanaa in the Jroud El Hermel. Another part was executed in year 2000, with irrigation canals from the following water sources: El Ricci, Idahchariye, El Ouagf, El Houwe, Bdeita, and Ras EL Mal for the villages of: Bdeita, Iraniyeh, El Ouaqf, Hermel Ed Daiaa, Daoura, Mtolle .
- 5- Wady El Nousour (hardcopy): Project was executed in 2007. Plans show layout of pipes (PE90) covering a total length of 1,000m and bringing water from the sources of Ain El Mokl and Ain El Nsour.
- 6- Knayseh (hardcopy): The project is divided into two parts which were executed in 2006. Part 1 with a total length of 3,300m consisted of irrigation pipes (PE110) bringing water from Ain El Kabir and Ain El Marje in Knayseh, while Part 2 with a total length of 2,060m

consisted of irrigation pipes (PE90) bringing water from Ain El Bahsa, Ain EL Lezabe, and Ain El Haramieh.

7- Ras El Assy (hardcopy): The project was executed in year 2000. It consists of irrigation canals in Al Mouaalaka area in Ras El Assy. The information included in the available documentation of these 7 schemes will be transformed into a GIS format and included in the database.

A major project entitled "Feasibility studies for the rehabilitation and modernization of small and medium irrigation schemes in Lebanon" was carried out by Jouzy & Partners in joint venture with Haskoning in 1997. The objective of this study was to provide a basis for the evaluation of the costs of rehabilitating and modernizing some existing schemes and an analysis of the financial, economic and social consequences of these works, with the aim to rank the schemes for each Mohafazat based on priority. The area studied covered about 20,000 ha of currently irrigated land, distributed over all of Lebanon. In the Bekaa, the scheme covered 6356 ha, distributed as follows: Rayak, Ali Nahri & surrounding: 800 ha, Zahle & surrounding: 552 ha, Laboue: 1527 ha, Yahfoufa, Jenta, Serraain & surrounding: 2045 ha, Ouadi Nahle & surrounding: 420 ha, Ouyoun Taktak: 100 ha, Marjhine and Jbab el Homr: 922 ha. For each scheme, the following components were evaluated: sociological aspects, soil and land classification, water resources, agronomical conditions, irrigation and rehabilitation works, and financial and economic aspects. Of the Bekaa scheme selected, four fall under the jurisdiction of the BWE, namely: Laboue, Ouadi Nahle, Marjhine, and Jbab El Homr. However, except for the Laboue scheme which has been implemented, the status of the other Bekaa schemes is still unknown to the writer at this point.

As listed in the NWSS (Table 3.7), two major irrigation projects are being planned or executed in the Bekaa outside the jurisdiction of the LRA. These are the Yammouneh scheme with a 1.5 million m³/year reservoir already under construction and the planned Assi scheme which will irrigate 6000 ha in its first phase from a 63 million m³/year reservoir. Efforts are underway to secure the documentation for these two projects. It is not known at this point whether the reservoir mentioned by the NWSS is the same one already shown on the plans.

A survey entitled "Recensement Général de l'Agriculture" has been carried out by the Ministry of Agriculture in 1997 and 1998. This survey gives an inventory of the land uses by type of crop for each caza. The results for the Bekaa are listed in Table 5.1 below. The total land area in the Bekaa was given as 151,157 ha. Subtracting from this area all the uncultivated lands (forests, abandoned lands, fallow, others, etc.), the cultivated area adds up to 102,715 ha which is more than twice the irrigated area taken into account by the NWSS (45,000 ha). There seems to be a discrepancy between the two sources as based on the listed crops and their corresponding areas, it is extremely unlikely that 58,000 ha of these cultivated lands do not need irrigation. Efforts are currently underway to find out whether a more recent survey exists for the Bekaa.



TABLE 5.1: LAND AND CROP INVENTORY FROM "RECENSEMENT GÉNÉRAL DE L'AGRICULTURE" (FAO 1999)

Caza	Cereals (ha)	Grains (ha)	Vegetable Crops (ha)	Industrial Crops (ha)	Fruit Trees (ha)	Oilseeds (ha)	Olives (ha)	Fallow (ha)	Abandoned Land (ha)	Uncultivated Land (ha)	Forests (ha)	Other (ha)	Total (ha)
Zahle	3334.4	182.9	7021.0	5148.1	4332.4	591.1	71.4	149.4	692.4	840.8	38.9	138.7	22541.7
Baalbeck	17279.1	2200.4	12387.9	5565.0	13776.7	1527.7	899.6	4021.9	14292.2	10865.5	1837.7	453.9	85107.7
Hermel	3500.1	1030.1	2799.0	155.9	634.0	509.0	438.5	503.3	1693.6	6597.5	1182.7	71.5	19115.3
West Bekaa	4960.7	117.0	3431.4	4450.9	1924.0	148.5	1038.3	190.6	792.9	1263.3	81.4	114.0	18512.8
Rachaya	699.3	353.7	335.0	3.2	1089.8	82.0	696.5	214.8	1832.4	485.6	28.8	58.8	5879.9
SubTotal	29773.7	3884.0	25974.3	15323.2	21757.0	2858.3	3144.3	5080.0	19303.6	20052.6	3169.6	836.9	151157.4



5.2 Wastewater effluent reuse in irrigation

The Terms of Reference of this study state that the recommended improvements to the wastewater systems in the BWE service area should be consistent with the NWSS. On the subject of wastewater reuse, the document entitled National Strategy for the Wastewater Sector (Resolution No. 35, date 17/10/2012) states the following:

"The strategy targets increases in reuse of treated effluent from zero percent in 2010 to 20% of treated wastewater by 2015, and 50% by 2020. Preliminary estimates indicate that at least 20 and 150 million cubic meters per year could be reused for irrigation purposes by 2015 and 2020, respectively.

- a. Specific studies of existing plants and of plants under implementation will be undertaken to assess technical and economical reuse potential for each plant. The studies will evaluate infrastructure requirements and propose the appropriate investments and institutional arrangements.
- b. Implementation of required infrastructure for re-use of treated wastewater (storage capacities, pumping stations, networks, etc.) will be undertaken."

The MEW strategy published on the website states, under the "Strategic Roadmap" section:

- "- Reuse of 20% of treated wastewater by 2015, and 50% by 2020.
- Secondary treatment and reuse of all inland wastewater by 2020 and secondary treatment by 2020 of coastal wastewater where reuse is economically justified."

There is a discrepancy between these two documents as the strategic roadmap adds that all inland wastewater must be reused by 2020, while the wastewater strategy does not differentiate between inland and coastal wastewaters in its requirement of a 50% reuse by 2020.

In the current study, a wastewater master plan will be proposed for the Bekaa along with a scope of work for an irrigation water master plan in the area under the jurisdiction of the BWE.

In view of the above, several issues arise:

- 1- The percentage of wastewater to be reused has to be agreed upon.
- 2- While the wastewater master plan covers the whole of the Bekaa, the irrigation master plan will only cover the area which is outside the jurisdiction of the LRA. Hence the BWE cannot decide on a plan for a scheme concerning the reuse of the wastewater outside its area of jurisdiction. As a substantial part of the Bekaa population lives in the LRA governed area, the reuse of the wastewater from the plants servicing this population cannot be devised without input from LRA.
- 3- As stated in the strategy (point a above), a specific study must be conducted for each plant to evaluate its reuse potential. As wastewater reuse encompasses many technical and economic issues (distance to areas to be irrigated, need for pumping, required storage, fate of wastewater during winter months, required network, types of crops present in the area of influence of the plant, etc.), it is unlikely that reuse would be an

economically feasible solution for all the Bekaa plants and hence a one-solution-fits-all scheme whereby all wastewater has to be reused would not be advisable. The above listed issues will have to be addressed during the course of the master plan study. For each plant, the potential for reuse will be preliminarily assessed based on its specific conditions. For plants where reuse is deemed to be a priori economically unfeasible, the potential for using the effluent for groundwater recharge will be evaluated. This part of the study will be carried out in close collaboration with the LRA.

A study entitled "Re-use of treated effluent and sludge at laat wastewater treatment plant" has been carried out by the FAO in 2011. The objective of the study was to maximize the benefits from the re-use of treated effluent and sludge and reduce its adverse impacts. The study outputs are: a soil report summarizing soil conditions and types of crops that can be cultivated and irrigated with the treated effluent; a pilot demonstration field for assessing the impact of the treated effluent and sludge on soil quality and crop yield; proposed guidelines for the reuse of treated effluent and sludge; proposed measures to enhance capacity of the technical personnel of the BWE and stakeholders for dealing with wastewater reuse; and an awareness campaign for all stakeholders concerned with the re-use of treated effluent and sludge. The conclusion of the soil report stated that the introduction of treated wastewater will shift the land use from rain fed crops to irrigated agriculture which will incite farmers to introduce new crops and intensive cropping. The quality of the treated wastewater was found to be suitable for irrigation, but the study recommends a long-term follow-up to monitor the accumulation of heavy metals in the soils irrigated with the treated effluent.

5.3 **Preparation of the scope of work**

In order to produce the scope of work that will allow the tendering process of an Irrigation Water Master Plan, the following steps will be undertaken:

- 1- Determine the agricultural areas of Northern and Central Bekaa that have to be served any existing official texts or laws related to this subject.
- 2- Divide the agricultural areas in irrigated, rainfed and fallow then determine if the latters are classified by the MOA as areas that can be potentially cultivated.
- 3- Collect information on existing irrigation systems in the studied area, and identify this area such as the MOA, MEW, etc.



by the BWE. This task will be completed by interviewing the BWE staff and by reviewing

whether these systems are built by the MEW, the local NGOs, or by the private sector such as farmers, cooperatives (with or without licenses from the MEW). This information will be collected by interviewing the related official bodies responsible of the irrigation in

- 4- Conduct limited field investigations, in cooperation with local municipalities to complete the collected information and assess its validity.
- 5- Conduct an investigation by interviewing a representative sample of water users to better define the current use of water irrigation and whether their needs are being met or unmet in the areas that can be practically served by the existing irrigation systems. The same interview will ask about the cultivation of crops and variety, some agricultural techniques and the irrigation methods used. The users sample will include farmers cultivating one or more of the 5 to 6 major crops (grapes, wheat, etc.). These interviews will lead for a better understanding of the water use efficiency and whether or not there is a possibility to reduce irrigation water volumes needed.
- 6- Identify constraints and major deficiencies of the existing water irrigation systems that decrease the provided water and thus prevent the systems from operating at their maximum potential.
- 7- Prepare a detailed scope of work for a consultant that will develop an Irrigation Water Master Plan for this area and suggest a budget for the completion of this task.



PAGE 28 OF 67

6 EXISTING BWE FACILITIES: ASSETS DATABASE

As mentioned in section 3.3, the results of the survey of all water supply facilities owned or rented by the BWE were handed over to the Consultant in late February. According to this project documentation (dated June 2010), each facility was visited and a data sheet, which includes a description of the general physical condition of the civil works and electromechanical equipment, filled. Photos were taken for each facility. Water transmission lines were identified and described by the person in charge and the maintenance crews of BWE. These data are mainly gathered and organized by the GIZ project, and fall under two main categories: spatial and non-spatial data.

- 1. The non-spatial data can be categorized as follows:
 - a) Excel sheets: they are mainly field templates used to gather attribute information about wells, springs, reservoirs, chlorination, flow meters. They include lists and specs of the available facilities, estimated replacement cost of facilities, and description of wastewater treatment plants (type of treatment, completion date, operated by, investment, cost of operation, etc....)
 - b) Photos for all existing facilities (wells, pumping stations, reservoirs, etc...)
 - c) Pdf files showing the completed field templates for all gathered facilities.
 - d) Word documents: an Infrastructure Documentation report summarizing the methodology used for data collection and the terminology for using Keys in building the facilities database; and a Valuation report evaluating the economic value of all surveyed water supply facilities.
 - e) An access data base, where all the previous mentioned non spatial documents are gathered in tables, gueries, forms and reports
- 2. The spatial data can be categorized as follows:
 - a) Jpg files showing mainly drawing of the irrigation schemes
 - b) Pdf.files showing drawing for water supply networks and some sewer networks.
 - c) Autocad files showing as-built drawings of the water supply networks (pipelines, transmission lines, valves, house connections) and some limited sewer system networks. Also there are some drawings of the pumping stations, treatment plants, and some crosssections showing well casings.
 - d) GIS data: it is separated in its turn into two ordinary shapefiles as spaghetti models this include: springs, wells, pumping stations, transmission lines etc. and geodatabase data. The latter consists of the main facilities connected together with simple direct and indirect relationships. This permits querying and identifying related entities. For instance when identifying or querying a certain well all related sub network, transmission lines, reservoirs, related village as well as existing chlorination system (if available) is gathered in one tabular form.

It is guite obvious that a lot of time and effort have been expended by GIZ and the BWE in order to gather all related information, structure them in a proper Access database, and implement the GIS format. An assessment of this massive database is currently being undertaken, however, a preliminary evaluation yielded the following comments:

At the GIS level:

- 1- A substantial part of the information is still missing spatial and attributal information. Some of these data exist as Autocad drawing or pdf files and need to be properly transformed into GIS.
- 2- The GIS database is not usable in its current status as none of the existing GIS layers hold related metadata. This makes it nearly impossible to evaluate and assess properly the data because it lacks data source, the date it was generated, the methodology of transforming it to GIS, the scale, spatial reference, etc..
- 3- A spatial shift between the Autocad data and the related GIS data in almost all layers was noticed. This shift needs to be corrected.
- 4- Entities in the database are not connected properly and none of the system behaviors is identified. This requires re- "cleaning" the data, building topologies and geometric networks, and defining subtypes, relationship and behavior.

At the technical level:

- 1- Sewer networks are missing for all localities except for Baalbeck.
- 2- There are discrepancies in the GIS models: transmission network layouts for some villages are different in the individual models from the global Bekaa GIS model.
- 3- Several plans are either scanned from hardcopies or available in PDF format. The scans are not tied to a grid or a coordinate system and hence cannot be imported or digitized to proper scale and georeference. These plans cannot be used for the purposes of this master plan.
- 4- Some values are present in the database but missing from the facility field sheets. For example: spring maximum and minimum yields in the "Spring" sheets, pipe length in the "Transmission Pipe Sheets", well depth and pump specifications (HMT and Q) in the "Well & Submersible Pump Sheets, etc. Efforts are underway to clarify the issue with the BWE.
- 5- Some information is missing from both the facility field sheets and the database such as the average yield of springs for all springs, or other punctual information for specific facilities.
- 6- Some facility field sheets are missing from the geodatabase.

7 GEOGRAPHICAL INFORMATION SYSTEM

7.1 Improving GIS functionality and updating database

A GIS system can be viewed as a database, which comprises all geometric elements of the geographical space with specific geometric accuracy together with information i.e., in tabular form which is related to geographic location. The GIS is associated by a set of tools, which ensure data management, processing, analysis and presentation of results for information and related geographic locations. To have a functional GIS system, the existing software hardware should be assessed in addition to the staff capability in handling GIS technology. Usually, one of the optimal technologies for operating the GIS applications that might be used is the tiered infrastructure. In the tiered infrastructure, the IT system is partitioned into tiers or layers where each layer performs specific type functionality. Using Business Logic Tier (n-tier infrastructure) will balance the work of the network over the server or several different servers. Moreover, the GIS system environment should be based on three levels. Level one is the GIS authors or creators; it is the BWE and the MEW and other related institutes. Level two is the GIS Engine (server), where all GIS data are gathered and compiled, this will be the host institute (BWE). The third level is the users and stakeholders of different types (staff, ministry engineers, decision makers, etc.). The hardware technology should not only include the computer system within the BWE offices but should cover all GIS mobile application that will facilitate onsite digital update and upgrade of the information. Within this framework the status of the existing BWE system (hardware, software and personnel) will be assessed and recommendations for upgrading and building capacities along with cost estimates can then be defined.

Scattering and discrepancies are major obstacles that face the optimal utilization of data from different aspects, and restrict related activities at the BWE. Therefore, there is an urge to update the existing data and build a suitable, organized, systematical database where the three major datasets (water supply, waste water, irrigation) and the related ancillary data (land cover use, updated road network, digital elevation models, etc...) are stored and compiled in a geo-referenced spatial form. This will include data collection and compilation, migration and conversion/standardization. All data will be structured in one geodatabase having the three main entities (water supply, waste water and irrigation) in a separate feature dataset. The later will insure the spatial referencing and will enable proper database connections, establishing topologies and defining integrity GIS rules. Having this completed, a geometric network between different feature classes of each dataset will be constructed. The geometric network will be created from multiple point and line feature classes, all of which are part of the same feature dataset. The point and line features acquire more behavior (like the ability to maintain connectivity with one another) and become *junction* and *edge* features in a single, integrated dataset. Examples of edges that would be utilized include drainage; transmission lines, irrigation pipes, while

junctions are places where the edges connect to each other or terminate, like wells, springs, reservoirs, etc.

Moreover, metadata will be built for each spatial entity. This will not only help in providing information about data availability within the BWE, but will help to interpret, use data and prevent spatial data redundancy. The metadata will be formulated to meet the ISO requirements and will include quality, source, data format and organization, collection schedule, uses, scale, precision, spatial references, distribution mechanisms and other.

The spatial/ attribute data that will be collected and/or updated under the scope of work will include but not restricted to: utilities (water supply, waste water and irrigation), land cover use, natural drainage system, soil map, population and population distribution and density, urban agglomeration, springs, wells reservoirs, existing and planned wastewater plants, digital elevation models, road networks, etc....

7.2 Support to the BWE

One of the major purposes of this study is to identify issues which should be the focus of future local efforts in the development, expansion, or extension of the water supply and waste water master plan. Thus, when the GIS system is completed it will allow all applications to connect to different kinds of spatial data sources (SHP, info, tiger, CAD files, maps, images, etc.), database (MYSQL, ORACLE, Access) and help in identifying, querying, evaluating and executing different types of attributal and spatial analysis.

The integration of attribute database with the spatial GIS data will permit annual evaluation and assessment of the adequacy of the capacity of the existing water supply, and wastewater systems, a search for opportunities for sharing facilities to either expand capacity or overcome deficiencies; an identification of areas in the region which are experiencing new development which could require future extensions or expansions of infrastructure facilities; and a listing of major problems or deficiencies which should be addressed in the regional priorities.

On the other hand, the constructed GIS system will help in designing the intended irrigation master plan and modeling current and future irrigation water demand based on existing information regarding cropping patterns, irrigated areas, information on crop water requirements, in combination with application and conveyance methods and leaching requirements given water quality. It will help in identifying areas and land subdivision in terms of irrigated areas for each crop group, irrigation methods, network maintenance, monthly net water requirements, crop yields, resources demands, etc...

At the operational and maintenance level, wells, reservoirs, pumping stations, transmission lines, valves, meters, treatment plants and other utility networks can be assessed depending on the type and lifetime of the equipment/utility, its original value and the maintenance costs. Thus through the continuous updating and upgrading of the GIS database system annual business plans could be devised.



8 ADDITIONAL INFORMATION GATHERED TO DATE

As part of the data collection campaign, a number of studies, background maps and information relevant to the current project have already been obtained by KREDO. From these a number of maps and tables have been extracted and processed (Appendix B). Their specific use will be defined in the next project phase as the master plan starts taking shape.

- Geological maps at a 1: 50000 scale produced by Dubertret in the fifties to cover all Lebanon. These maps were re-printed and made commercially available by L'Association Des Amis d'Ibrahim-Aal.
- Topographical maps at the 1:20000 scale prepared by the DGA (Directorate General of the Army) in 1962. These maps also show water bodies and sources.
- Pedological map: a 1:200000 scale soil type map produced for Lebanon by Bernard Gèze in 1952, and followed by an explanation note in 1956. The author identifies 41 pure soil units and 43 associations, 34 of which are issued from the mixing of 2 soils and 9 others from the mixing of 3 soils. We are currently investigating whether a newer map has been produced in the last 10 years or so.
- Land cover plan: A 1:50000 land cover map has been produced for Lebanon by the FAO in 1991 using satellite imaging (later digitized by the MOE). This map however presents some limitations as its use should always be coupled with field checks. We are currently investigating whether newer land cover maps exist.
- Land use plan (1:20000) produced by the LNCSR (Lebanese National Council for Scientific Research) and the MOA (Ministry of Agriculture) in 2001. To our knowledge, this is the most recent land use map available for the Bekaa.
- Hydrogeological map: The latest national groundwater assessment that covers the entire Lebanese territory was undertaken in 1970 by UNDP. Based on borings and pilot studies, it issued a 1:200000 hydrogeological map for Lebanon in 1967, followed by a technical report in 1970 entitled "Liban Etude des Eaux Souterraines". Although the study was quite comprehensive and the methodology accurate, the information is outdated due to the ever changing climatic conditions, soil use and land cover and water use regimes. As mentioned above, the ongoing Groundwater Assessment and Database Project will hopefully provide more updated information once completed by the end of 2013.
- Climatic conditions for Lebanon are available from the Atlas Climatique du Liban prepared by the Lebanon Meteorological Service in 1966. Data used to prepare the Atlas were obtained from various meteorological stations scattered around the country. Other sources of information are also available such as the pluviometry map of Lebanon at a scale of 1:200,000 by Plassard (1971), Ministry of Public Affairs - General Direction of Civil Aviation.

- A road network map for the Bekaa produced by Dar Al Handasah in 2005 and updated from SDATL (Schéma D'Aménagement du Territoire Libanais, Diagnostic et Problématiques. Rapport, CDR- Groupement DAR-IAURIF - 2002).
- Industries distribution in the Bekaa, surveyed as part of the SDATL project (2002).



9 WORK ORGANISATION

An updated timeline for the different tasks to be accomplished is included hereafter. It is worth noting that a delay in the original schedule of data collection and consequently in the field survey has occurred due to a delay in receiving information from the BWE regarding its facilities and from other sources such as the CDR, the CAS, and the MEW regarding planned or executed projects and various other data. Presently, while a sizable amount of information still needs to be collected (requests have mainly been placed to various parties and the Consultant is awaiting their reply), a substantial amount of information has already been obtained and is currently being assessed and processed.



INCEPTION REPORT

PAGE 32 OF 67

PROPOSED TIMELINE



INCEPTION REPORT

PAGE 33 OF 67

Activities								Mon	ths							
	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14
Objective A :Water Supply System Master Plan										_						
A.1-Collect existing water supply system information working in																
close collaboration with BWE staff				[1								
		-	-					-			-	-		-	-	
A 1.1 Collect and review all studies and reports		2														
		1		1			Í									
A.1.2 Meet with CDR , MoEW, and bilateral donors																
A 1.2 Conduct a physical and opportunized accorregate of all water								1			9					
sunnly system elements																
soppy system contents																
A.1.4 Collect and Review cost data of the BWE																
													-			
A.1.5 Collect all soils and topographic information , hydro-geological																
data, and hydrographic studies fro the Bekaa service area			1						T							
A 2-Collect and analyze historical and projected population data.		-					-				-					
and water supply demand data, for various parts of the Bekaa			-	1	1	1										
service area and conduct a limited population survey.																
A.2.1 Collect and review existing reports and studies																
						1										
A.2.2 Limited Population Survey																
A.2.3 Develop low, medium and high population growth projections																
		-					-		-	-	-			-	-	
A.2.4 Using the final master plan projected population develop					-											
projected water supply demand																
											-					
A.3-Recommend specific improvements to the water supply systems											10					
				0												
A.3.1 Develop alternative recommended improvements to the water					5											
suppry systems in the owe.																
4.3.2 Present the alternative recommendations to the management																
of BWE for review								-								
															-	
A.3.3 Prepare an action plan																
										-					-	
A.4-Estimate the capital cost for each finally approved improvement																
and the timing of the use of capital for each improvement												Ī				
		S 5			~					A 52	1 N		2	5 C	2	

Proposed Timeline for the different Tasks



PAGE 34 OF 67

Activities								Mon	ths							
	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14
A.4.1 Prepare a separate capital cost estimate for each "new improvement"																
A.4.2 Prepare a schedule for the timing of the use of capital for each new capital improvement																
A.4.3 Prepare a separate capital cost estimate for each " capital repair or replacement".	<															
A.4.4 Prepare a schedule for the timing of the use of capital for each " capital repair or replacement".																
A.4.5 Develop cost estimates for the operation and maintenance																
A.5-Assess and estimate the needed capital investment to achieve system-wide metering across the entire service area of the BWE																
A.5.1 Develop a separate capital investment program to achieve system-wide metering across the service area of the BWE																
A.5.2 Develop a detailed implementation plan for the logical installation of the meters under the investment program developed.																
Objective B :Wastewater System Master Plan																
B.1-Collect existing wastewater system information working in close collaboration with the BWE staff		-														
B.1.1 Collect and review all studies and reports																
B.1.2 Meet with CDR , MoEW, and bilateral donors																
B.1.3 Conduct a physical and operational assessment of all wastewater plants			12													
B.1.4 Collect and Review cost data of the BWE																



PAGE 35 OF 67

Activities								Mont	ths							
	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14
B.2-Forecast the volume of wastewater to be generated and needing to be treated																
B.2.1 Determine volume of wastewater based on the projected water supply demand for each of the major service areas								6000								
B.3-Recommend specific improvements to the wastewater systems																
B.3.1 Develop alternative recommended improvements to the wastewater systemS in the BWE service area.																
B.3.2 Present the alternative recommendations to the management of BWE for review and final approval.																
B.3.3 Prepare an action plan								1								
8.4-Estimate the capital cost for each finally approved improvement and the timing of the use of capital for the each improvement																
B.4.1 Prepare a separate capital cost estimate for each " new capital improvement that is approved by the management of BWE.																
B.4.2 Prepare a schedule for the timing of the use of capital for each new capital improvement.																
B.4.3 Prepare a separate capital cost estimate form each " capital repair or replacement , or renewal improvement" approved of BWE.																
B.4.4 Prepare a schedule for the timing of the use of capital of capital for each capital repair or replacement , or capital renewal improvement.																
B.4.5 Develop cost estimates for the operation and maintenance of the wastewater system facilities.																
Objective C : Framework for Irrigation Services																
C.1-Collect existing irrigation system information working in close collaboration with the BWE staff		10														
C.1.1 Collect existing irrigation water system information.		Ű.														
C.1.2 Collect and review all studies, reports and available data that have been prepared regarding irrigation systems and services of the BWE.																



PAGE 36 OF 67

Artivities								Mon	ths							1
	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14
C.1.3 Meet with MoEW and bilateral donors working on irrigation																
system related projects in the Bekaa to gather data.				-			1	A								
							1									
C.2-Define existing irrigation water system information								_								
C.2.1 Conduct investigations and irrigation water user interviews to																
define the current need for irrigation waters in the areas that can be											-					
served by the existing irrigation systems.																
C.3-Identify major current physical defeciencies in the existing											-	·				
irrigation system																
C.3.1 Identify major current physical deficiencies in the existing										2	-					
irrigation water system.																
			1	-	-			1				1				
C.4-Develop scope of work to tender development of an Irrigation																
Water Master Plan																
C.4.1 Prepare a detailed scope of work and cost estimate for its																
undertaking for a qualified consultant to develop an Irrigation Water																
Master Plan for the BWE.																
Objective D: Other Deliverables under the Scope of Work																
D.1-Improve existing GIS functionality and update GIS database																
							li li							Î I	1	
D.1.1 Assess and make recommendations for any needed						-	-									
improvements in the existing GIS software and hardware.																
D 1 3 Decidate the improved CIC with the particular staticity to date																
collected updat this Scoop of Work for all water sweeks																
collected under this scope of work for all water supply.																
D 2 Suspent IMPRISS and DMIS in its property ing of its approal													6			
business also undate																
business plan update																
D.2.1 Support LWSS and BWE to properly reflect the forecasted																
capital needs and operation and maintenance costs defined in the													2		~ 3	
water Supply Master Plan.																
Deliverables							Î. Î		í í						ĩ î	
Inception Report			\diamond													
Water Supply System Assessment Report									>							
Wastewater Supply System Assessment Report									0							
Water Suply Capital Investment Plan and Priority Action Plan										(
Wastewater Capital Investment Plan and Priority Action Plan																
Irrigation Services Assessment Report												1				
TOR for Irrigation Systems Master Plan													(
Updated GIS Software and Current Data Base	1															-
Monthly Reports																
Final Report																(
Final Master Plan with above Deliverables as Annexes																(



APPENDIX A:

APPENDIX A:

- A.1 POPULATION ESTIMATES FROM PREVIOUS STUDIES
- A.2 NUMBER OF TOWNS AND VILLAGES IN THE BEKAA ACCORDING TO DIFFERENT SOURCES
- A.3 TOWNS AND VILLAGES NAMES ACCORDING TO CDR & DGA
- A.4 TOWNS AND VILLAGES NAMES ACCORDING TO CAS
- A.5 POPULATION SURVEY QUESTIONNAIRE
- A.6 WATER NEEDS IN THE BEKAA REGION FROM "ANALYSE DES STRATEGIES ET PROSPECTIVES DE L'EAU AU LIBAN" (PLAN BLEU-UNEP 2001)
- A.7 WASTEWATER TREATMENT PLANTS FOR IN THE NORTH & SOUTH OF BEKAA FROM SIU-MRHE (2000)
- A.8 WASTEWATER TREATMENT PLANT LOCATIONS FROM "MASTER PLAN STUDY TO LOCATE WASTE WATER TREATMENT PLANTS IN BEKAA" (DAHNT 1994 MINISTRY OF HOUSING AND COOPERATIVE)



INCEPTION REPORT

INCEPTION REPORT

PAGE 38 OF 67

A.1: Population estimates from previous studies

		CAZA OF HERME	L	
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*
1	Bestane	500	810	50
2	Boueida	800	1,295	
3	Brissa	300	486	
4	Charbiné (Sh)	1,300	2,105	1,200
5	Chouaghir el Faouka	600	972	600
6	Chouaghir el Tahta	400	648	
/	Eissana	70	810	400
0	Haouch as saved aali	300	486	400
9	Haret el Maaser	100	480	
11	Harida	150	243	
12	Hav Bdita	100	162	
13	Hay El Hara	100	162	
14	Hay el Ouaqf	100	162	
15	Hermel	12,000	19,425	13,000
16	Hermel Jbab			
17	Jmeira	100	162	
18	Jouar el Hachich	500	810	300
19	Kharayeb	105	170	
20	Koauakh			500
21	Maaïsra (El)	150	243	
22	Maaser	150	243	
23	Mazraart el Faqih	150	234	7 .0
24	Mazraat Beit el Toch	200	324	50
25	Mazraat Soujod	100	162	
20	Nohr al Aiin	200	243	
27	Natif el Alli	300	480	10
20	Quadi el Fagra			300
30	Quadi et Tourkman	300	486	400
31	Oanafez	175	284	300
32	Qasr	2,000	3,238	2,000
33	Qouakh	385	624	500
34	Ras Baalbeck el Gharbi	100	162	1,300
35	Sahet el Mai	150	243	60
36	Soueiss	225	365	
37	Wadi Bnit	200	324	
38	Wadi el Karm	200	324	10
39	Wadi el Nira	100	162	
40	Wadi el Ratl	400	648	400
41	Zighrine	500	810	400
42	Zoueitini	1,250	2,024	200
	Hermel Total Population	25,210	40,813	21,980

[*] Taken from Khatib & Alami	Report (Lebanon's Staged	Wastewater Program,	Year 1994)
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	CAZA OF BAALBECK			
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*
1	Aaddous	100	162	
2	Aain Bnayé	100	162	
3	Aain es Saa	100	162	
4	Aalaq Tell	1,000	1,619	
5	Aamichki	100	162	
6	Aaqidieh	1,000	1,619	
7	Aarsal	7,000	11,331	5,800
8	Ain (El)	5,000	8,094	3,400
9	Ain Bourdai	639	1,035	600
10	Ain el Jaouzé	100	162	
11	Ain Es Saouda	65	106	50
12	Ainata	1,700	2,752	900
13	Amhazié	0	1,200	
14	Baalbeck	52,000	84,173	25,300
15	Bajjajé (El)	200	324	50
16	Barqa	910	1,474	500
17	Bechouat	650	1,053	500
18	Bednayel	7,000	11,331	3,500
19	Beit Chama	1,200	1,943	
20	Beit Mcheik	1,000	1,619	500
21	Beliqa	57	93	50
22	Boudai	3,000	4,857	2,100
23	Britel	5,000	8,094	3,000
24	Btedaai	590	956	400
25	Chaaibé	100	162	
26	Chaat	3,500	5,666	2,000
27	Chlifa	1,200	1,943	1,400
28	Chmistar	8,000	12,950	5,500
29	Dar el Wasseaa	1,000	1,619	50
30	Deir el Ahmar	4,340	7,026	3,600
31	Deir Mar Maroun	100	162	
32	Douris	1,415	2,291	1,900
33	Fekehe	3,000	4,857	2,800
34	Flaoue	1,000	1,619	500
35	Hadet (El)	1,900	3,076	1,600
36	Halbata	700	1,134	400
37	Ham	300	486	200
38	Haouch Barada	420	680	400
39	Haouch ed Dahab	69	112	50
40	Haouch en Nabe	1,000	1,619	200
41	Haouch er Rafqa	3,000	4,857	1,200
42	Haouch Snaid	120	195	70
43	Haouch Tell Safiyé	600	972	400
44	Harbata	2,500	4,047	1,200
45	Harfouche	180	292	30
46	Hizzine	430	697	400



INCEPTION REPORT

PAGE 39 OF 67

CAZA OF BAALBECK				
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*
47	Hortaala	1,500	2,429	1,800
48	Iaat	3,000	4,857	2,200
49	Jabboulé	100	162	200
50	Jdeidé	2,000	3,238	1,900
51	Jebaa	300	486	50
52	Jenta	900	1,457	
53	Kfar Dabach	400	648	200
54	Kfardaane	800	1,295	700
55	Khoder (El)	600	972	500
56	Khraibé (El)	300	486	300
57	Kneissé	1,065	1,724	900
58	Laboué	2,500	4,047	3,000
59	Maaraboun	800	1,295	400
60	Machaitiye			30
61	Majdaloun	600	972	
62	Maqné	2,120	3,432	1,800
63	Masnaa Bednayel			400
64	Mazraat Beit Matar	300	486	50
65	Mazraat Beit Slaibi	160	259	
66	Mazraat ed Dallil	130	211	
67	Mazraat es Syad	130	211	50
68	Moqraq	400	648	200
69	Mousraye			
70	Nabha	2,200	3,562	1,300
71	Nabi Chbat (En)	120	195	90
72	Nabi Chit (En)	6,000	9,713	3,200
73	Nabi Osmane (En)	1,800	2,914	
74	Nabi Rchad	100	1,619	600
75	Nahlé	3,000	4,857	2,000
76	Ouadi el Aaoss			50
77	Qaa (El)	5,000	8,094	3,500
78	Qaa Baayoun			
79	Qaa Jouar Maqiye			
80	Qaa Ouadi El Khanzer	100	640	200
81	Qarha	400	648	200
82	Qasrnaba	2,500	4,047	1,700
83		1,500	2,429	500
84		000	1.005	30
85	Kam (El)	800	1,295	400
86	Kas Baalbeck	3,200	5,180	4,000
8/	Kas el Aassi	150	243	20
88	Kina Conidá	660	1,069	500
89	Saalde	/50	1,215	300
90	Saira	410	004	400
91	Serveine al Charbick/Hallaniah			
92	Seracine el Gnarbien/ Hallanien	1 200	2.072	1 200
93		1.280	2.072	1.200

CAZA OF BAALBECK				
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*
94	Serraain el Faouka	2,000	3,238	1,400
95	Sifri	250	405	
96	Slouqi			
97	Talia	940	1,522	900
98	Taoufiqié	500	810	800
99	Taraya	3,000	4,857	2,200
100	Taybeh (Et)	1,200	1,943	500
101	Temnine el Faouqa	2,000	3,238	1,500
102	Temnine el Tahta	4,000	6,475	2,700
103	Tfail	190	308	
104	Wadi Faara	450	729	50
105	Yahfoufa	700	1,134	200
106	Yammouné	1,200	1,943	800
107	Younine	5,000	8,094	3,200
108	Zabboud	480	777	400
109	Zraieb	300	486	1,200
110	Zrazir	270	438	400
	Baalbeck Total Population	193,840	316,473	121,470

* Taken from Khatib & Alami Report (Lebanon's Staged Wastewater Program, Year 1994)



	CAZA OF ZAHLE				
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*	
1	Aanjar/Haouch Moussa	6,400	10,360	10,500	
2	Ablah	3,200	5,180	900	
3	Ain Kfar Zabad	1,300	2,105	2,000	
4	Ali en Nahri	5,500	8,903	1,700	
5	Barr Elias	12,000	19,425	8,000	
6	Betyas	100	162		
7	Bouarej	1,200	1,943	700	
8	Chebrqieh	100	162	500	
9	Chtaura	No.23	No.23	500	
10	Dalkaniye			500	
11	Deir el Ghazal	810	1,312	600	
12	Deir Zanoun	250	405	10	
13	Delhamiye	700	1,134		
14	Faaour	1,000	1,619		
15	Fourzol (El)	2,600	4,209	900	
16	Haouch el Ghanam	48	78		
17	Haouch es Siyadi	100	162		
18	Haouch Handari	100	162		
19	Haouch Qaissar	90	146	10	
20	Hay el Fikani	700	1,134	200	
21	Hazerta	3,500	5,666	700	
22	Hoshmosh	40	65		
23	Janta			300	
24	Jdita	7,000	11,331	5,000	
25	Jlala			600	
26	Kfar Zabad	1,800	2,914	1,900	
27	Ksara		2,000		
28	Maallaqa	6,600	10,684		
29	Maallaqa Aradi				
30	Majdel Aanjar	6,000	9,713	4,200	
31	Maksé	500	810		
32	Massa	1,100	1,781	200	
33	Mazraa (El)	100	162		
34	Mraijat (El)	1,750	2,833	1,100	
35	Nabi Ayla	1,200	1,943	400	
36	Nasireh	100	162		
37	Nasriye	350	567	200	
38	Nasriyet Rizk				
39	Niha	600	972	800	
40	Ouadi Ed Dellem	100	162	300	
41	Qaa er Rim	1,500	2,429	1,000	
42	Qabb Elias	16,200	26,223	10,000	
43	Qoussaya	1,000	1,619	200	
44	Quommol	200	324		
45	Raite	1,500	2,429	500	
46	Ramtaineh	100	162		
47	Raouda	450	729		
48	Rayak- Haouch Hala	8,000	12,950	6,400	

	CAZA OF ZAHLE				
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*	
49	Saadnayel	5,500	8,903	1,200	
50	Taalabaya - Jalala	14,000	22,662	2,100	
51	Taanayel (Deir)	200	324		
52	Tell el Akhdar	100	162	50	
53	Terbol	3,300	5,342	1,800	
54	Touaite	150	234		
	Zahlé	100,000	161,870	90,100	
	Aradi				
	Al-Rassieh				
	Barbara				
	Haouch El-Oumara Aradi				
	Haouch El-Oumara				
55	Haouche Al-Zaraan				
	Mar Antonios				
	Mar Elias				
	Mar Gerios				
	Medan				
	Ouadi El-Aarayech			1,100	
	Saidet Al Najda			3,000	
56	Zebdol	100	162	400	
	Zahlé Total Population	219,238	356,890	156,470	

* Taken from Khatib & Alami Report (Lebanon's Staged Wastewater Program, Year 1994)



INCEPTION REPORT

CAZA OF WEST BEKAA				
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*
1	Ain El Tine (2)	600	972	700
2	Ain Zebdé	1,050	1,700	1,100
3	Aaitanit	2,000	3,238	2,400
4	Aammiq	550	891	200
5	Aana	800	1,295	500
6	Baaloul	1,350	2,186	1,200
7	Bab Mareh	450	729	400
8	Dakoué (El)	600	972	200
9	Deir Ain ej Jaouzé	60	98	20
10	Deir Tahnich	40	65	20
11	Fadar El Faouka			600
12	Fadar El Tahta			400
13	Ghazze	3,000	4,857	900
14	Hammara (Manara)	1,300	2,105	1,600
15	Harimet es Soghra			
16	Haouch El Harime	1,025	1,660	1,100
17	Jeziré (El)	100	162	
18	Joubb Jannine	6,500	10,522	5,500
19	Kamed el Loz	3,000	4,857	2,500
20	Kefraiya	850	1,376	900
21	Khiara (El)	1,250	2,024	200
22	Khirbet Qanafar	3,000	4,857	3,500
23	Lala	2,110	3,416	2,000
24	Libbaya	1,270	2,056	1,600
25	Loussa	150	243	400
26	Machghara	10,000	16,187	6,500
27	Maidoun	450	729	200
28	Manara	1,200	1,943	1,400
29	Mansoura	1,500	2,429	1,200
30	Mari (El)	2,980	4,824	1,900
31	Ouaqf (El)	100	162	
32	Qaraaoun (El)	5,000	8,094	4,500
33	Qelia	1,200	1,943	600
34	Raouda			
35	Saghbine	3,000	4,857	3,500
36	Sohmor	3,500	5,666	2,100
37	Saouiri	1,700	2,752	2,000
38	Sltan Yaqoub El Aradi			
39	Sltan Yacoub el Fouqa	1,600	2,590	700
40	Sltan Yaqoub el Tahta	1,000	1,619	300
41	Tell Ez Zaazaa	,	,	
42	Tell Znoub	450	729	300
43	Yohmor el Beqaa	1,880	2,914	1,100
44	Zellaya	400	648	200
	West Bekaa Total Population	67,015	108,367	54,440

	CA	ZA OF RACHAYA		
No.	Town Name	DAHNT (1980)	DAHNT (1994)	CDR (1992)*
1	Aaiha	1,400	2,267	1,900
2	Aain Arab	800	1,295	
3	Aakabe (El)	1,000	1,619	1,700
4	Ain Aata	1,200	1,943	1,300
5	Ain Horche	760	1,231	800
6	Aita El Foukhar	1,200	1,943	2,300
7	Bakka	750	1,215	500
8	Bakkifa	750	1,215	800
9	Beit Lahia	700	1,134	700
10	Bire (El)	1,300	2,105	1,500
11	Dahr el Ahmar	700	1,134	2,100
12	Deir el Aachayer	500	810	500
13	Ezzé (Aazzi)	0	2,000	
14	Haloua	185	300	200
15	Haouch El Qinnaabe	780	1,263	600
16	Kaoukaba	300	486	400
17	Kfar Qouq	1,200	1,943	1,400
18	Kfardenis	750	1,215	500
19	Kfarmechki	1,140	1,846	1,600
20	Khirbet Rouha	1,200	1,943	1,500
21	Majdel Balhiss	1,000	1,619	300
22	Mazraat Deir el Aachayer	100	162	60
23	Mazraat Jaafar	100	162	30
24	Mazraat Salsata	100	162	
25	Mdoukha	1,000	1,619	
26	Mhaidthé (El)	1,000	1,619	300
27	Nabaat			10
28	Qennabé	100	162	200
29	Rachaiya	5,500	8,903	
30	Rachaya el Faouka			1,100
31	Rachaya El Kouasbe'			900
32	Rachaya el Wadi	2,000	3,238	
33	Rafid (Er)	1,200	1,943	1,800
34	Tannoura	600	972	400
35	Yanta	1,100	1,781	1,500
	Rachaya Total Population	30,415	51,249	26,900

* Taken from Khatib & Alami Report (Lebanon's Staged Wastewater Program, Year 1994)



INCEPTION REPORT	
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A.2: Number of towns and villages in the Bekaa according to different sources

	No. of Towns as per			
Source	CNRS			
Caza Name	CDR DGA			
Zahle	62	62		
West Bekaa	41	41		
Baalbek	113	116		
Hermel	57	61		
Rachiaya	31	31		
Total	304 311			

	No. of Towns as per		
Source	Dar Al Handasah K&		
Caza Name	1980/ 1994	1992	
Zahle	50	25	
West Bekaa	38	35	
Baalbek	98	81	
Hermel	40	21	
Rachiaya	32	29	
Total	258	191	

A.3: Towns and villages names according to CDR & DGA

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
1	Zahle	Zahle	Zahle	
2	Zahle	Hawch Al Oumara	Haouch el Oumara	
3	Zahle	Hawch Al Sayyade	Haouch el Sayade	
4	Zahle	Hawch Al Zaraina	Houch ez Zaraane	
5	Zahle	Karak Nouh	Karak Nouh	
6	Zahle	Madinat Al Sinaiyat	MADINAT AL SINA'IYAT	
7	Zahle	Mealaka	Maalaqa	
8	Zahle	Wady Al Arayech	Ouadi el Aarayech	
9	Zahle	Ablah	Ablah	
10	Zahle	Bar Elias	Bar Elias	
11	Zahle	Bouwarej	Bouarej	
12	Zahle	Bayyadat	Bayyadat	
13	Zahle	Terbol	Terbol	
14	Zahle	Ta'labaya	Taalabaya	
15	Zahle	Te'nayel	Taanayel	
16	Zahle	Tall el Akhdar	Tall el Akhdar	
17	Zahle	Tal Al Amara	TAL AL AMARA	
18	Zahle	Twayte	Touaite	
19	Zahle	Jdita	Jdita	
20	Zahle	Jlala	Jlala	
21	Zahle	Hzarta	Hazerta	
22	Zahle	Hechmoch	Hechmech	
23	Zahle	Hakl Hammana	Hakl Hammana	
24	Zahle	Hawch Hala	Houch Hala	
25	Zahle	Hawch Al Ghanam	Houch El-Ghanam	
26	Zahle	Hawch Kayssar	Qeisser	
27	Zahle	Hawch Mandarah	Haouch el Mendara	
28	Zahle	Hay Al Fikany	Hai el Fikani	
29	Zahle	Dalhamiyeh	Dalhamiye	
30	Zahle	Deir Zanoun	Deir Zenoun	
31	Zahle	Deir Al Ghazal	Deir el Ghazal	
32	Zahle	R'yte	Raite	
33	Zahle	Riyak	Rayak	
34	Zahle	Zebdol	Zebdol	
35	Zahle	Sa'dnayel	Saadnayel	
36	Zahle	Chabrakiyet Tabet	Chabrakiyet Tabet	
37	Zahle	Chtoura	Chtaura	
38	Zahle	Chamssine	Chamssine	
39	Zahle	Dahr Al Ballite	Dahr Blait	



INCEPTION REPORT

INCEPTION REPORT

PAGE **43** OF **67**

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
40	Zahle	Dahr Al Harf	Dahr al Harf	
41	Zahle	Ali Al Nahry	Aali en Nahri	
42	Zahle	Anjar	Aanjar	
43	Zahle	Ain Kafar Zabad	Ain Kfar Zabad	
44	Zahle	Ferzol	Fourzol	
45	Zahle	Kaal Rime	Qaa er Rim	
46	Zahle	Kob Elias	Qabb Elias	
47	Zahle	Kamel	Qommol	
48	Zahle	Kssara	Ksara	
49	Zahle	Kfar Zabad	Kfar Zabad	
50	Zahle	Kousaya	Koussaya	
51	Zahle	Masna	Masnaa	
52	Zahle	Massa	Massa	
53	Zahle	Majdel Anjar	Majdel Anjar	
54	Zahle	Mazraet Zahle	Mazraat el Mehqane	
55	Zahle	Mrayjat	Mreijat	
56	Zahle	Maksseh	Meksi	
57	Zahle	Nassriyet	Nassriyet	
58	Zahle	Nassriyet Rezk	Nasriye	
59	Zahle	Naby Ayla	Nabi Aila	
60	Zahle	Na'ssate	Na'ssate	
61	Zahle	Niha	Niha	
62	Zahle	Wady Al Delm	Ouadi ed Deloum	
63	West Bekaa	Jeb Jannine	Joub Janine	
64	West Bekaa	Saghbine	Saghbine	
65	West Bekaa	Bab Mare'	Bab Maraa	
66	West Bekaa	Ba'loul	Baaloul	
67	West Bekaa	Tal Zanoub	Tall Znoub	
68	West Bekaa	Tal Zanoub Al Jadid	Tall Znoub ej Jdide	
69	West Bekaa	Tal Al Zazaa	Tal al Za'za'a	
70	West Bekaa	Hawch Al Harimeh	Houch el Harime	
71	West Bekaa	Hawch Ammik	Houch Aammiq	
72	West Bekaa	Kherbet Kanafar	Khirbet Qanafar	
73	West Bekaa	Khayara	Khiara	
74	West Bekaa	Dakkouh	Dakoue	
75	West Bekaa	Deir Tahnich	Deir Tahnich	
76	West Bekaa	Deir ain Al Jawzeh	Deir Ain ej Jaouze	
77	West Bekaa	Zlaya	Zellaya	
78	West Bekaa	Sohmor	Sohmor	
79	West Bekaa	Sa'louk	Houch es Saalouk	
80	West Bekaa	Soltane Ya'koub Al Tahta	Soultane Yaaqoub el Tahta	

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
81	West Bekaa	Soltane Ya'koub Al Fawka	Soultane Yaaqoub el Faouqa	
82	West Bekaa	Chaberkiyet 'Ammik	Chebreqiye	
83	West Bekaa	Swayry	Souairi	
84	West Bekaa	Ana	Aana	
85	West Bekaa	Ammik	Aammiq	
86	West Bekaa	Aytanite	Aitanit	
87	West Bekaa	Ain Al Tineh	Ain et Tine	
88	West Bekaa	Ain Zebdeh	Ain Zebde	
89	West Bekaa	Ghazzeh	Ghazze	
90	West Bekaa	Kar'oun	Qaraoun	
91	West Bekaa	Kellaya	Qillaya	
92	West Bekaa	Kamed Al Lawz	Kamed el Laouz	
93	West Bekaa	Kefraya	Kafraiya	
94	West Bekaa	Lala	Lala	
95	West Bekaa	Lbaya	Libbaya	
96	West Bekaa	Loussiya	Loussia	
97	West Bekaa	Marj	El Marj	
98	West Bekaa	Machghara	Machgara	
99	West Bekaa	Manara Ou Hammara	Manara ou Hammara	
100	West Bekaa	Mansourat	Mansoura	
101	West Bekaa	Maydoun	Meidoun	
102	West Bekaa	Yohmor	Yohmor	
103	West Bekaa	Istabl	Istabl	
104	Baalbek	Baalbek	Baalbek	
105	Baalbek	l'ate	laat	
106	Baalbek	Bted'y	Betdaai	
107	Baalbek	Bjajeh	Bejjaje	
108	Baalbek	Bednayel Baalbek	Bednayel	
109	Baalbek	Barkeh	Barqa	
110	Baalbek	Britale	Britel	
111	Baalbek	Bechwat	Bechouat	
112	Baalbek	Bsayleh Al Tahta	Bsayleh al Tahta	
113	Baalbek	Bsayleh Al Fawka	Bsayleh al Fawka	
114	Baalbek	Bouday	Boudai	
115	Baalbek	Beit habchi	Beit Habchi	
116	Baalbek	Beit Chama	Beit Chama	
117	Baalbek	Beit Mchik	Beit Mchik	
118	Baalbek	Temnine Al Tahta	Tammine et Tahta	
119	Baalbek	Temnine Al Fawka	Tamnine El Faouqa	
120	Baalbek	Toufikiyeh	Toufiqiye	
121	Baalbek	Jeba	Jabaa	



INCEPTION REPORT

PAGE 44 OF 67

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
122	Baalbek	Jbouleh	Jabboule	
123	Baalbek	Jdaydet Al Fakha	Jdaide	
124	Baalbek	Janta	Janta	
125	Baalbek	Joubaniyeh	Joubaniyeh	
126	Baalbek	Hame	Ham	
127	Baalbek	Hadath Baalbek	Hadet	
128	Baalbek	Hrabta Baalbek	Harata	
129	Baalbek	Harfouche	Harfouch	
130	Baalbek	Hezzine	Hizzine	
131	Baalbek	Hfayer	Hfayer	
132	Baalbek	Hlabta Baalbek	Halbata	
133	Baalbek	Hawch Al Naby	Haouch En Nabi	
134	Baalbek	Hawch Barada	Haouch Barada	
135	Baalbek	Hawch tal Safiyeh	Haouch Tall Safiye	
136	Baalbek	Hawch Al Rafkeh	Houch Er Rafqa	
137	Baalbek	Hawch Al Zahab	Haouch Ed Dahab	
138	Baalbek	Hawch Snide	Haouch Snaid	
139	Baalbek	Khermateh	Khermateh	
140	Baalbek	Khraybet Baalbek	Khraibe	
141	Baalbek	Khodor	Khodor	
142	Baalbek	Dar El Wasia	Dar el Ouassaa	
143	Baalbek	Deir Al Ahmar	Deir El Ahmar	
144	Baalbek	Ras Baalbek	Ras Baalbek	
145	Baalbek	Rame Baalbek	Ram	
146	Baalbek	Rasm Al Hadath	Rasm El Hadet	
147	Baalbek	Riha	Riha	
148	Baalbek	Douress	Douris	
149	Baalbek	Zboud	Zabboud	
150	Baalbek	Zrazyre	Zrazir	
151	Baalbek	Zrayeb Chakar	Zarayeb	
152	Baalbek	serine el Tahta	Saraain et Tahta	
153	Baalbek	Serine el Fawka	Saraain el Faouqa	
154	Baalbek	Saydeh	Saaide	
155	Baalbek	Safry	Sifri	
156	Baalbek	Siret Hanna	Siret Hanna	
157	Baalbek	Cha't	Chaat	
158	Baalbek	Chlifa	Chlifa	
159	Baalbek	Chmestare	Chmistar	
160	Baalbek	Sboubeh	Sbouba	
161	Baalbek	Safra Baalbek	Safra	
162	Baalbek	Taraya	Taraiya	

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
163	Baalbek	Tfayl	Tfail	
164	Baalbek	Talya	Talia	
165	Baalbek	Ersale	Aarsal	
166	Baalbek	Tibet Baalbek	Taibe	
167	Baalbek	Amachiki	Amachiki	
168	Baalbek	Elak Al TAl	Aallaq	
169	Baalbek	Aynata Baalbek	Ainata	
170	Baalbek	Ain Baalbek	El Ain	
171	Baalbek	Ain Al Binniyeh	Ain El Bnaiye	
172	Baalbek	Ain Bourday	Ain Bourday	
173	Baalbek	Ain Al Jawzeh Baalbek	Ain Ej Jaouze	
174	Baalbek	Klaylet Baalbek	Qlaile	
175	Baalbek	Fakihat	Fakehe	
176	Baalbek	Frayj	Freij	
177	Baalbek	Ка'	Qaa	
178	Baalbek	Kdame Baalbek	Qiddam (el)	
179	Baalbek	Karha Baalbek	Qarha	
180	Baalbek	Kassernaba	Qsarnaba	
181	Baalbek	Flawy	Flaoui	
182	Baalbek	Kfar Dane	Kfar Dane	
183	Baalbek	Kfar Dabach	Kfar Dabach	
184	Baalbek	Knaysset Baalbek	Knaisse	
185	Baalbek	Labweh	LabouO	
186	Baalbek	Majdaloune	Majdaloun	
187	Baalbek	Mrah Sem'ane	Mrah Semaan	
188	Baalbek	Mrah Al Assi	Mrah El Aassi	
189	Baalbek	Mrah Al Aouja	Mrah El Aaouja	
190	Baalbek	Mrah Al Kloude	Mrah Kloude	
191	Baalbek	Mazraet Al Ramassy	Mazraat al Ramassy	
192	Baalbek	Mazraet Al Takech	Mazraat al Takch	
193	Baalbek	Mazraet Al Sayed	Mazraat Es Saiyed	
194	Baalbek	Mazraet Al Dalile	Mazraat Ed Dallil	
195	Baalbek	Mchayrfeh	Mehairfe	
196	Baalbek	Masna Bednayel	Masnaa	
197	Baalbek	Malakaal Jadideh	El Maalqa	
198	Baalbek	Maraboun	Maarboun	
199	Baalbek	Mekrak	Moqraq	
200	Baalbek	Makneh	Maqneh	
201	Baalbek	Mkaybel al Kala'	Mkaybel Al Kala'	
202	Baalbek	Nabha Baalbek	Nabha	
203	Baalbek	Naby Rchadeh	Nabi Rachade	



INCEPTION REPORT

PAGE 45 OF 67

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
204	Baalbek	Naby Sabate	Nabi Sbat	
205	Baalbek	Naby Chite	Nabi Chit	
206	Baalbek	Naby Osmane	Nabi Osmane	
207	Baalbek	Nahleh	Nahle	
208	Baalbek	Yahfoufeh	Yahfoufa	
209	Baalbek	Yammouneh	Yammoune	
210	Baalbek	Younaine	Younine	
211	Baalbek	Hourta'la	Haour Taala	
212	Baalbek	Mrah El Harfouch	Mrah EL Harfouch	
213	Hermel	Hermel	Hermel	
214	Hermel	Berghoch	Berghoch	
215	Hermel	Brayj Al Hermel	Bray	
216	Hermel	Hay Bdita	Bdita	
217	Hermel	Brissa	Brissa	
218	Hermel	Bestane Al Hermel	Boustane	
219	Hermel	B'oule	Boule	
220	Hermel	Beit Hira	Beit Hira	
221	Hermel	Bouwaydet Hermel	Bouaida	
222	Hermel	Tal Al Hermel	Tall El far	
223	Hermel	Jware Al Hachiche	Jouar El Hachich	
224	Hermel	Jawz	Jawz	
225	Hermel	Haret Al M'aysyre	Haret El Maasser	
226	Hermel	Hariket Al Hermel	Hariqa	
227	Hermel	Hmayret Al Hermel	Hmaire	
228	Hermel	Hawch Beit Isma'l	Hawch Beit Ismail	
229	Hermel	Hawch Al Sayyed Ali	Haouch Es Saiyad Aali	
230	Baalbek	Khrayeb Al Hermel	Kharayeb	
231	Baalbek	Ras Al 'Assy	Ras al Assy	
232	Hermel	Zeghrine	Zighrine	
233	Hermel	Zkiyeh	Mrah Ez Zakbe	
234	Hermel	Zwaytini	Zouaitini	
235	Hermel	Swayssy	Souaisse	
236	Hermel	Sahleite Al Maa	Salhat El Ma	
237	Hermel	Chrbine Al Hermel	Charbine	
238	Hermel	Chwaghyre Al Tahta	Chouaghir	
239	Hermel	Ain Al Jadideh Al He	Ain al Jadideh	
240	Hermel	Faara	Faara	
241	Hermel	Fissane	Fissane	
242	Hermel	Kasser	Qasr	
243	Hermel	Knafez	Qanafez	
244	Hermel	Kwakh	Kouakh	

		Town Name as per		
	Source	CNRS		
No.	Caza Name	CDR	DGA	
245	Hermel	Mrah Bou Kamar Al Dine	Mrah Bou Kamar al Dine	
246	Hermel	Mrah Beit "Elou	Mrah Beit Aalaoui	
247	Hermel	Mrah Al Sayyade	Mrah es Siyaid	
248	Hermel	Mrah Al Chaeb	Mrah Ech Chaab	
249	Hermel	Mrah Al 'Abbas	Mrah Aabbas	
250	Baalbek	Mrah Al Abed	Mrah El Aabed	
251	Hermel	Mrah Al Mechref	Mrah El Mouchref	
252	Hermel	Mrah Al Magher	Mrah El Mougher	
253	Hermel	Mrah Nawass	Mrah Naaouas	
254	Hermel	Mrah Yassine	Mrah Yassine	
255	Hermel	Mrah Al Ain	Mrah El Ain	
256	Hermel	Mazraet Beit Al Tac	Mazraat Beit Et Tachm	
257	Hermel	Mazraet Al Fkyh	Mazret al Fkyh	
258	Hermel	Mazraet Sajed	Mrah Sejoud	
259	Hermel	Me'aser Al Hermel	Maaisr	
260	Hermel	Mansouret Al Hermel	Mansoureh	
261	Hermel	Mnayra	Mnaira	
262	Hermel	Nassriyet Al Hermel	Nasriye	
263	Hermel	Wady Bnyte	Quadi Bnit	
264	Hermel	Wadi Al Terkmane	Ouadi et Tourkmane	
265	Hermel	Wady Al Ratel	Ouadi Er Ratle	
266	Baalbek	Wady A'lass	Ouadi el Oss	
267	Hermel	Wady Al Karem	Quadi el Karm	
268	Hermel	Wady Al Nyreh	Ouadi en Nayra	
269	Hermel	Haouchariye	Haouchariye	
270	Hermel	Mazraet et Talle	Mazraat Et Talle	
271	Hermel	Mrah El Dalil	Mrah El Dalil	
272	Hermel	Mrah Al Qraita	Mrah el Qraita	
273	Hermel	Zighrine Et Tahta	Zighrine Et Tahta	
274	Rachiaya	Rachaya Al Wady	Rachaiya	
275	Rachiaya	Baka	Bakka	
276	Rachiaya	Bkifa	Bakkifa	
277	Rachiaya	Beit Lahya Beit Lahia		
278	Rachiaya	Byret Bire		
279	Rachiaya	Tannourah Tannoura		
280	Rachiaya	Helwet	Haloua	
281	Rachiaya	Hawch Rachaya	Haouch	
282	Rachiaya	Kherbet Rouha	Khirbet Rouha	
283	Rachiaya	Deir Al Achayer	Deir el Aachayer	
284	Rachiaya	Rfyde	Rafid	
285	Rachiaya	Dahr Al Ahmar	Dahr el Ahmar	



INCEPTION REPORT

PAGE 46 OF 67

		Town Name as per	
	Source	CNRS	
No.	Caza Name	CDR	DGA
286	Rachiaya	Akbet	Aaqbe
287	Rachiaya	Ayta Al Foukhare	Aita el Foukhar
288	Rachiaya	Ayha	Aaiha
289	Rachiaya	Ain Harcha	Ain Hircha
290	Rachiaya	Ain Arab	Ain Aarab
291	Rachiaya	Ain Ata	Ain Aata
292	Rachiaya	Kanabeh	Qnaabe
293	Rachiaya	Kfar Danisse	Kfar Danis
294	Rachiaya	Kfar Kouk	Kfar Qouq
295	Rachiaya	Kfar Mechki	Kfar Mechki
296	Rachiaya	Kawkaba	Kaoukaba
297	Rachiaya	Majdel Balhisse	Majdel Balhis
298	Rachiaya	Mhaydsset	Mhaidse
299	Rachiaya	Mdoukha	Mdoukha
300	Rachiaya	Marj Al Samah	Marj es Simah
301	Rachiaya	Mazraet Ja'far	Mazraat Jaafar
302	Rachiaya	Mazraet Deir Al Achaer	Mazraat Dier el Aachayer
303	Rachiaya	Mazraet Al Chmis	Mazret Al Chmis
304	Rachiaya	Yanta	Yanta
305	Baalbek		Mhattat Ras Baalbeck
306	Baalbek		Aayoun Orghoush
307	Baalbek		Qalaat BakdГch
308	Hermel		Ouadi Faara
309	Hermel		Mrah Houssain Taane
310	Hermel		AaqabO
311	Hermel		Jisr el Aassi

A.4: Towns and villages names according to CAS

		_
	_	Town
	Source	
No.	Caza Name	
1	Zahle	Zahleh
2	Zahle	Zahleh El Midane
3	Zahle	Zahleh Haouch Ez Zaraaneł
4	Zahle	Zahleh Mar Mikhayel
5	Zahle	Zahleh Mar Gerges
6	Zahle	Zahleh Er Rassiyeh
7	Zahle	Zahleh El Berbara
8	Zahle	Zahleh Karak Nouh
9	Zahle	Zahleh El Maallaqa
10	Zahle	Zahleh Mar Antonios
11	Zahle	Zahleh Maallaqa Aradi
12	Zahle	Zahleh Haouch El Oumara
13	Zahle	Zahleh Saydet En Najat
14	Zahle	Karmeh (Qommol)
15	Zahle	Zahleh Haouch El Oumara
16	Zahle	Zahleh Aradi
17	Zahle	Tall Chiha
18	Zahle	Zahleh Mar Elias
19	Zahle	Fourzol
20	Zahle	Haql Hammana
21	Zahle	Touayteh (Zahleh)
22	Zahle	Dahr El Harf
23	Zahle	Nabi Ayla
24	Zahle	Hazerta
25	Zahle	Ablah
26	Zahle	Qaa Er Rim
27	Zahle	Niha (Zahleh)
28	Zahle	Ksara
29	Zahle	Mazraat Er Remtaniyeh
30	Zahle	Ain El Ghmiga
31	Zahle	Nabaa El Aassal (Remtanive
32	Zahle	Ouadi El Aarayech
33	Zahle	, Jalala
34	Zahle	Chtaura
35	Zahle	Biyada (Zebdoul)
36	Zahle	Naassat
37	Zahle	Zebdoul
38	Zahle	Makseh
39	Zahle	Taalabaya
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INCEPTION REPORT

PAGE 47 OF 67

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
40	Zahle	Jdita
41	Zahle	Dahr Es Souane (Jdita)
42	Zahle	Dahr El Blayet
43	Zahle	Taanayel
44	Zahle	Saadnayel
45	Zahle	Qabb Elias
46	Zahle	Sahret El Qach
47	Zahle	Haouch Mandra
48	Zahle	Sraij
49	Zahle	Mrayjat (Zahleh)
50	Zahle	Bouarej
51	Zahle	Chebrqiyet Tabet
52	Zahle	Haouch Es Siyadeh
53	Zahle	Ouadi Ed Delm
54	Zahle	Ras El Ain (Ouadi Ed Delm)
55	Zahle	Tcheflek Qiqano
56	Zahle	Haouch Ed Dibs
57	Zahle	Haouch Qayssar
58	Zahle	Deir Zenoun
59	Zahle	Barr Elias
60	Zahle	Mazraat Zahleh
61	Zahle	Tcheflik Eddeh Haouch
62	Zahle	Tall El Akhdar
63	Zahle	Aanjar (Haouch Moussa)
64	Zahle	Chemsine
65	Zahle	Bitias (Aanjar)
66	Zahle	Kaboussiyeh (Aanjar)
67	Zahle	Youghoun Oulouk (Aanjar)
68	Zahle	Khodr Beik (Aanjar)
69	Zahle	Haji Hbila (Aanjar)
70	Zahle	Ouaqf (Aanjar)
71	Zahle	Masnaa (Majdel Aanjar)
72	Zahle	Majdel Aanjar
73	Zahle	Nasriyeh (Zahleh)
74	Zahle	Riyaq
75	Zahle	Haouch Hala
76	Zahle	Sahm Et Taoubeh
77	Zahle	Aali En Nahri
78	Zahle	Haouch El Ghanam
79	Zahle	Tall El Aamara
80	Zahle	Hoshmosh

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
81	Zahle	Deir El Ghazal
82	Zahle	Qoussaya
83	Zahle	Nasriyet Rizk
84	Zahle	Raait
85	Zahle	Haret El Fikani
86	Zahle	Terbol (Zahleh)
87	Zahle	Qarqoud
88	Zahle	Massa
89	Zahle	Ain Kfar Zabad
90	Zahle	Dalhamiyeh (Zahleh)
91	Zahle	Faaour
92	Zahle	Kfar Zabad
93	West Bekaa	machghara
94	West Bekaa	ain et tineh (b-g)
95	West Bekaa	aaytanit
96	West Bekaa	bab mareaa
97	West Bekaa	deir ain ej jaouzeh
98	West Bekaa	saghbine
99	West Bekaa	loussia
100	West Bekaa	ain zebdeh
101	West Bekaa	khirbet qanafar
102	West Bekaa	nabaa el khrayzat
103	West Bekaa	kefraiya (b -g)
104	West Bekaa	aana
105	West Bekaa	deir tahniche
106	West Bekaa	mansoura (b-g)
107	West Bekaa	haouch aammiq
108	West Bekaa	saalouk
109	West Bekaa	aammiq (b-g)
110	West Bekaa	jird aammiq
111	West Bekaa	chebrqiyet aammiq
112	West Bekaa	maydoun
113	West Bekaa	joubb jannine
114	West Bekaa	lala
115	West Bekaa	kamed el laouz
116	West Bekaa	tall znoub
117	West Bekaa	tall znoub jdideh
118	West Bekaa	baaloul (b-g)
119	West Bekaa	ghazzeh
120	West Bekaa	soultan yaaqoub
121	West Bekaa	soultan yaaqoub et tahta



INCEPTION REPORT

PAGE 48 OF 67

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
122	West Bekaa	tall ez zaazeaa
123	West Bekaa	khiara
124	West Bekaa	qaraaoun
125	West Bekaa	soultan yaaqoub aradi
126	West Bekaa	manara (hammara) (b-g)
127	West Bekaa	khiara el aatiqa
128	West Bekaa	dakoueh
129	West Bekaa	haouch el harimeh
130	West Bekaa	jazira (b-g)
131	West Bekaa	ouaqf (b-g)
132	West Bekaa	saouiri
133	West Bekaa	sohmor
134	West Bekaa	harimeh es soughra
135	West Bekaa	libbaya
136	West Bekaa	marj (b-g)
137	West Bekaa	yohmor (b-g)
138	West Bekaa	zilaya
139	West Bekaa	qelaya
140	West Bekaa	raouda (istabel)
141	Baalbek	baalbek
142	Baalbek	chraouneh
143	Baalbek	ras el ain (baalbek)
144	Baalbek	magassed
145	Baalbek	camp wavel
146	Baalbek	ain bourday
147	Baalbek	douris
148	Baalbek	iaat
149	Baalbek	aaddous
150	Baalbek	aamchki
151	Baalbek	haouch tall safiyeh
152	Baalbek	taybeh (baalbek)
153	Baalbek	nahleh
154	Baalbek	majdaloun
155	Baalbek	haouch barada
156	Baalbek	maqneh
157	Baalbek	haouch ed dahab
158	Baalbek	ain siyaa chadoura
159	Baalbek	saaideh
160	Baalbek	jebaa
161	Baalbek	kfar dane
162	Baalbek	mazraat ed dhour

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
163	Baalbek	nabi rchadeh
164	Baalbek	ain es saouda
165	Baalbek	ouadi el assouad
166	Baalbek	mazraat qold es sabaah
167	Baalbek	masnaa ez zohr
168	Baalbek	hadath (baalbek)
169	Baalbek	mrah es sirghane
170	Baalbek	siret hana
171	Baalbek	ras baalbek es sahel
172	Baalbek	fekeheh
173	Baalbek	jdaidet el fekeheh
174	Baalbek	ain (baalbek)
175	Baalbek	ain baalbek haret ech chmaliye h
176	Baalbek	ain baalbek haret el qobliyeh
177	Baalbek	bajjajeh
178	Baalbek	jabbouleh
179	Baalbek	nabi osmane
180	Baalbek	haouarteh
181	Baalbek	khirbet haouarteh
182	Baalbek	ras baalbek ech charqi
183	Baalbek	mrah rafi
184	Baalbek	maallaqet ej jdideh
185	Baalbek	khirbet daoud (aarsal)
186	Baalbek	khirbet et tineh
187	Baalbek	khirbet younine
188	Baalbek	aarsal haret ech chmaliyeh
189	Baalbek	aarsal haret el qobliyeh
190	Baalbek	aarsal
191	Baalbek	laboueh
192	Baalbek	taoufiqiyeh
193	Baalbek	zabboud
194	Baalbek	qaa baalbek
195	Baalbek	ras el aassi
196	Baalbek	ain ez zarqa
197	Baalbek	deir mar maroun (baalbek)
198	Baalbek	daouret en naml
199	Baalbek	hlabta
200	Baalbek	moqraq
201	Baalbek	nouqra
202	Baalbek	qaa ouadi el khanzir
203	Baalbek	khirab ed dmaneh



INCEPTION REPORT

PAGE 49 OF 67

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
204	Baalbek	qaa baayoun
205	Baalbek	sbouba
206	Baalbek	hay el mathaneh
207	Baalbek	harbata
208	Baalbek	qaa jouar maqiyeh
209	Baalbek	faqrat
210	Baalbek	nabha el qeddam
211	Baalbek	aayoun orghoush
212	Baalbek	nabha ed damdoum
213	Baalbek	mrah el khaoukh (nabha ed damdoum)
214	Baalbek	souaneh (nabha ed damdoum)
215	Baalbek	harfouch
216	Baalbek	aaiara
217	Baalbek	qalileh (nabha)
218	Baalbek	nabha el mehfara
219	Baalbek	rasm el hadeth
220	Baalbek	chaat
221	Baalbek	qarha (baalbek)
222	Baalbek	ram (baalbek)
223	Baalbek	joubbaniyeh
224	Baalbek	khourmata
225	Baalbek	younine
226	Baalbek	deir el ahmar
227	Baalbek	qerrami
228	Baalbek	bessailet et tahta
229	Baalbek	bessailet el faouqa
230	Baalbek	mrah el aaouja (deir el ahmar)
231	Baalbek	mrah beit el qazah
232	Baalbek	mchayrfeh
233	Baalbek	mchaitiyeh
234	Baalbek	kneisseh (baalbek)
235	Baalbek	bechouat
236	Baalbek	zrazir
237	Baalbek	beit es stayteh
238	Baalbek	beit habchi
239	Baalbek	safra (bechouat)
240	Baalbek	blaiqa
241	Baalbek	mrah semaane
242	Baalbek	mrah el aaouja (barqa)
243	Baalbek	barqa
244	Baalbek	mrah soukkar

	-	Town N
	Source	
No.	Caza Name	
245	Baalbek	mrah el aassi
246	Baalbek	riha
247	Baalbek	dar el ouassaa
248	Baalbek	marmagha
249	Baalbek	beit bou slaybi
250	Baalbek	mrah bou chahine
251	Baalbek	mazraat beit el ghoussain
252	Baalbek	btedaai
253	Baalbek	aaynata (baalbek)
254	Baalbek	maqial el qalaa
255	Baalbek	mrah el qloud
256	Baalbek	yammouneh
257	Baalbek	bednayel (baalbek)
258	Baalbek	masnaa (bednayel)
259	Baalbek	louayzeh (qsarnaba)
260	Baalbek	qsarnaba
261	Baalbek	temnine el faouqa
262	Baalbek	beit chama
263	Baalbek	fraij
264	Baalbek	mazraat beit taqch
265	Baalbek	haouch er rafqa
266	Baalbek	mousrayeh
267	Baalbek	slouqi
268	Baalbek	temnine et tahta
269	Baalbek	aaqidiyeh
270	Baalbek	kfar dabach
271	Baalbek	mazraat beit slaybi
272	Baalbek	chmistar
273	Baalbek	haouch en nabi
274	Baalbek	haouch snaid
275	Baalbek	mazraat al souaydane
276	Baalbek	taraya
277	Baalbek	serraaine el faouqa
278	Baalbek	serraaine et tahta
279	Baalbek	talia
280	Baalbek	hizzine
281	Baalbek	sifri
282	Baalbek	khodr (baalbek)
283	Baalbek	nabi chit
284	Baalbek	jenta
285	Baalbek	yahfoufa



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INCEPTION REPORT

PAGE 50 OF 67

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
286	Baalbek	haour taala
287	Baalbek	brital
288	Baalbek	khreibeh (baalbek)
289	Baalbek	mazraat beit mchaik
290	Baalbek	mrah oum aali
291	Baalbek	mazraat beit mchaik (bouday)
292	Baalbek	mrah el ahmar
293	Baalbek	zarayeb choukr
294	Baalbek	mrah beit aassaf
295	Baalbek	mrah beit slim
296	Baalbek	hafayer
297	Baalbek	mazraat er remassa
298	Baalbek	bouday
299	Baalbek	zarayeb (baalbek)
300	Baalbek	aallaq et tell
301	Baalbek	mazraat ed dallil
302	Baalbek	zribet es sabha
303	Baalbek	mazraat et tout
304	Baalbek	flaoueh
305	Baalbek	mrah ej jaddaoui
306	Baalbek	mrah bou brahim
307	Baalbek	maaraboun
308	Baalbek	ham
309	Baalbek	ain el bounaya
310	Baalbek	mazraat beit matar
311	Baalbek	mrah najib
312	Baalbek	chlifa
313	Baalbek	mazraat es sayed
314	Baalbek	chaaibeh
315	Baalbek	nabi chbat
316	Baalbek	ain ej jaouzeh (baalbek)
317	Baalbek	tfail
318	Hermel	hermel
319	Hermel	bdayta
320	Hermel	brayj (hermel)
321	Hermel	daoura (hermel)
322	Hermel	hermel ed daiaa
323	Hermel	hermel el ouaqf
324	Hermel	kouakh
325	Hermel	mrah ez zekbi
326	Hermel	mansoura (hermel)

		Town N
	Source	
No.	Caza Name	
327	Hermel	qanafez
328	Hermel	tall el far
329	Hermel	aaqabeh (hermel)
330	Hermel	bouayda (hermel)
331	Hermel	chouaghir et tahta
332	Hermel	chouaghir el faouqa
333	Hermel	jisr el aassi
334	Hermel	sahlat el may
335	Hermel	nasriyeh (hermel)
336	Hermel	qasr (hermel)
337	Hermel	beit et tachm
338	Hermel	beit hira
339	Hermel	haouch beit ismail
340	Hermel	haouch es sayed aali
341	Hermel	mrah ech charqi
342	Hermel	mrah el gharbi
343	Hermel	mchaa marjhine
344	Hermel	souaydiyeh
345	Hermel	jaouz
346	Hermel	zighrine el hermel
347	Hermel	barghach
348	Hermel	haret el maasser
349	Hermel	mrah en naouas
350	Hermel	ouadi er ratl
351	Hermel	mrah el moghr
352	Hermel	ouadi el karm (hermel)
353	Hermel	ouadi et tourkmane
354	Hermel	mrah ez zouaitineh
355	Hermel	baaoul (hermel)
356	Hermel	mrah yassine
357	Hermel	mazraat el fqih
358	Hermel	mazraat sejoud (hermel)
359	Hermel	mrah beit aallaou
360	Hermel	mrah bou qamar ed dine
361	Hermel	mrah ech chqif
362	Hermel	mrah es siyad
363	Hermel	mrah aabbas
364	Hermel	mrah el mechref
365	Hermel	mrah chnayn
366	Hermel	ras aaqabet er ratl
367	Hermel	charbine el hermel



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INCEPTION REPORT

PAGE 51 OF 67

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
368	Hermel	marjhine
369	Hermel	mrah es souaisseh
370	Hermel	brissa
371	Hermel	jouar el hachich
372	Hermel	ain ej jdideh (hermel)
373	Hermel	beit es semmaqa
374	Hermel	hmaireh (hermel)
375	Hermel	mrah ras el ain
376	Hermel	fissane
377	Hermel	hariqa (hermel)
378	Hermel	mazraat et talleh
379	Hermel	boustane (hermel)
380	Hermel	mrah el aarab
381	Hermel	mrah ech chmis
382	Hermel	ras baalbek el gharbi
383	Hermel	kneisseh (ras baalbek el gharbi)
384	Hermel	ouadi en nayra
385	Hermel	qorrayti
386	Hermel	mrah el qorneh
387	Hermel	ouadi bnit
388	Hermel	ras baalbek ouadi faara
389	Hermel	qalaat bakdach
390	Hermel	mrah ed dahr
391	Hermel	ouadi faara
392	Hermel	faara
393	Hermel	mrah el mahlisseh
394	Hermel	mrah el aaqabeh
395	Hermel	mrah ez zouarib
396	Hermel	hermel jbab
397	Hermel	bou sawaya
398	Hermel	biyout el hajj hsain
399	Hermel	biyout es souh
400	Hermel	jouret el mzar
401	Hermel	biyout aaouad
402	Hermel	biyout er rouais
403	Hermel	mdaouesh
404	Hermel	beit aallaou
405	Hermel	beit aallam
406	Hermel	maaysra (hermel)
407	Hermel	kharayeb (hermel)
408	Hermel	mrah ech choaab

		Town N
	Source	
No.	Caza Name	
409	Hermel	ouadi el aaoss
410	Hermel	mrah el aabd
411	Rachiaya	rachaiya el ouadi
412	Rachiaya	rachaiya el faouqa
413	Rachiaya	rachaiya el kaouasbeh
414	Rachiaya	rachaiya el midane
415	Rachiaya	marj es samah
416	Rachiaya	mazraat el faqaa
417	Rachiaya	aaqabet rachaiya
418	Rachiaya	mazraat jebb farah
419	Rachiaya	mazraat aaz el aarab
420	Rachiaya	aayha
421	Rachiaya	bakkifa (rachaiya)
422	Rachiaya	dahr el ahmar
423	Rachiaya	beit lahia
424	Rachiaya	tannoura
425	Rachiaya	kfar qouq
426	Rachiaya	kfar denis
427	Rachiaya	mhaiydseh (rachaiya)
428	Rachiaya	kaoukaba bou aarab
429	Rachiaya	ain horcheh
430	Rachiaya	khirbet rouha
431	Rachiaya	kfar michki
432	Rachiaya	mazraat ech chamisseh
433	Rachiaya	rafid (rachaiya)
434	Rachiaya	haouch el qinnaabeh (rachai
435	Rachiaya	mazraat jaafar
436	Rachiaya	qinaabeh
437	Rachiaya	bireh (rachaiya)
438	Rachiaya	mazraat aazzi
439	Rachiaya	ain aarab (rachaiya)
440	Rachiaya	ain aata
441	Rachiaya	majdel balhis
442	Rachiaya	bakka
443	Rachiaya	mdoukha
444	Rachiaya	mazraat ain qeniyeh
445	Rachiaya	yanta
446	Rachiaya	mazraat el qalyoun
447	Rachiaya	deir el aachayer
448	Rachiaya	mazraat selsata
449	Rachiaya	aayta el foukhar



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INCEPTION REPORT

PAGE 52 OF 67

		Town Name as per
	Source	CAS
No.	Caza Name	DGA
450	Rachiaya	bayader el aadas
451	Rachiaya	heloueh (rachaiya)
452	Rachiaya	nabi safa
453	Rachiaya	toultata

A.5: Population Survey Questionnaire

-	Caza	:
-	Town (or Village(s) within Municipali	: ty):
-	Name of Mayor	:
-	Nb of registered inhabitants	:
-	Nb of Residents in summer	:
-	Nb of Residents in winter	:
-	Nb of dwellings	:
-	Nb of restaurants	:
-	Nb of clubs	:
-	Nb of hotels (Total hotel rooms)	:
-	Nb of touristic complexes (Number of Chalets & Apartme	:nts rented seasona
-	Nb of NGOs	:
-	Nb of hospitals (Total Number of Beds)	: :
-	Nb of dispensaries	:
-	Nb of industrial plants & shops	:
-	Nb of fuel stations	:
-	Nb of commercial facilities	:
-	Nb of car repair shops	:

- Nb of industrial zones: actual & projected within



ally) :
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INCEPTION REPORT

Is there a master plan at the Urban Planning Directorate that encompasses the municipality:

Yes		No	
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Number of Schools	Туре	Number of Students

Population Expansion : -Number of building permits within last 10 years : Nb of housing projects planned :

Well

- Nb of subscribers with Electricité du Liban :
- Nb of subscribers with BWE • •_____
- Potable Water Sources Network

Please provide a Description of the network & its status (size of pipes, network extent, etc....)

Spring

- Status of Wastewater in the Municipality:
Septic Tank Treatment Plant Sewer Network Other

Please provide a Description of the sewer network (size of pipes, network extent, etc....). If there is a treatment plant, provide the name of the authority responsible for its execution, the execution date, and the discharge location (river, valley, etc...)

Remarks:		
Date	Signature of May	or



PAGE 54 OF 67

A.6: Water Needs in m³ for the Bekaa Region from "Analyse des stratégies et prospectives de l'eau au Liban" – (Plan Bleu-UNEP 2001)

Fau Botable	october	november	december	jan	feb	mar	avr	may	juin	juillet	aout	sep	annee
Irrigation	3,881,022	3,755,828	3,881,022	3,881,022	3,536,738	3,881,022	3,755,828	3,881,022	3,755,828	3,881,022	3,881,022	3,755,828	45,727,200
Industrio	22,987,142	22,987,142	14,366,963	14,366,963	14,366,963	14,366,963	11,498,571	45,974,288	80,684,867	78,903,363	50,341,840	31,434,916	402,274,97
muustrie	1,292,272	1,265,786	1,115,571	1,115,571	1,042,734	1,115,571	1,080,185	1,763,473	2,448,501	2,438,469	1,853,001	1,438,952	17,920,08
TOTAL	28,160,435	28,008,755	19,363,557	19,363,557	18,946,436	19,363,557	16,279,583	51,618,778	86,889,195	85,22,854	56,057,863	36,629,696	456,922,26
Fau Botable	juin	juillet	aout	sep	oct	total	% ANNEE	3		×		\$C	
Irrigation	3,755,828	3,881,022	3,881,022	3,755,828	3,881,022	19,154,720	41.9						
Inductrio	80,684,867	78,903,363	50,341,840	31,434,916	22,987,142	264,352,128	65.7						
industrie	2,448,501	2,438,469	1,853,001	1,438,952	1,292,272	9,471,195	52.9						
TOTAL	86,889,159	85,222,854	56,075,863	36,629,696	28,160,435	292,978,043	62.9						

Table A.7: Wastewater Treatment Plants for in the North & South of Bekaa from SIU-MRHE (2000)

Code	Caza	Region / Village	Population equivalent	Capaciy m3/day	Horizon	Design Office	Niveau de l'étude	Treatment level	Cost treatment USD	Land cost USD	Total cost USD	Authority	Financing
1401	Hermel	Madaech	3,354	500	2020	DAH-NT	Plan Direct.	Secondaire	570,000	50,000	670,000	MRHE	
1402	Hermel	Beit Ismail	106,284	10932	2020	DAH-NT	Plan Direct.	Secondaire	5,420,000	500,000	5,920,000	MRHE	
1403	Hermel	El Boustan	9,648	989	2020	DAH-NT	Plan Direct.	Secondaire	1,100,000	100,000	1,200,000	MRHE	
1501	Baalbek	Baalbeck	88,660	12412	2005	HH	Détaillé	Secondaire	4,790,000	800,000	5,590,000	MRHE	
1503	Baalbek	Chlifa	67,874	9500	2020	DAH-NT	Plan Direct.	Secondaire	3,870,000	350,000	4,220,000	MRHE	
1504	Baalbek	Mrah Abiad	40,230	4515	2020	DAH-NT	Plan Direct.	Secondaire	2,780,000	150,000	2,930,000	MRHE	
1505	Hermel	Mrah El-Dahar	2,858	275	2020	DAH-NT	Plan Direct.	Secondaire	510,000	45,000	760,000	MRHE	
1506	Baalbek	Laboue	59,980	7800	2020	DAH-NT	Détaillé	Secondaire	3,600,000	400,000	4,000,000	CDR	
1510	Baalbek	Maaraboun	3,727	383	2020	DAH-NT	Plan Direct.	Secondaire	600,000	60,000	660,000	MRHE	
1511	Baalbek	Yammouneh	5,840	632	2020	DAH-NT	Plan Direct.	Secondaire	810,000	90,000	900,000	MRHE	
1512	Baalbek	Ainata	3,870	398	2020	DAH-NT	Plan Direct.	Secondaire	630,000	70,000	700,000	MRHE	
1513	Baalbek	Harfouch	62,966	6709	2020	DAH-NT	Plan Direct.	Secondaire	3,780,000	420,000	4,200,000	MRHE	
1514	Baalbek	Aarsal	46,287	4,967	2020	DAH-NT	Plan Direct.	Secondaire	3,050,000	340,000	3,390,000	MRHE	
1515	Baalbek	Qaa	10,526	1144	2020	DAH-NT	Plan Direct.	Secondaire	1,170,000	130,000	1,300,000	MRHE	
GRAND T	OTAL		512,104	61,156					32,680,000	3,505,000	36,440,000		

Wastewater Treatment Plants for in the North of Bekaa



INCEPTION REPORT

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PAGE 55 OF 67

Wastewater	[•] Treatment	Plants	for in	the Sout	n of	Bekaa
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Code	Caza	Region / Village	Equivalent population	Capacity m3/day	Horizon	Design Office	Type of study	Treatment level	Treatment cost USD	Land cost USD	Total cost USD	Authority	Financing
1401	Hermel	Madaech	3,354	500	2020	DAH-NT	MasterPlan	Secondaire	570,000	17,000	670,000	MRHE	
1402	Hermel	Beit Ismail	106,284	10932	2020	DAH-NT	MasterPlan	Secondaire	5,420,000	531,000	5,920,000	MRHE	
1403	Hermel	El Boustan	9,648	989	2020	DAH-NT	MasterPlan	Secondaire	1,100,000	48,000	1,200,000	MRHE	
1501	Baalbek	Baalbeck	88,660	12412	2005	HH	Detailed	Secondaire	4,790,000	887,000	5,590,000	MRHE	
1502	Zahlé	Timnine Tahta	366,500	42000	2020	DAH-NT/MM	MasterPlan	Secondaire	12,090,000	2,566,000	12,540,000	MRHE	
1503	Baalbek	Chlifa	67,874	9500	2020	DAH-NT	MasterPlan	Secondaire	3,870,000	339,000	4,220,000	MRHE	
1504	Baalbek	Mrah Abiad	40,230	4515	2020	DAH-NT	MasterPlan	Secondaire	2,780,000	201,000	2,930,000	MRHE	
1505	Hermel	Mrah El-Dahar	2,858	275	2020	DAH-NT	MasterPlan	Secondaire	510,000	29,000	760,000	MRHE	
1506	Baalbek	Laboue	59,980	7800	2020	DAH-NT	Detailed	Secondaire	3,600,000	480,000	4,000,000	CDR	
1510	Baalbek	Maaraboun	3,727	383	2020	DAH-NT	MasterPlan	Secondaire	600,000	30,000	660,000	MRHE	
1511	Baalbek	Yammouneh	5,840	632	2020	DAH-NT	MasterPlan	Secondaire	810,000	47,000	900,000	MRHE	
1512	Baalbek	Ainata	3,870	398	2020	DAH-NT	MasterPlan	Secondaire	630,000	39,000	700,000	MRHE	
1513	Baalbek	Harfouch	62,966	6709	2020	DAH-NT	MasterPlan	Secondaire	3,780,000	441,000	4,200,000	MRHE	
1514	Baalbek	Aarsal	46,287	4,967	2020	DAH-NT	MasterPlan	Secondaire	3,050,000	463,000	3,390,000	MRHE	
1515	Baalbek	Qaa	10,526	1144	2020	DAH-NT	MasterPlan	Secondaire	1,170,000	105,000	1,300,000	MRHE	
1601	Zahlé	Zahlé	206,600	37000	2015	Franceshetti	Prog. conc.	Secondaire	8,680,000	-	9,730,000	CDR	Italy
1602	Zahlé	El Marj	180,000	25200	2015	BTD	Prog. conc.	Secondaire	7,560,000	1,080,000	8,400,000	CDR	
1605	Zahlé	Delhamieh	21,500	2590	2020	M. Mezher	MasterPlan	Secondaire	1,810,000	215,000	2,010,000	MRHE	
1606	Zahlé	Kfar Zabad	31,600	3800	2020	M. Mezher	MasterPlan	Secondaire	2,370,000	316,000	2,630,000	MRHE	
1701	Bekaa west	Joub Jannin	71,600	10700	2015	BTD	Detailed	Secondaire	4,080,000	501,000	4,320,000	MRHE	
1702	Bekaa west	Qaraoun	24,000	3600	2015	BTD	Detailed	Secondaire	1,940,000	168,000	2,130,000	MRHE	Italy
1703	Bekaa west	Saghbine	4,100	600	2015	BTD	Detailed	Secondaire	640,000	41,000	680,000	MRHE	
1704	Bekaa west	Deir Tahnic	5,000	800	2015	BTD	MasterPlan	Secondaire	740,000	50,000	840,000	MRHE	
1705	Bekaa west	Sohmor	4,800	720	2015	BTD	Detailed	Secondaire	710,000	48,000	810,000	MRHE	
1706	Bekaa west	Yohmor	6,000	900	2015	BTD	MasterPlan	Secondaire	810,000	60,000	910,000	MRHE	
1707	Bekaa west	Kellaya	1,200	144	2015	BTD	MasterPlan	Secondaire	310,000	12,000	360,000	MRHE	
1708	Bekaa west	Zellaya	300	36	2015	BTD	MasterPlan	Secondaire	140,000	3,000	170,000	MRHE	
GRA	ND TOTAL		1,435,304	189,246					74,560,000	8,717,000	81,970,000		



PAGE 56 OF 67

A.8: Wastewater Treatment Plant locations from "Master Plan Study to Locate Waste Water Treatment Plants in Bekaa" (DAHNT 1994 – Ministry of Housing and Cooperative)

First Proposal: Local Treatment Plants

Hermel Caza

Designation	Location	Pop. 1994	Pop. 2014	Pop. 2034	Туре
1.Н	Charbiné	2105	3450	5653	Stabilization ponds
2.Н	Boueida	1295	2123	3478	Stabilization ponds
3.H	El Qasr	3238	5306	8695	Stabilization ponds
4.H	Hermel	21159	34673	56815	Stabilization ponds

Baalbeck Caza

1.B	Qaa	8094	13263	21733	Stabilization ponds
2.B	Ras Baalbeck	10037	16448	26951	Stabilization ponds
3.B	Aainata	2752	4510	7390	Extended aeration
4.B	Zabboud	2081	3412	5589	Stabilization ponds
5.B	Ziré	11332	18569	30428	Stabilization ponds
6.B	Harabta	4047	6632	10867	Stabilization ponds
7.B	Laboué	6057	9927	16265	Stabilization ponds
8.B	Jdeidé	3238	5306	8695	Stabilization ponds
9.B	Aarsal	11331	18568	30425	Stabilization ponds
10 .B	Yammouneh	1943	3184	5218	Extended aeration
11 .B	Kneissé	2793	4577	7501	Extended aeration
12 .B	Chaat	11657	19103	31302	Stabilization ponds
13 .B	Chlifa	9925	16264	26651	Stabilization ponds
14 .B	Maqné	3432	5624	9216	Stabilization ponds
15 .B	Boudaï	6476	10612	17390	Stabilization ponds
16 .B	Kfardane	5990	9817	16086	Stabilization ponds
17 .B	Saaïdé	2979	4883	8000	Stabilization ponds
18.B	Iaat	90065	147582	241831	Extended aeration
19.B	Douris	2291	3755	6152	Stabilization ponds
20 .B	Younine	8094	13263	21733	Stabilization ponds
21 .B	Nahlé	4857	7959	13042	Extended aeration
22 .B	Chmistar	18293	29977	49119	Extended aeration
23 .B	Taybé	1943	3184	5218	Stabilization ponds

Designation	Location	Pop. 1994	Pop. 2014	Pop. 2034	Туре
24 .B	Haouch El Rafka	10686	17511	28696	Extended aeration
25 .B	Sifri	13422	21995	36041	Stabilization ponds
26 .B	Seraïne El Tahta	15023	24619	40340	Stabilization ponds
27 .B	Temnine El Tahta	25091	41117	67373	Extended aeration

Zahleh Caza

1.Z	Ablah	12304	20161	33038	Stabilization ponds
2.Z	Haouch Hala	36099	59156	96930	Extended aeration
3.Z	Qabb Elias	31809	52125	85411	Extended aeration
4.Z	Taanayel	34884	57164	93667	Extended aeration
5.Z	Sahl Zahlé	189552	310605	508963	Extended aeration
6.Z	Dalhamieh	6476	10613	17389	Stabilization ponds
7.Z	Sahl Barr Elias	24654	40400	66199	Extended aeration
8.Z	Faaour	6638	10878	17826	Stabilization ponds
9.Z	Raïte	5360	8784	14394	Stabilization ponds
10 .Z	Aanjar	22827	37409	61289	Extended aeration

West Bekaa Caza

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1.W	Kefraya	1376	2255	3695	Stabilization ponds
2 .W	Aammiq	2186	3584	5871	Stabilization ponds
3 .W	Ghazzé	8905	14593	23913	Stabilization ponds
4 .W	Khiara	2996	4910	8045	Stabilization ponds
5.W	Haouch El Harimé	2389	3916	6416	Stabilization ponds
6.W	Khirbet Kanafar	6557	10745	17607	Stabilization ponds
7.W	Bab Maréaa	5684	9315	15264	Extended aeration
8 .W	Joub Jannine	13938	22840	37426	Stabilization ponds
9.W	Tell Zenoub	729	1195	1985	Stabilization ponds
10 .W	Kamed el Laouz	4857	7960	13042	Stabilization ponds
11 .W	El Hammara	6638	10879	17826	Stabilization ponds
12 .W	Qaraaoun	10280	16846	27603	Extended aeration
13 .W	Sedd el Qaraaoun	19425	31831	52159	Extended aeration
14 .W	Sohmor	5666	9285	15214	Extended aeration
15 .W	Libbaya	2056	3369	5521	Extended aeration



INCEPTION REPORT

PAGE 57 OF 67

Second Proposal: Collective Treatment Plants

Hermel Caza

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Designation	Location	Pop. 1994	Pop. 2014	Pop. 2034	Туре
1 .HC	El Qasr	6638	10879	17826	Stabilization ponds
4 .H	Hermel	21159	34673	56815	Stabilization ponds

Baalbeck Caza

1 .BC	Ziré	17389	28523	46693	Stabilization ponds
2 .BC	Kneissé	6225	10201	16717	Extended aeration
3 .BC	Saaïdé	107801	176649	289459	Extended aeration
4 .BC	Haouch El Rafka	41074	67309	110295	Extended aeration
1.B	Qaa	8094	13263	21733	Stabilization ponds
2.B	Ras Baalbeck	10037	16448	2695	Stabilization ponds
3.B	Aainata	2752	4510	7390	Extended aeration
4.B	Zabboud	2081	3412	5589	Stabilization ponds
6.B	Harabta	4047	6632	10867	Stabilization ponds
8.B	Jdeidé	3238	5306	8695	Stabilization ponds
9.B	Aarsal	11331	18568	30425	Stabilization ponds
10 .B	Yammouneh	1943	3184	5218	Extended aeration
12 .B	Chaat	11657	19103	31302	Stabilization ponds
13 .B	Chlifa	9925	16264	26651	Stabilization ponds
20 .B	Younine	8094	13263	21733	Stabilization ponds
21 .B	Nahlé	4857	7959	13042	Extended aeration
22 .B	Chmistar	18293	29977	49119	Extended aeration

Zahleh Caza

1 .ZC	Ablah	37395	61278	100411	Extended aeration
2 .ZC	Al Dalhamieh	49213	80647	132145	Extended aeration
9.ZC	Raïte	5360	8784	14394	Stabilization ponds

Rachaya Caza

Designation	Location	Pop. 1994	Pop. 2014	Pop. 2034	Туре
1 .R	Mdoukha	1619	2653	4348	Stabilization ponds
2 .R	Bakka	2996	4910	8046	Extended aeration
3 .R	Kfarmechki	3465	5678	9305	Stabilization ponds
4 .R	Kherbet Rouha	3238	5307	8696	Stabilization ponds
5.R	Mhaïdthé	10016	16414	26897	Stabilization ponds
6.R	Akaba	1619	2653 ·	4348	Stabilization ponds
7.R	Rachaya	8903	14589	23906	Stabilization ponds
8.R	Aaiha	4210	6899	11306	Stabilization ponds
9.R	Deïr El Aachayer	972	1594	2610	Stabilization ponds
10 .R	Rachaya el Ouadi	3238	5306	8695	Extended aeration
11 .R	Beit Lahya	2349	3850	6308	Stabilization ponds
12 .R	Tannoura	972	1593	2610	Extended aeration
13 .R	Aïn Aata	1943	3184	5218	Stabilization ponds



Designation	Location	Pop. 1994	Pop. 2014	Pop. 2034	Туре
1 .WC	Haouch El Harimé	306115	501619	821945	Extended aeration
1 .W	Kefraya	1376	2255	3695	Stabilization ponds
2 .W	Aammiq	2186	3584	5871	Stabilization ponds
3 .W	Ghazzé	8905	14593	23913	Stabilization ponds
4 .W	Khiara	2996	4910	8045	Stabilization ponds
6 .W	Khirbet Kanafar	6557	10745	17607	Stabilization ponds
7.W	Bab Maréaa	5684	9315	15264	Extended aeration
8 .W	Joub Jannine	13938	22840	37426	Stabilization ponds
9.W	Tell Zenoub	729	1195	1985	Stabilization ponds
10 .W	Kamed el Laouz	4857	7960	13042	Stabilization ponds
11 .W	El Hammara	6638	10879	17826	Stabilization ponds
12 .W	Qaraaoun	10280	16846	27603	Extended aeration
13 .W	Sedd el Qaraaoun	19425	31831	52159	Extended aeration
14 .W	Sohmor	5666	9285	15214	Extended aeration
15 .W	Libbaya	2056	3369	5521	Extended aeration

West Bekaa Caza

Rachaya Caza

1 .R	Mdoukha	1619	2653	4348	Stabilization ponds
2 .R	Bakka	2996	4910	8046	Extended aeration
3 .R	Kfarmechki	3465	5678	9305	Stabilization ponds
4.R	Kherbet Rouha	3238	5307	8696	Stabilization ponds
5.R	Mhaïdthé	10016	16414	26897	Stabilization ponds
6.R	Akaba	1619	2653	4348	Stabilization ponds
7.R	Rachaya	8903	14589	23906	Stabilization ponds
8.R	Aaiha	4210	6899	11306	Stabilization ponds
9.R	Deïr El Aachayer	972	1594	2610	Stabilization ponds
10 .R	Rachaya el Ouadi	3238	5306	8695	Extended aeration
11 .R	Beit Lahya	2349	3850	6308	Stabilization ponds
12 .R	Tannoura	972	1593	2610	Extended aeration
13 .R	Aïn Aata	1943	3184	5218	Stabilization ponds



INCEPTION REPORT

PAGE 59 OF 67

APPENDIX B:

APPENDIX B:

B.1 ROAD NETWORKS, SDATL, 2002
B.2 RAINFALL DISTRIBUTION MAP, PLASSARD, 1:200,000, 1971
B.3 GEOLOGICAL MAP, L. DUBERTRET, 1:50,000, 1945
B.4 HYDROLOGICAL MAP, TOPOGRAPHIC MAP DGA, 1:50,000, 1945
B.5 INDUSTRIES DISTRIBUTION IN THE BEKAA, SDATL, 2002
B.6 LAND USE, MOA, 1:20,000, 2001
B.7 SOIL MAP, GEZE, 1954



INCEPTION REPORT

PAGE 60 OF 67

B.1 ROAD NETWORKS, SDATL, 2002





INCEPTION REPORT

INCEPTION REPORT

PAGE 61 OF 67









INCEPTION REPORT

B.3 GEOLOGICAL MAP, L. DUBERTRET, 1:50,000, 1945



INCEPTION REPORT

B.4 HYDROLOGICAL MAP, TOPOGRAPHIC MAP DGA, 1:50,000, 1945















B.6 LAND USE, MOA, 1:20,000, 2001





INCEPTION REPORT

B.7 SOIL MAP, GEZE, 1954





INCEPTION REPORT