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

WATER CAPITAL INVESTMENT PLAN & PRIORITY ACTION PLAN REPORT

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LIST OF ACRONYMS

BWE	BEKAA WATER ESTABLISHMENT
CAS	CENTRAL ADMINISTRATION OF STATISTICS
CDR	COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION
DAI	DEVELOPMENT ALTERNATIVES, INC.
GIS	GEOGRAPHIC INFORMATION SYSTEM
LRA	LITANI RIVER AUTHORITY
LWWSS	LEBANON WATER AND WASTEWATER SECTOR SUPPORT
MEW	MINISTRY OF ENERGY AND WATER
NWSS	NATIONAL WATER SECTOR STRATEGY
USAID	UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

1 INTRODUCTION

1.1 Background

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 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 water component encompasses the following activities under objective A of the terms of reference:

Objective A. Water Supply System Master Plan

Task A.1: Collect existing water supply system information working in close collaboration with the BWE staff.

A.1.1 Collect and review all studies, reports and available data that have been prepared regarding water supply in the Bekaa service area to include those that have addressed water resources, as well as transmission, storage and distribution of water supply.

A.1.2 Meet with CDR, Moew and bilateral donors working on water supply related projects in the Bekaa to gather data, and document programs and projects that are planned or underway.

A.1.3 Conduct a physical and operational assessment of all water supply system elements (wells, springs, treatment plants, pump stations, reservoirs, transmission mains, and primary network piping systems, and document their location and attributes for entry into the GIS. The Subcontractor will prepare a data reporting form, to be reviewed and approved by BWE, and will use this form to collect the relevant data from all water supply system elements.

A.1.4 Collect and review cost data of the BWE as it particularly relates to energy, treatment chemicals, and labor as a basis for recommendations that would improve cost efficiency.

A.1.5 Collect available soils and topographic information, hydro-geological data, and hydrographic studies for the Bekaa service area.

Task A.2: Collect and analyze historical and projected population data, and water supply demand data, for various parts of the Bekaa service area.

A.2.1 Collect and review existing reports and studies to support assumptions to be made concerning base year populations and growth rates, and economic development through the planning period. Base year populations should consider and integrate population data maintained by local government authorities, as well as those maintained by CAS.

A.2.2 Using the base year population, develop low, medium and high population growth projections, and allocate these populations by major service areas within the BWE. Present these projections to the management of BWE for review and approval of final master plan projected populations.

A.2.3 Using the final master plan projected populations under A.2.2 above, develop projected water supply demand for each of the major service areas within the BWE.

Task A.3 Recommend specific improvements to the water supply systems.

A.3.1 Develop alternative recommended improvements to the water supply systems in the BWE service area that are consistent with the National Water Sector Strategy of the Government and the Strategic Goals of BWE, as stated in its 2012 – 2016 Business Plan.

A.3.2 Present the alternative recommendations to the management of BWE for review and final approval.

A.3.3 Prepare an action plan, based on the finally approved improvements that will prioritize the steps and actions to be undertaken for each improvement. The priority action plan will detail the activities and deliverables based on a well-defined timeframe.

Task A.4 Estimate the capital cost for each finally approved improvement and the timing of the use of capital for each improvement.

A.4.1 Prepare a separate capital cost estimate for each "new capital improvement" that is approved by the management of BWE. New capital improvements shall be those improvements that perform a function or service that did not previously exist in the current system, or that significantly changes the capacity of an existing asset.

A.4.2 Prepare a schedule for the timing of the use of capital for each new capital improvement under A.4.1.

A.4.3 Prepare a separate capital cost estimate for each "capital repair or replacement, or capital renewal improvement" that is approved by the management of BWE. Capital repair or replacement, or capital renewal improvements shall be those improvements that return an existing asset to its design intent as well as improves its efficiency.

A.4.4 Prepare a schedule for the timing of the use of capital for each capital repair or replacement, or capital renewal improvement under A.4.3.

A.4.5 Develop cost estimates for the operation and maintenance (power, fuels, lubricants, and routine maintenance consumables) of the water supply system facilities that will make up the future capital plan for the BWE within the planning period.

Task 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 including production, zone and consumer meters.

A.5.2 Develop a detailed implementation plan for the logical installation of the meters under the program developed under A.5.1, and a schedule for the timing of the use of capital for each metered subsystem.

Tasks under A.1 and A.2 were covered in previous deliverables. This report addresses mainly Tasks under A.3, A.4 and A.5 starting at A.2.3 in order to present a comprehensive set of recommendations for improvements to the water networks and facilities aligned with the NWSS in order to meet the future water needs based on the population projections for the year 2035.

This report is divided in 7 chapters. Chapter 1 presents the background and gives a general overview of the approach taken in order to arrive at the proposed modifications and improvements to the water supply systems.

Chapters 2, 3, 4, 5, and 6 present in details the proposed modifications to the existing systems regarding water supply sources, reservoirs, distribution networks and facilities for the cazas of Hermel, Baalbeck, Zahle, West Bekaa, and Rachaiya, respectively.

Chapter 7 presents the estimated costs for the different components of the proposed new systems and the improvements to existing ones divided in short term, medium term, and long term priorities presented under the current year of 2013 (or 2015) and the design horizon years of 2025 and 2035. The capital investments of the newly proposed schemes are assigned to the short term priority given the lead time required for their study and construction and the expected dates of their entry into service. For budgeting purposes the short term priorities would be budgeted over the period extending from 2015 to 2025, the medium term priorities over the period from 2025 to 2030, and the long term priorities over the period from 2030 to 2035. A particular capital investment plan is presented separately for the system wide metering across the service area of the BWE spanning its production, distribution zone and consumer meters.

1.2 Existing Situation

During the first year, a data collection campaign was carried out to gather all existing information about potable water supply, storage, treatment, and distribution infrastructure in the service area of the BWE. It consisted of: (i) the review of information available in the electronic databases and hardcopy archives of the BWE, (that are planned or under construction (iii) and of extensive field visits to assess the condition of those parts of the infrastructure that ii) the collection and analysis of those studies and reports that have been prepared regarding projects are visible such as reservoirs, springs, well heads, and treatment stations. The results of this campaign were presented in a separate document during 2013 in the Water Supply System Assessment Report. The current situation can be summarized as follows:

1. The BWE currently operates a patchwork of potable water systems constituted of the different water boards and local committees that were consolidated into the regional water establishment by law 221/2000 most of these systems are more than 30 years of age some dating from before the civil war.
2. The CDR has invested over the last twenty years an estimated $150 million USD in the potable water infrastructure of the Bekaa. 90% of these investments were concentrated on systems supplying Baalbeck city and the neighboring villages as well as as Yammouneh and Hermel. The remainder was invested in the West Bekaa region. The largest funding contribution to these projects was secured through the World Bank and the Kuwait Fund.
3. The CDR is currently in the process of constructing or tendering large projects targeted at the rehabilitation, replacement and extension of networks in the cazas of West Bekaa, Rachaiya and Zahle.
4. Of the 330 or so towns and villages in its service area, 240 representing a little bit more than two thirds of the population are currently serviced by the BWE. Some of the remaining villages rely on systems operated by municipal or local informal authorities.
5. The BWE operates 196 independent potable water supply systems of variable sizes. 36 systems are supplied from small, medium or large local springs whereas the other 160 systems are supplied from an estimated 238 wells. Small village systems are typically supplied from a single well whereas larger systems are supplied by groups of wells. The BWE also operates one water treatment station and a couple pumping or boosting stations. All distribution storage is provided by 338 existing reservoirs with 31 under construction. The total distribution network length is estimated at 3,000 km including parts under construction.

1.3 Projection of Water Demand

The projected volumes of water for every locality, village, town and region were calculated based on the population projections presented in earlier reports using an estimated 180 liters per capita per day inclusive of all water uses as per NWSS for the year 2010 growing to 195 liters per capita per day at the planning horizon of 2035.

The MEW National Water Sector Strategy (NWSS) uses the following figures for a moderate demand scenario in 2010:

160 L/capita/day for rural areas demand (140 for low demand scenario, 180 for high demand scenario);

180 L/capita/day for urban areas demand (160 for low demand scenario, 200 for high demand scenario);

30% of domestic demand for industrial demand (or 51 L/cap/d on average).

400 L/person/day for tourism demand;

The latest BWE Business Plan estimated the following range of values for water usage in areas similar to those in Lebanon:

Household	90 – 120 L/cap/day
Commercial	25 – 30 L/cap/day
Institutional	15 – 20 L/cap/day
Industrial	30 – 40 L/cap/day
Total	160 – 210 L/cap/day

Based on the above mentioned data, the BWE decided to apply an aggregate norm for water demand per capita (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 inclusive of all domestic and industrial demand. One of the reasons for this lower value being that the Business Plan aims at remaining conservative in terms of profitability and hence is concerned with not overstating sales once meters are installed and billing is based on metered consumption.

Based on the above it is proposed to adopt an all-inclusive water demand of 180 L/cap/day for the year of preparation of the NWSS, i.e. 2010, for both urban and rural populations in the Bekaa noting the rapid urbanization and rural exodus towards the main cities. If the NWSS moderate scenario for water demand projection is adopted it then gives the following demand values until the design horizon:

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

The dip in the NWSS forecasted demand is a result of the projected effect of water conservation measures to be introduced by 2020 (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 due to a more conscientious use of the water by the consumers after meters are installed. For the sake of simplicity the present study will adopt 180 L/cap/day for the current aggregate water demand and 195 L/cap/day as the aggregate value for water demand for the year 2035. The aggregate value for water demand for the year 2025 is subsequently calculated as 188 L/cap/day.

Table 1-1 presents the estimated current and projected daily water demand per caza based on the water demand per capita per day and the projected populations to be serviced by the year 2035 design horizon.

TABLE 1-1: ESTIMATED CURRENT AND PROJECTED DAILY WATER DEMAND PER CAZA

Caza	Year 2013		Year 2025		Year 2035	
	Estimated Population	Water Demand (m^3/d)	Projected Population	Water Demand (m^3/d)	Projected Population	Water Demand (m^3/d)
Hermel	83,131	14,964	102,367	19,245	121,762	23,744
Baalbeck	416,483	74,967	512,875	96,421	610,035	118,957
Zahle	364,149	65,547	448,426	84,304	533,377	104,009
West Bekaa	134,798	24,264	165,992	31,206	197,441	38,501
Rachaiya	60,342	10,862	74,309	13,970	88,382	17,234
Total	**1,058,903**	**190,603**	**1,303,969**	**245,146**	**1,550,997**	**302,444**

* The water demand rates of each locality in the Bekaa Cazas for the years 2013, 2025, and 2035 are calculated based on the following formulas:

$$\text{Daily Water Demand (2013) (m}^3\text{/d)} = 0.180 m^3/cap/d \times \text{ Population (2013)}$$

$$\text{Daily Water Demand(2025) (m}^3\text{/d)} = 0.188 m^3/cap/d \times \text{ Population (2025)}$$

$$\text{Daily Water Demand (2035) (m}^3\text{/d)} = 0.195 m^3/cap/d \times \text{ Population (2035)}$$

The total required storage capacity per locality, village or town considered was also calculated as the sum of three components:

- Balancing Storage or the quantity of water required to be stored in the reservoir for equalizing or balancing fluctuating demand against constant supply. Balancing storage was estimated at eight hours of daily average flow as per common design standards in Lebanon.
- Breakdown Storage or the emergency storage which is preserved in order to tide over the emergencies posed by the failure of pumps, electricity, or any other mechanism driving the water supply to the reservoir. A value of about 25% of the balancing storage quantity required for a given reservoir is generally recommended for breakdown storage. For a balancing storage of eight hours of daily average flow the breakdown storage would correspond to an additional two hours of daily average flow. A value of 30% of the balancing storage or the equivalent of almost 2.5 hours of daily average flow was adopted in this study noting the particularly high rate of failures and electrical power outages that Lebanon has been suffering for the last 20 years.
- Fire Storage or the third component of the total reservoir storage. This provision takes care of the requirements of water for extinguishing fires. A provision of 1 to 4 liters per person per day is sufficient to meet the requirement. Noting the lower fire risks in Lebanon save for summer bush and forest fires and the relatively small sizes of most of the reservoirs a fixed volume of 61m^3 was added to reservoirs serving less than 10000 people and 122m^3 for larger reservoirs. This addition is aligned with common design standards in Lebanon noting that maximum single reservoir size was capped at 2500m^3 for practical construction considerations.

1.4 Recommended Improvements to Water Supply Systems

As discussed previously a significant part of the Bekaa population is not currently served by a potable water system operated by the BWE whereas the rest is served with varying degrees of quality and reliability. The objective of the present study is to recommend improvements or changes to the water supply systems which would allow the BWE, by the design horizon of 2035, to provide quality and reliable potable water services, to all of the projected Bekaa population whether currently served by existing systems or not, in a technically efficient, cost effective, power-wise, and environmentally sustainable fashion.

Until the adoption by the Council of Ministers resolution 35 dated 17/10/2010 of the NWSS no systematic strategy had existed in Lebanon for the management of water resources and the provision of potable water to the population. Water supply and distribution systems developed historically in an organic fashion around population centers as the needs increased. Local springs were tapped when available and wells were dug when the need increased. The MEW adopted an expedient and practical approach of equipping villages with one or two wells and a distribution reservoir that would supply the local network. This was

done also to avoid the technical and political complications of developing large systems that supply multiple localities and different communities from one single large spring that may be considered by locals, albeit erroneously, as theirs to use as they wish. As a result of this approach many contiguous systems are not connected, and many others rely on pumping water from wells in spite of the presence of ample supply from a large surface water source in the nearby locality.

Projects recently constructed or planned for construction by the CDR reflect this mixed approach. The Baalbeck system relies on groups of wells and so does the proposed extension to Zahle systems whereas the systems under construction in West Bekaa and Rachaiya are centrally supplied from the Chamsine spring and the Ain El Zarqa (Litani).

Following the recommendations of the NWSS and those of the BWE priority was given to water supply from principal and reliable surface springs in the Bekaa whereby: (i) additional volumes would be extracted from springs currently used for potable water and (ii) springs currently used for irrigation only would be partially or totally diverted to potable water supply. In the absence of surface water springs groundwater would be tapped to provide the required water supplies. Redevelopment of existing wells to increase yield or the drilling of new wells would be required. The approach recommended by the NWSS would ultimately reduce the cost of energy used for pumping from wells and would safeguard the groundwater reserves to be used strategically and not be systematically depleted.

A plan was developed for each village, group of villages, or service area, to meet the water needs by either improving the existing systems, combining or extending service regions and systems, or modifying the water supply schemes to include new sources of supply.

Spring sources for water supply based on current and projected needs were surveyed for the whole service area of the BWE with the objective of obtaining the largest amount of potable water supply from those large reliable surface springs thus saving on water pumping from wells and reducing the number of small systems. Historical data was obtained from the LRA and used in the analysis. It was assumed that potable water supply has priority over current irrigation use and historical water rights if any. Large spring based systems that are under construction by the CDR such as the West Bekaa and Rachaiya systems were adopted as is. It is suggested that existing wells operated by the BWE in areas to be supplied from large springs be maintained as back up. It is also suggested that small springs currently in use and whose safe yield could not be assessed be maintained in the systems.

Each water supply system was divided into three functional parts:

1) The distribution system which is constituted by a multi-tiered piping network covering the inhabited areas of each locality delivering potable water to each and every home by gravity from a local or regional reservoir located at the required elevation.
2) Storage and distribution reservoirs which are located optimally at a naturally elevated high ground convenient to one or more inhabited areas. These reservoirs supply water and maintain pressure through the distribution networks they serve. Elevated water tanks are used when needed in flat terrain.
3) The water supply system which is constituted of a source of water such as a spring catchment or well, the submersible pumps, the pumping stations, boosting stations, treatment stations and the gravity or pressure transmission pipes that supply the storage and distribution reservoirs.

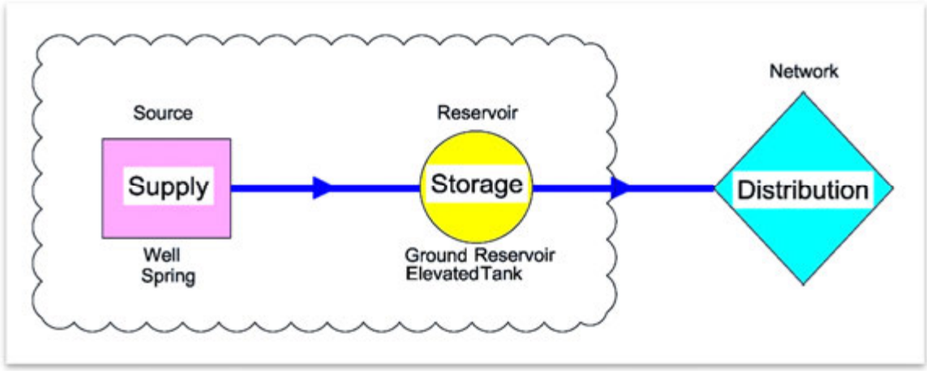


FIGURE 1-1: GENERAL SCHEMATIC OF A WATER SYSTEM

The status of the distribution networks was reviewed previously in the Assessment Report and the required improvements were tabulated. They are presented in this report by locality and region with recommendations for extension, replacement, or new construction. Their lengths, dimensions, and cost were estimated. It is estimated that 4,308 km of distribution networks would be required by the year 2035, and that about one third of the existing 3,003 km would need replacement or rehabilitation by then, which would put the total length of new networks to be constructed at about 1,305 km during the period extending from 2015 to 2035.

Table 1-2 presents these lengths by caza.

TABLE 1-2: SUMMARY OF THE WATER NETWORK LENGTHS IN THE BEKAA IN 2035

Caza	Total Length Needed for Water Network (m)	Length of Existing Water Network (Includes Under construction) (m)	Length of Existing Water Network to be Rehabilitated or Replaced (m)	Length of Proposed Water Network (m)
Hermel	259,887	109,315	109,315	150,572
Baalbeck	2,099,177	1,736,402	742,115	362,775
Zahle	871,592	474,652	155,595	396,940
West Bekaa	635,959	409,559	24,441	226,400
Rachaiya	441,796	273,293	0	168,503
Whole Bekaa	**4,308,411**	**3,003,221**	**1,031,466**	**1,305,190**

Existing distribution storage capacities were reviewed and new distribution reservoirs were suggested where required based on the projected storage demand. The locations for the new reservoirs were identified on GIS to provide the necessary ground elevations that can guarantee and maintain required minimum pressures for supplying the distribution networks. These locations were then used to estimate the transmission pipelines length. Where no location with the required natural ground elevation was identified within reasonable distance from the served area, an elevated water tank was suggested.

Schematics and/or preliminary conceptual designs were developed for the water supply schemes and their transmission lines showing the proposed modifications if any, and the required new facilities. 13 spring based systems were proposed combining existing facilities such as reservoirs, catchments, pumping stations and treatment plants with new proposed facilities. They are,

In Hermel:

- Ain El Hawr and Ras El Meil springs system
- Ain El Zarqa spring system

In Baalbeck:

- Laboue spring system
- Yammoune spring system (existing system to be extended to Baalbeck)
- Oyoun Orghosh system (existing system)
- Yahfoufa spring system

In Zahle:

- Anjar spring system
- Qaa El Rim spring system
- Qabb Elias spring system
- Chamsine spring (exsiting system with extension under construction)

In West Bekaa:

- Ain El Zarqa (Litani) system part 1 (under construction)
- Aana-Amiq spring system

In Rachaiya:

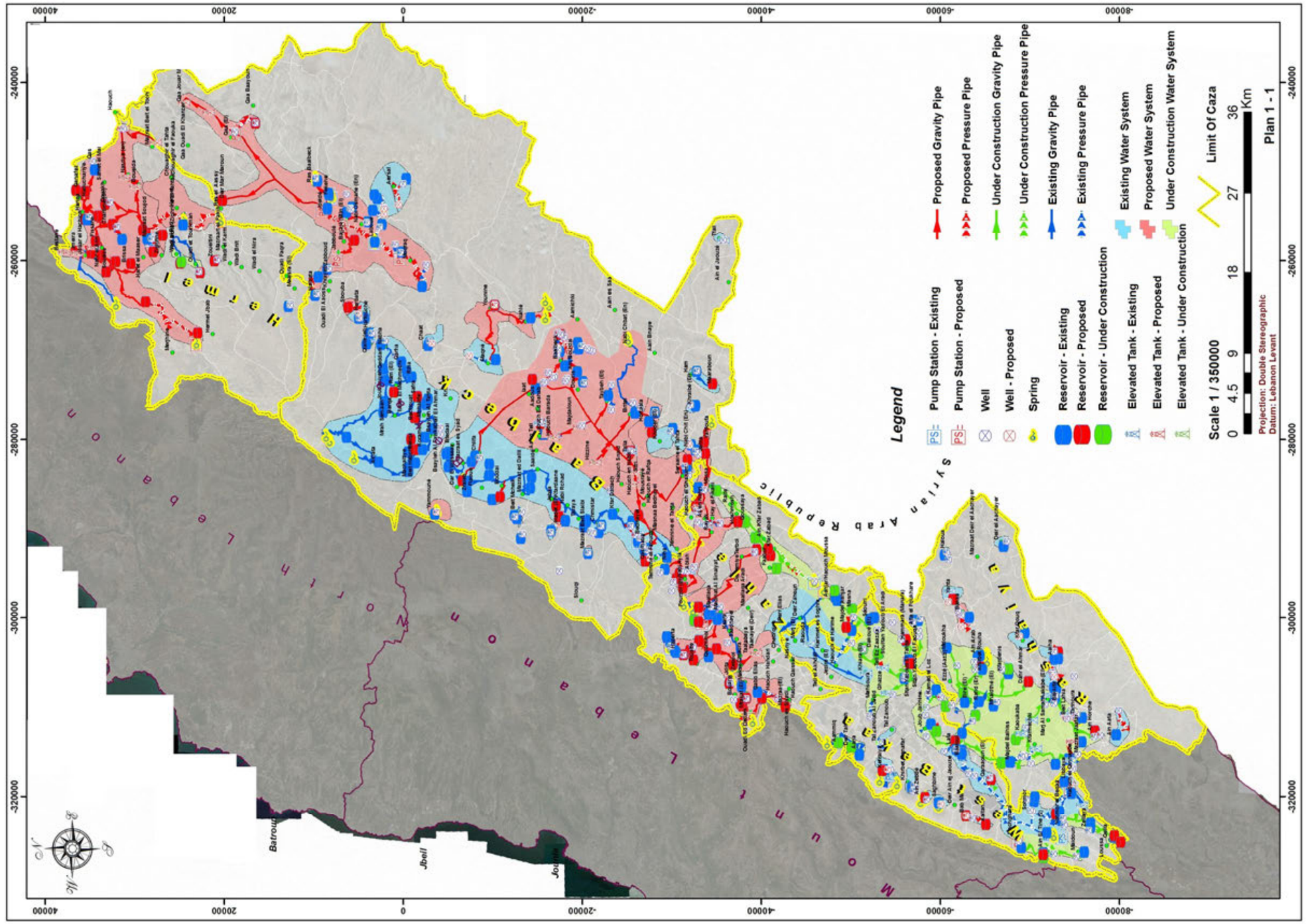
- Ain El Zarqa (Litani) system part 2 (under construction)

In addition to these 13 medium to large spring based supply systems there are 6 small systems that combine spring and well supply and 31 independent well based small systems serving one or more villages were proposed with the improvements needed to meet the projected 2035 water needs. Most of the well based systems are existing ones requiring upgrade and extension. The BWE currently operates 160 well based systems of various sizes and 36 spring based systems. These systems partially cover the geographical service area of the BWE leaving part of the population of the Bekaa without access to potable water service. This situation was presented in the Assessment Report. The proposed systems in this report cover the totality of the geographic service area of the BWE and allow all its residents equal access to potable water services.

Detailed feasibility studies should be carried out to confirm the proposed new schemes and insure that all spring water sources have been properly accounted for before moving to the implementation phase. The BWE in coordination with the LRA should establish a program to monitor systematically all the springs in the Bekaa and update and complete their hydrological information.

Detailed capital investment estimates for new systems and required improvements for each of the proposed systems are summarized in Ch. 7, and a three level priority list is established.

Plan 1-1 attached presents a general view of all the systems over the area of the Bekaa by the design horizon of 2035.



PLAN 1-1: WATER SYSTEMS IN THE BEKAA

2 HERMEL CAZA

The water demand projections and the required storage for the different villages and localities of Hermel are presented in tabular form in section 2.1 for the study year and the design horizons of 2025 and 2035. The schematics or functional diagrams for the supply systems are presented in section 2.2 with the existing infrastructure in blue, the proposed infrastructure in red, and the infrastructure under construction in green.

Each system is described and its components sized up. All systems are shown on the attached plans showing their geographic extent in the caza.

Section 2.3 compares the demand over the design horizons with the average yield and the adopted safe yield for each spring supplying a system.

Section 2.4 summarizes all the facilities and infrastructure components that the systems serving the caza in question will be composed of; namely the:

- Reservoirs,
- Wells,
- Pumping/boosting stations,
- Transmission lines,
- Distribution networks.

The total length of distribution networks required by the design horizon is presented. The length and status of the existing networks is also presented. The total length proposed for construction is then calculated based on the need for extension and replacement.

2.1 Water Demand for Hermel Caza

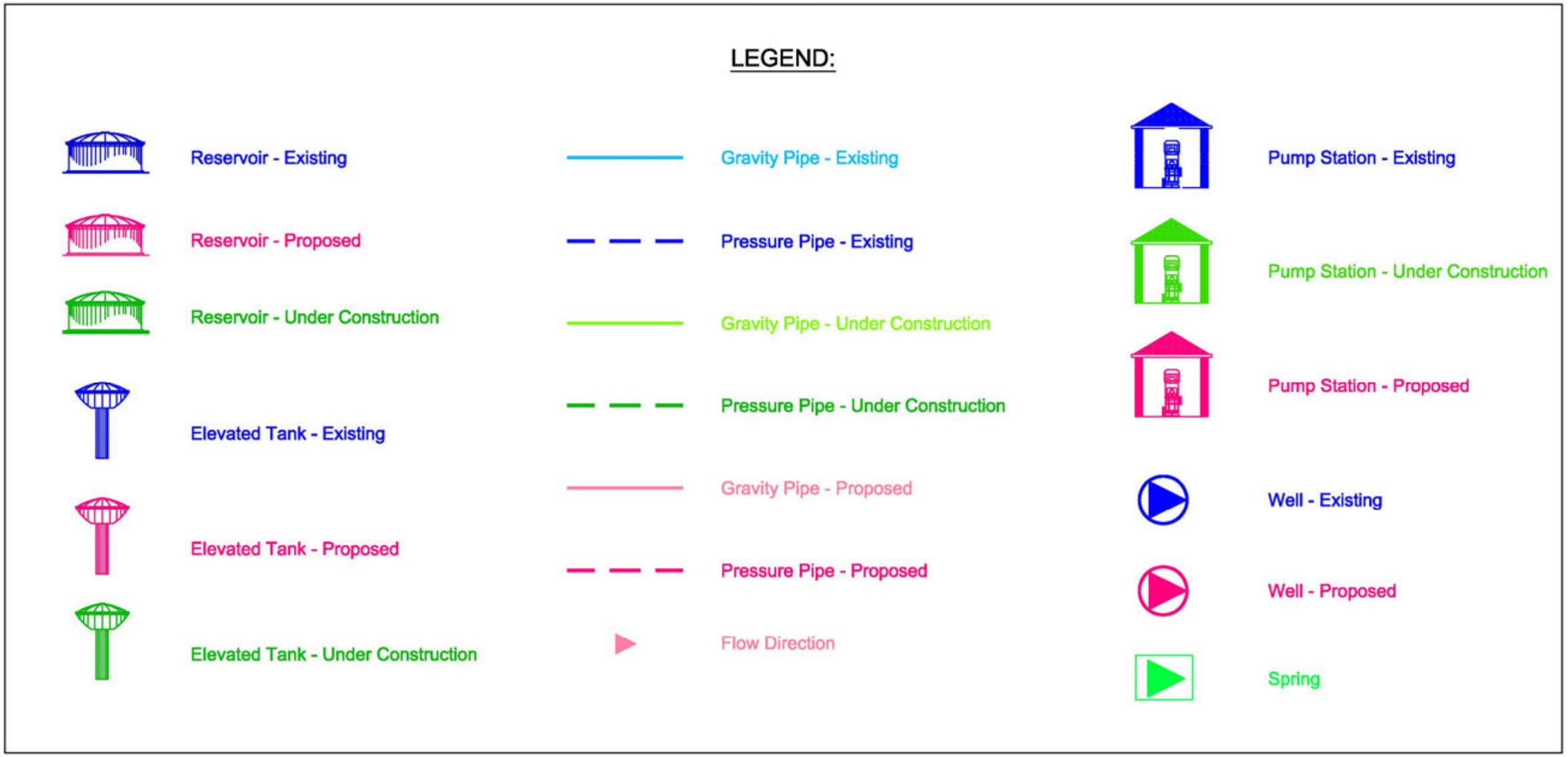
TABLE 2-1: WATER DEMAND AND REQUIRED STORAGE FOR HERMEL CAZA

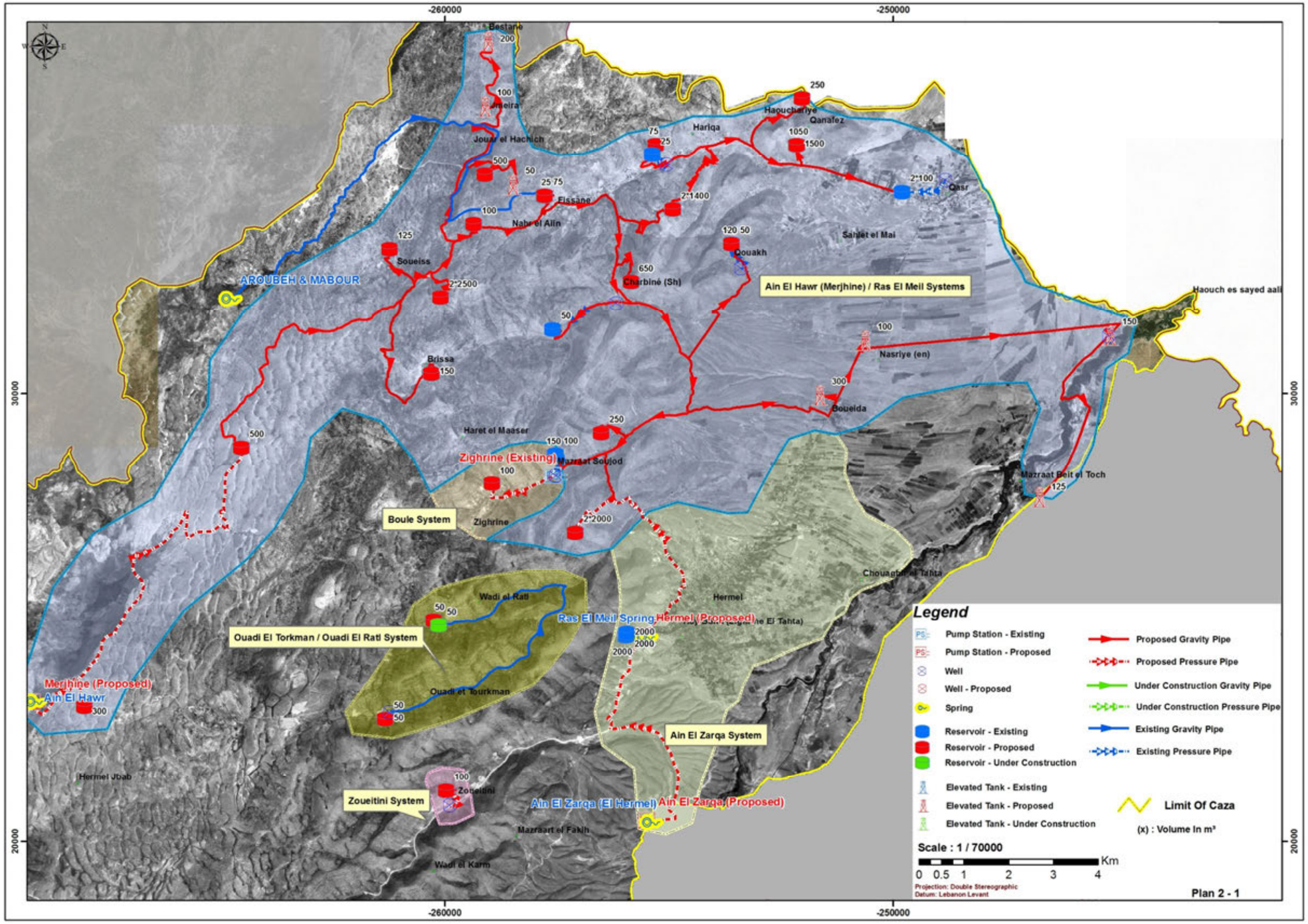
No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Required Storage (m^3)
1	Bestane	1,126	203	89	1,387	261	115	1,650	322	203
2	Boueida	1,801	324	143	2,217	417	183	2,637	514	287
3	Brissa	676	122	54	832	156	69	990	193	146
4	Charbiné (Sh)	1,917	345	213	2,361	444	256	2,808	548	302
5	Chouaghir el Faouka	3,381	609	329	4,164	783	405	4,952	966	486
6	Chouaghir el Tahta (Chouaghir El Faouka)	---	---	---	---	---	---	---	---	---
7	Fissane	1,200	216	156	1,478	278	183	1,758	343	212
8	Haouch es sayed aali	676	122	54	832	156	69	990	193	146
9	Haret el Maaser (Zighrine)	---	---	---	---	---	---	---	---	---
10	Hariqa	338	61	27	416	78	34	495	97	103
11	Hay Bdita (Zighrine)	---	---	---	---	---	---	---	---	---
12	Hermel	37,606	6,769	3,100	46,310	8,706	3,953	55,083	10,741	4,910
13	Hermel Jbab*	---	---	---	---	---	---	---	---	---
14	Jmeira	225	41	18	277	52	23	330	64	89
15	Jouar el Hachich	3,000	540	299	3,694	695	367	4,394	857	438
16	Maaïsra (El) (Zighrine)	---	---	---	---	---	---	---	---	---
17	Maaser (Zighrine)	---	---	---	---	---	---	---	---	---
18	Mazraart el Faqih (Zighrine)	---	---	---	---	---	---	---	---	---
19	Mazraat Beit el Toch	451	81	36	555	104	46	660	129	118
20	Mazraat Soujod	225	41	18	277	52	23	330	64	89
21	Merjhine	1,890	340	211	2,327	438	254	2,768	540	299
22	Nahr el Aiin	676	122	54	832	156	69	990	193	146
23	Nasriye (en)	225	41	18	277	52	23	330	64	89
24	Ouadi el Faara	450	81	97	554	104	107	659	128	118
25	Ouadi et Tourkman	300	54	24	369	69	31	439	86	99
26	Qanafez & Haouchariye	1,200	216	156	1,478	278	183	1,758	343	212
27	Qasr	15,000	2,700	1,310	18,472	3,473	1,650	21,971	4,284	2,007
28	Qouakh	868	156	69	1,068	201	88	1,271	248	170
29	Ras Baalbeck el Gharbi	257	46	81	316	59	87	376	73	93
30	Sahet el Mai	5,000	900	396	6,157	1,158	509	7,324	1,428	689
31	Soueiss	508	91	40	625	117	52	743	145	125

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Required Storage (m^3)
32	Wadi Bnit*	---	---	---	---	---	---	---	---	---
33	Wadi el Karm*	---	---	---	---	---	---	---	---	---
34	Wadi el Nira*	---	---	---	---	---	---	---	---	---
35	Wadi el Ratl	420	76	33	517	97	43	615	120	114
36	Zighrine (& Boule)	3,427	617	332	4,220	793	410	5,019	979	492
37	Zoueitini	288	52	23	355	67	29	422	82	97
	Hermel Total	**82,906**	**14,964**	**7,380**	**102,367**	**19,245**	**9,261**	**121,762**	**23,744**	**12,279**

* Vacant land or locality that has a very small number of houses (<10).

2.2 Water Systems for Hermel Caza





PLAN 2-1: WATER SYSTEMS IN HERMEL CAZA

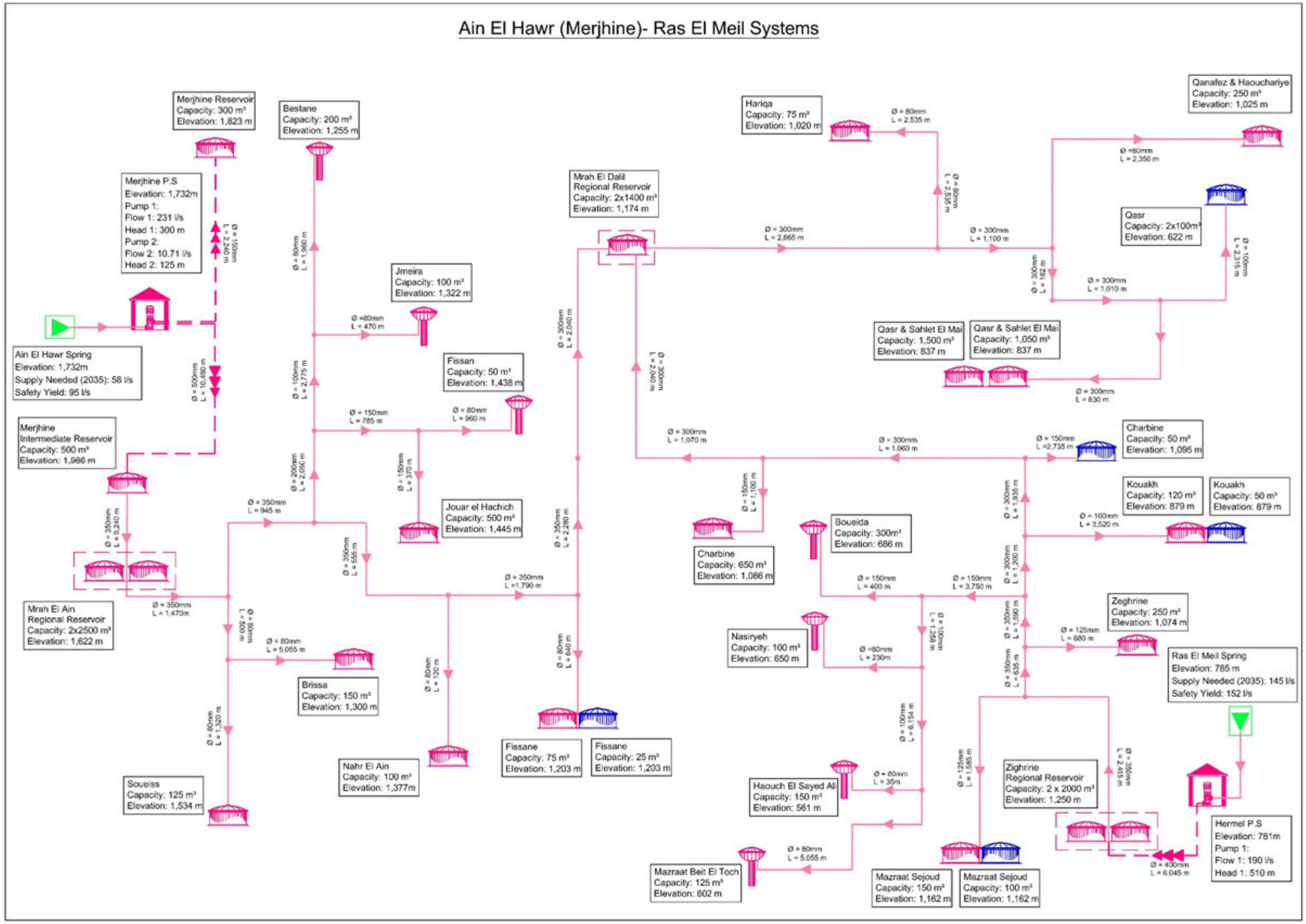


FIGURE 2-1: AIN EL HAOUR (MERJHINE)- RAS EL MAIL SYSTEM

Ain El Haour- and Ras El Mail is a proposed system, it will supply the area north of Hermel city through three regional reservoirs Mrah El Ain (2 x 2,500 m³), Mrah El Dalil (2 x 1,400 m³) and Zighrine (2x 2,000 m³).

- *Mrah El Ain regional reservoir:*
  Soueiss, Brissa, Jouar El Hachich, Mrah El Ain, Bestane, Jmeira, and Fissane will be fed from the proposed Mrah El Ain regional reservoirs at an elevation of 1,622 m. Water will be pumped from proposed Ain El Haour spring (located in Merjhine valley) bottom catchment structure to Mrah El Ain reservoir with a capacity of 5,000 m³ (2 x 2,500 m³). Also this regional reservoir is connected to Mrah El Dalil regional reservoir.

- *Mrah El Dalil regional reservoir:*
  Haouchariyeh, Hariqa, Qanafez, Mrah Ez Zakbi, Sahlet El Mai and Qasr will be fed from the regional reservoir of Mrah El Dalil. Water will be supplied by gravity from Zighrine and Mrah El Ain regional reservoirs to the proposed Mrah El Dalil reservoir at an elevation 1,174 m with a capacity of 2,800 m³ (2 x 1,400 m³).

- *Zighrine regional reservoir:*
  Mrah Sejoud, Zighrine, Boueida, Nassriyeh, Haouch El Sayed Ali, Mazraat Beit El Toch, Qouakh, and Charbine will be fed from the proposed Zighrine regional reservoirs at an elevation of 1,250 m. Water will be pumped from Ras El Mail spring (located in Hermel city) bottom catchment structure to Zighrine reservoir with a capacity of 4,000 m³ (2 x 2,000 m³). Also this regional reservoir is connected to Mrah El Dalil regional reservoir.

Merjhine village will be fed directly from Ain El Haour spring through a pump with a capacity of 10.71 l/s and a total head of 125 m.

The adopted safe yield for Ain El Haour- and Ras El Mail springs is around 247 l/s. The supply is larger than the average daily demand of the villages served by the system in year 2035 which will be 203 l/s. Thus the system is acceptable.

All existing small systems in the villages of Ain El Haour- and Ras El Mail system will be used as backup.

Fissane existing reservoir needs rehabilitation; Mrah Sejoud existing reservoir needs some minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 143,956 m.

TABLE 2-2: SUMMARY OF WATER FACILITIES FOR AIN EL HAWR (MERJHINE)-RAS EL MEIL SYSTEM BY YEAR 2035

Ain El Hawr (Merjhine)-Ras El Meil System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	25	1	**Pump Station**	*Proposed*	---	2
		50	2	**Pipe**	*Gravity - Proposed*	80	16,830
		100	3			100	1,622
	Proposed	75	2			125	2,465
		100	2			150	9,140
		120	1			200	2,050
		125	1			300	12,892
		150	2			350	21,000
		250	1		Pressurized -Proposed	150	2,240
		300	1			400	6,045
		500	2			500	10,480
		650	1				
		1050	1				
		1400	2				
		1500	1				
		2000	2				
		2500	2				
Elevated Tank	*Proposed*	50	1				
		100	2				
		125	1				
		150	1				
		200	1				
		300	1				

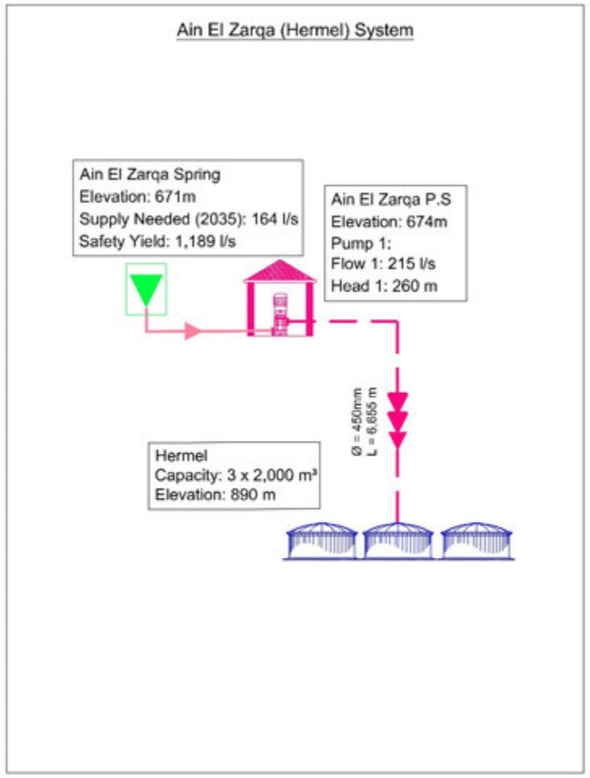


FIGURE 2-2: AIN EL ZARQA SYSTEM

Ain El Zarqa system is a proposed system. It supplies Hermel existing reservoirs.

The existing main water supply lines in Hermel city will be replaced because Ras El Mail spring which was the water source for the city of Hermel will supply another proposed system. The existing length of water distribution network for Hermel city is around 61,585 m but this network needs replacement since it is in bad condition The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 104,855 m.

System description:

A proposed pump station will pump water from Ain El Zarqa spring to Hermel existing reservoirs (3 x 2,000 m³) through a 450 mm diameter proposed pipe and these reservoirs will distribute water to Hermel city. The existing (3 x 2,000 m³) are new and they are in good condition.

TABLE 2-3 : SUMMARY OF WATER FACILITIES FOR AIN EL ZARQA SYSTEM BY YEAR 2035

System	Ground Reservoir	Pump Station	Pipe Diameter
Description	Existing 2,000 m³	Proposed	Proposed 450mm
Number/Length	3	1	6,655m
Comments	---	---	---

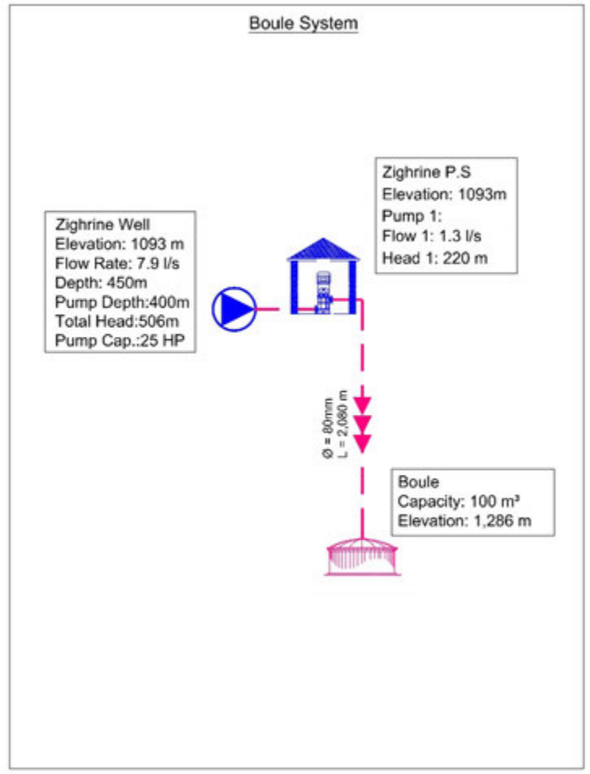


FIGURE 2-3: BOULE SYSTEM

Boule system is a proposed system. The length and layout of the existing water transmission and distribution network systems are unknown. The total length of the proposed water distribution network will be around 3,550 m.

System description:

An existing pump station will pump water from Zighrine well to Boule proposed reservoir (100 m³) through an 80 mm diameter proposed pipe and this reservoir will distribute water to Boule village. The existing well and pump station are in an acceptable condition.

TABLE 2-4: SUMMARY OF WATER FACILITIES FOR BOULE SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pump Station	Pipe Diameter
Description	Proposed 100 m³	Existing	Existing	Proposed 80 mm
Number/Length	1	1	1	2,080m
Comments	---	---	---	---

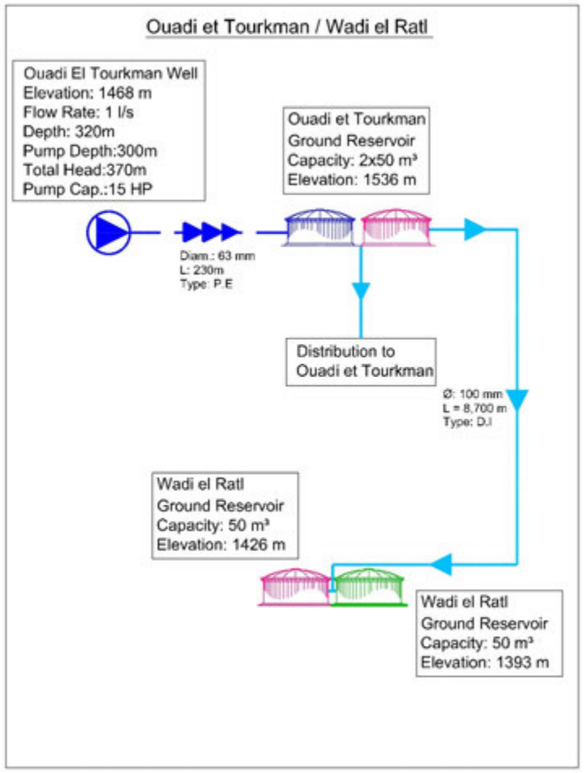


FIGURE 2-4: OUADI EL TOURKMAN SYSTEM

Ouadi El Tourkman system is a system that is under construction. Existing water transmission and distribution network systems are unknown. The total length of the proposed water distribution network will be around 5,234 m.

System description:

An existing well with new pump and generator chamber located in Ouadi El Tourkman will pump water to Ouadi El Tourkman proposed and under construction reservoirs (2 x 50 m³) through an 63 mm diameter pipe and these reservoirs are connected by gravity to Wadi El Ratl existing and proposed reservoirs (2 x 50 m³) through an 100mm pipe diameter and they will distribute water to Ouadi El Tourkman village.

TABLE 2-5: SUMMARY OF WATER FACILITIES FOR OUADI EL TOURKMAN SYSTEM BY YEAR 2035

System	Ground Reservoir			Well	Pipe Diameter	
Description	Proposed 50 m³	Existing 50 m³	Under.Const. 50m³	Existing	Existing 80 mm	Existing 100 mm
Number/Length	2	1	1	1	230m	8,700m
Comments	---	---	---	---	---	---

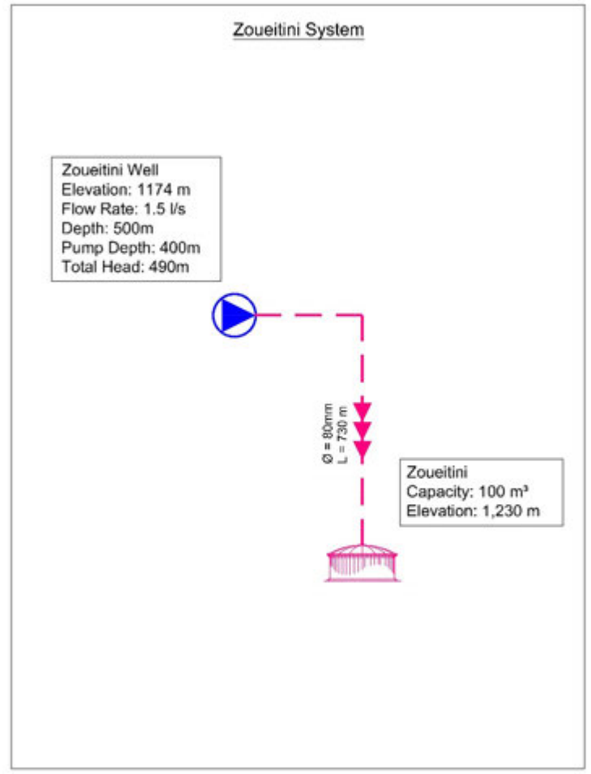


FIGURE 2-5: ZOUEITINI SYSTEM

Zoueitini system is a proposed system. Existing water transmission and distribution network systems are unknown. The total length of the proposed water distribution network will be around 2,292 m.

System description:

Zoueitini existing well will pump water to Zoueitini proposed reservoir (100 m³) through an 80 mm diameter proposed pipe and this reservoir will distribute water to Zoueitini village. The existing well is in an acceptable condition.

TABLE 2-6: SUMMARY OF WATER FACILITIES FOR ZOUEITINI SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Proposed 100 m³	Existing	Proposed 80 mm
Number/Length	1	1	730m
Comments	---	---	---

2.3 Spring Water Supply vs Demand for Hermel Regional Systems

TABLE 2-7: SPRING WATER SUPPLY VS DEMAND FOR REGIONAL SYSTEMS IN HERMEL CAZA

System	Average Demand Flow (Year 2013) (l/s)	Average Demand Flow (Year 2025) (l/s)	Average Demand Flow (Year 2035) (l/s)	Average Yearly Flow (Reference) (l/s)	Adopted Safe (Dry Year) Yield Flow (l/s)	System Status	Comments
Ain El Hawr System	40	49	58	190 (LRA)	**95**	Proposed	Adopted water quantity is more than water demand - System is Ok
Ras El Mail System	99	122	145	304 (MEW [1962 -1974])	**152**	Proposed	Adopted water quantity is more than water demand - System is Ok
Ain El Zarqa System	112	138	164	2,377 (LRA [2011-2013])	**1,189**	Proposed	Adopted water quantity is more than water demand - System is Ok

* The adopted safe (dry year) yield flow is the average yearly flow / 2.

2.4 Summary of Water Facilities for Systems of Hermel Caza by Year 2035

TABLE 2-8: NUMBER OF RESERVOIRS IN CAZA OF HERMEL

Reservoir Facility	Volume (m³)																Total	Total Storage (m³)
	25	50	75	100	120	125	150	200	250	300	500	1050	1400	1500	2000	2500		
Reservoir - Existing	1	3	-	3	-	-	-	-	-	-	-	-	-	-	3	-	10	6,475
Reservoir – Under Construction	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	50
Reservoir - Proposed	-	2	2	4	1	1	3	-	1	1	2	1	2	1	2	2	25	17,245
Elevated Tank - Proposed	-	1	-	2	-	1	1	1	-	1	-	-	-	-	-	-	7	1,025
Total	**1**	**7**	**2**	**9**	**1**	**2**	**4**	**1**	**1**	**2**	**2**	**1**	**2**	**1**	**5**	**2**	**43**	**25,595**

TABLE 2-9: NUMBER OF WELLS USED IN CAZA OF HERMEL

Village Name	Existing well Used	Proposed well Used
Boule (Zighrine)	1	---
Ouadi El Tourkman /Wadi El Ratl	1	---
Zoueitini	1	---
Total	**3**	**---**

TABLE 2-10: CHARACTERISTICS OF PROPOSED PUMP STATIONS IN CAZA OF HERMEL

Pump Station Name	Status	Ground Elevation (m)	Capacity Needed in year 2035 (L/s)	Total Head Needed (m)
Ain El Zarqa	Proposed- Booster	674	215	260
Hermel	Proposed- Booster	781	190	510
Merjhine	Proposed- Booster Set 1	1,732	231	300
	Proposed- Booster Set 2	1,732	11	125

TABLE 2-11: LENGTHS OF PROPOSED TRANSMISSION PIPE SYSTEMS IN CAZA OF HERMEL

Type	Diameter (mm)	Total length (m)
Ductile Iron	80	19,640
	100	1,622
	125	2,465
	150	11,380
	200	2,050
	300	12,892
	350	21,000
	400	6,045
	450	6,655
	500	10,480

TABLE 2-12: LENGTHS OF EXISTING AND PROPOSED WATER DISTRIBUTION NETWORK FOR HERMEL CAZA

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Bestane	7,806	---	---	---	---	7,806
Boueida	5,497	---	---	---	---	5,497
Brissa	8,028	---	---	---	---	8,028
Charbiné (Sh)	3,952	2,275	B	M.C	Replacement	1,677
Chouaghir el Faouka	6,295	---	---	---	---	6,295
Chouaghir el Tahta (Chouaghir El Faouka)	---	---	---	---	---	---
Fissane	9,199	---	---	---	---	9,199
Haouch es sayed aali	1,437	---	---	---	---	1,437
Haret el Maaser (Zighrine)	---	---	---	---	---	---
Hariqa	1,372	---	---	---	---	1,372
Hay Bdita	5,195	4,725	B	W.C	Replacement	470
Hermel	93,365	61,585	B	M.C	Replacement	31,780
Hermel Jbab*	---	---	---	---	---	---
Jmeira	3,617	---	---	---	---	3,617
Jouar el Hachich	1,095	---	---	---	---	1,095
Maaïsra (El) (Zighrine)	---	---	---	---	---	---
Maaser (Zighrine)	---	---	---	---	---	---
Mazraart el Faqih (Zighrine)	---	---	---	---	---	---
Mazraat Beit el Toch	5,000	---	---	---	---	5,000
Mazraat Soujod	1,343	---	---	---	---	1,343
Merjhine	10,418	---	---	---	---	10,418
Nahr el Aiin	1,732	---	---	---	---	1,732
Nasriye (en)	10,414	---	---	---	---	10,414
Ouadi el Faara	---	---	---	---	---	---
Ouadi et Tourkman	2,793	---	---	---	---	2,793
Qanafez (Including Haouchariye, Mrah El Zakbe)	7,250	---	---	---	---	7,250
Qasr	41,733	37,940	B	W.C	Replacement	3,793
Qouakh	4,093	2,790	B	M.C	Replacement	1,303
Ras Baalbeck el Gharbi*	---	---	---	---	---	---
Sahet el Mai	2,166	---	---	---	---	2,166
Soueiss	2,554	---	---	---	---	2,554
Wadi Bnit*	---	---	---	---	---	---
Wadi el Karm*	---	---	---	---	---	---
Wadi el Nira*	---	---	---	---	---	---

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Wadi el Ratl	2,441	---	---	---	---	2,441
Zighrine (& Boule)	18,800	---	---	---	---	18,800
Zoueitini	2,292	---	---	---	---	2,292
Total	**259,887**	**109,315**				**150,572**

* Vacant land or locality that has a very small number of houses (<10).

V.G = Very Good Condition
M = Medium Condition
B = Bad Condition
M.C = Partially Covered
G = Good Condition
M = Medium Condition
W.C = Well Covered
P.C = Poorly Covered

3 BAALBECK CAZA

The water demand projections and the required storage for the different villages and localities of Baalbeck are presented in tabular form in section 3.1 for the study year and the design horizons of 2025 and 2035. The schematics or functional diagrams for the supply systems are presented in section 3.2 with the existing infrastructure in blue, the proposed infrastructure in red, and the infrastructure under construction in green.

Each system is described and its components sized up. All systems are shown on the attached plans showing their geographic extent in the caza.

Section 3.3 compares the demand over the design horizons with the average yield and the adopted safe yield for each spring supplying a system.

Section 3.4 summarizes all the facilities and infrastructure components that the systems serving the caza in question will be composed of; namely the:

- Reservoirs,
- Wells,
- Pumping/boosting stations,
- Transmission lines,
- Distribution networks.

The total length of distribution networks required by the design horizon is presented. The length and status of the existing networks is also presented. The total length proposed for construction is then calculated based on the need for extension and replacement.

3.1 Water Demand for Baalbeck Caza

TABLE 3-1: WATER DEMAND AND REQUIRED STORAGE FOR BAALBECK CAZA

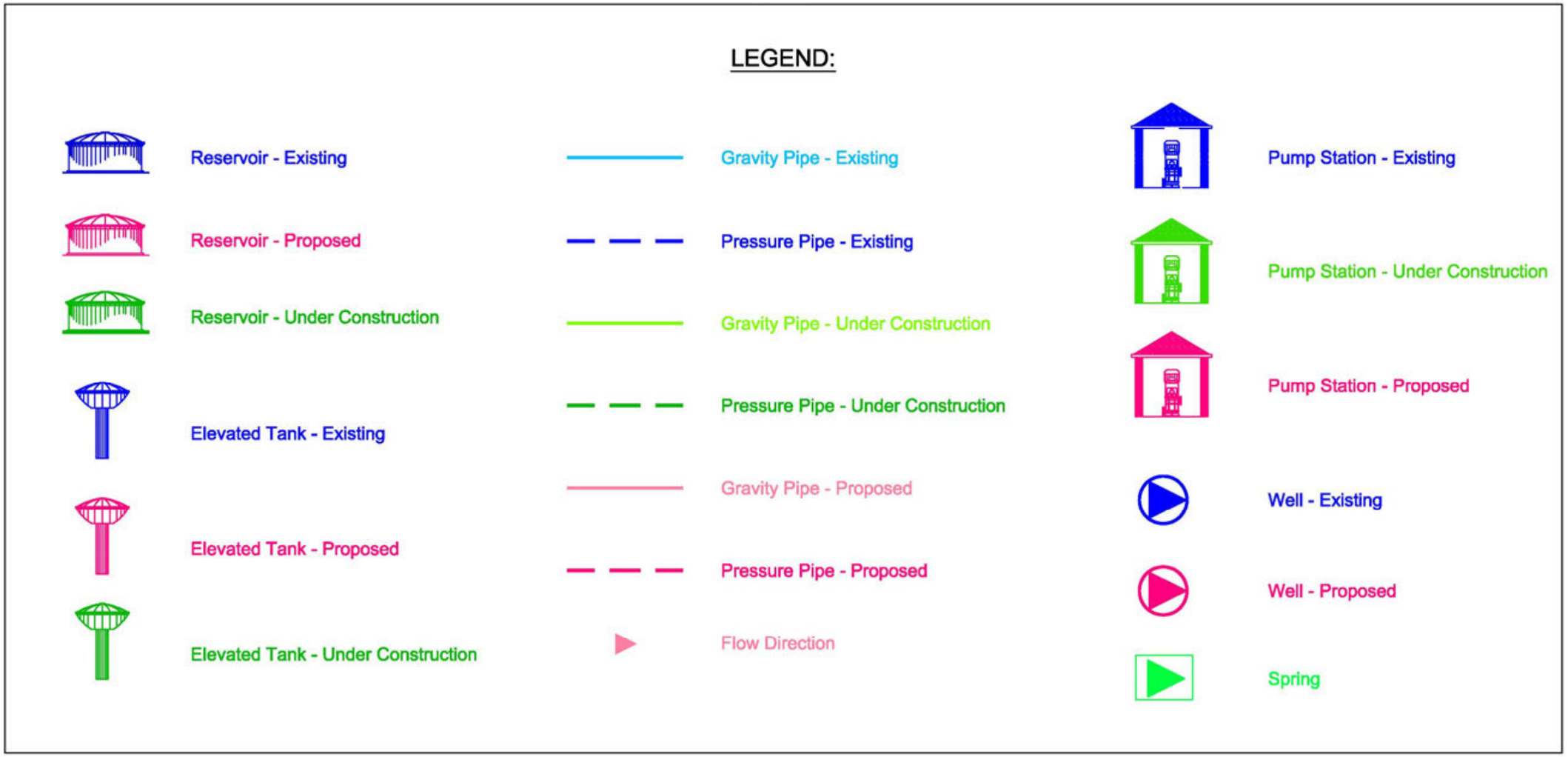
No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Required Storage (m^3)
1	Aaddous	327	59	87	402	76	94	478	93	102
2	Aain Bnayé*	---	---	---	---	---	---	---	---	---
3	Aalaq Tell (Boudai)	---	---	---	---	---	---	---	---	---
4	Aamichki (Baalbeck)	---	---	---	---	---	---	---	---	---
5	Aaqidieh*	---	---	---	---	---	---	---	---	---
6	Aarsal	27,064	4,872	2,265	33,328	6,266	2,879	39,642	7,730	3,523
7	Ain (El)	9,878	1,778	904	12,164	2,287	1,128	14,469	2,821	1,363
8	Ain Bourdai	916	165	134	1,127	212	154	1,341	261	176
9	Ain el Jaouzé*	---	---	---	---	---	---	---	---	---
10	Ain Es Saouda *	---	---	---	---	---	---	---	---	---
11	Ainata	2,000	360	219	2,463	463	265	2,929	571	312
12	Amhazié *	---	---	---	---	---	---	---	---	---
13	Baalbeck	90,873	16,357	7,381	111,904	21,038	9,441	133,104	25,955	11,604
14	Bajjajé (El)	916	165	134	1,127	212	154	1,341	261	176
15	Barqa	1,124	202	150	1,385	260	176	1,647	321	202
16	Bechouat	1,800	324	204	2,217	417	244	2,637	514	287
17	Bednayel	11,233	2,022	1,012	13,832	2,600	1,266	16,453	3,208	1,534
18	Beit Chama	4,315	777	403	5,314	999	501	6,321	1,233	603
19	Beit Mcheik (Ramasa & Qeld El Sabeh)	2,400	432	251	2,955	556	305	3,515	685	363
20	Beliqa	60	11	66	74	14	67	88	17	69
21	Boudai	9,139	1,645	785	11,254	2,116	1,115	13,386	2,610	1,333
22	Britel	13,604	2,449	1,199	16,753	3,150	1,508	19,927	3,886	1,832
23	Btedaai	1,301	234	164	1,602	301	194	1,906	372	225
24	Chaaibé *	---	---	---	---	---	---	---	---	---
25	Chaat	6,425	1,156	570	7,912	1,487	715	9,411	1,835	868
26	Chlifa	2,067	372	225	2,545	478	272	3,027	590	321
27	Chmistar	14,750	2,655	1,290	18,164	3,415	1,625	21,605	4,213	2,038
28	Dar el Wasseaa	444	80	96	547	103	106	651	127	117
29	Deir el Ahmar	6,366	1,146	565	7,839	1,474	709	9,324	1,818	861
30	Deir Mar Maroun	96	17	69	119	22	71	141	28	73
31	Douris	10,842	1,952	981	13,351	2,510	1,226	15,880	3,097	1,485
32	Fekehe	11,747	2,114	1,052	14,465	2,719	1,319	17,206	3,355	1,598

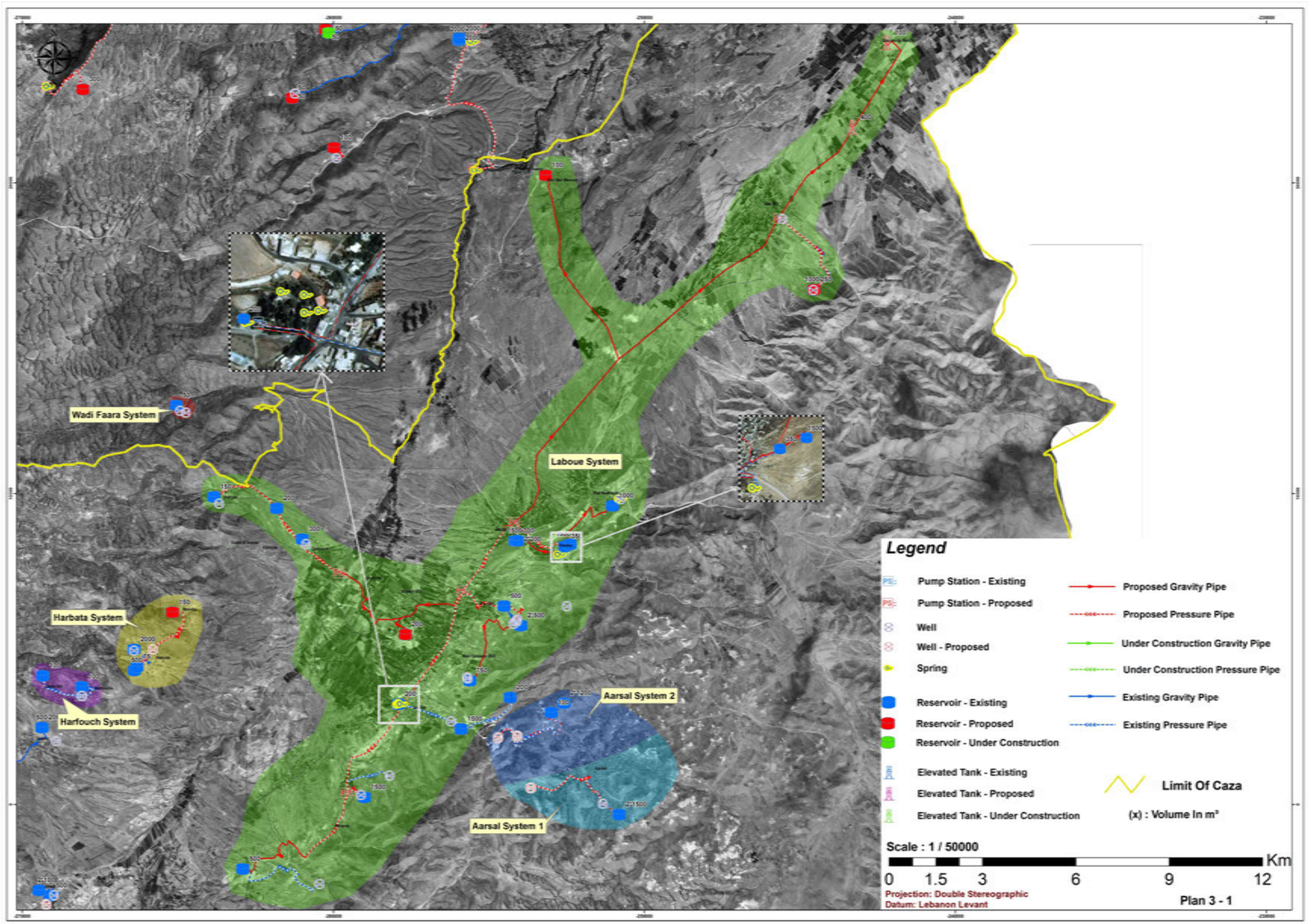
No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Required Storage (m^3)
33	Flaoue	2,251	405	178	2,772	521	229	3,297	643	344
34	Hadet (El)	6,039	1,087	539	7,437	1,398	676	8,846	1,725	820
35	Halbata	509	92	101	626	118	113	745	145	125
36	Ham	546	98	104	672	126	117	800	156	130
37	Haouch Barada	487	88	100	600	113	111	714	139	122
38	Haouch ed Dahab	96	17	69	119	22	71	141	28	73
39	Haouch en Nabe	1,472	265	178	1,813	341	211	2,157	421	246
40	Haouch er Rafqa	7,164	1,289	628	8,822	1,658	791	10,493	2,046	1,022
41	Haouch Snaid	1,537	277	183	1,892	356	218	2,251	439	254
42	Haouch Tell Safiyé	1,269	228	161	1,563	294	190	1,859	362	220
43	Harbata	4,321	778	403	5,321	1,000	501	6,329	1,234	604
44	Harfouche (Qlaile (el))	---	---	---	---	---	---	---	---	---
45	Hizzine	2,067	372	225	2,545	478	272	3,027	590	321
46	Hortaala	3,796	683	362	4,674	879	448	5,560	1,084	538
47	Iaat	4,406	793	410	5,426	1,020	510	6,454	1,259	615
48	Jabboulé (Bajjajé (El))	---	---	---	---	---	---	---	---	---
49	Jdeidé (Fekehe)	---	---	---	---	---	---	---	---	---
50	Jebaa	557	100	105	686	129	118	816	159	131
51	Jenta	471	85	98	580	109	109	690	135	120
52	Kfar Dabach	996	179	140	1,226	231	162	1,459	284	186
53	Kfardaane	2,597	467	267	3,198	601	326	3,803	742	387
54	Kharayeb	203	37	77	250	47	82	297	58	87
55	Khoder (El)	4,958	892	454	6,105	1,148	566	7,262	1,416	684
56	Khraibé (El)	1,231	222	159	1,516	285	186	1,804	352	216
57	Kneissé	1,713	308	197	2,110	397	236	2,509	489	276
58	Laboué	12,341	2,221	1,099	15,197	2,857	1,379	18,076	3,525	1,673
59	Maaraboun	1,478	266	178	1,820	342	212	2,164	422	247
60	Machaitiye	120	22	71	148	28	73	176	34	76
61	Majdaloun	899	162	132	1,108	208	153	1,317	257	174
62	Maqné	3,164	570	312	3,897	733	383	4,635	904	459
63	Masnaa Bednayel (Bednayel)	---	---	---	---	---	---	---	---	---
64	Mazraat Beit Ghousain	200	36	16	246	46	20	293	57	86
65	Mazraat Beit Slaibi	800	144	63	985	185	81	1,172	228	162
66	Mazraat ed Dallil (Kfardaane)	---	---	---	---	---	---	---	---	---

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Required Storage (m^3)
67	Mazraat es Syad	300	54	69	369	69	86	439	86	99
68	Moqraq	1,740	313	199	2,143	403	238	2,549	497	280
69	Mousraye	498	90	100	613	115	112	729	142	124
70	Nabha	5,113	920	466	6,296	1,184	582	7,489	1,460	704
71	Nabi Chbat (En)	43	8	64	53	10	65	63	12	66
72	Nabi Chit (En)	13,438	2,419	1,186	16,549	3,111	1,491	19,684	3,838	1,811
73	Nabi Osmane (En)	4,096	737	385	5,044	948	478	5,999	1,170	576
74	Nabi Rchad	1,800	324	204	2,217	417	244	2,637	514	287
75	Nahlé	6,000	1,080	536	7,389	1,389	672	8,788	1,714	815
76	Ouadi el Aaoss *	---	---	---	---	---	---	---	---	---
77	Qaa (El)	8,791	1,582	757	10,826	2,035	1,018	12,877	2,511	1,227
78	Qaa Baayoun (Qaa (El))	---	---	---	---	---	---	---	---	---
79	Qaa Jouar Maqiye	2,843	512	286	3,501	658	351	4,164	812	418
80	Qaa Ouadi El Khanzer	439	79	96	541	102	106	643	125	116
81	Qarha	493	89	100	607	114	111	721	141	123
82	Qasrnaba	6,302	1,134	560	7,760	1,459	703	9,230	1,800	853
83	Qeddam	720	130	57	886	0	0	1,054	206	151
84	Qlaile (el)	120	22	71	148	28	73	176	34	76
85	Ram (El)	2,000	360	219	2,463	463	265	2,929	571	312
86	Ras Baalbeck	7,000	1,260	615	8,620	1,621	774	10,253	1,999	1,002
87	Ras el Aassi *	---	---	---	---	---	---	---	---	---
88	Riha	792	143	124	976	183	142	1,161	226	161
89	Saaidé	1,681	303	194	2,070	389	232	2,462	480	272
90	Safra	1,800	324	204	2,217	417	244	2,637	514	287
91	Sbouba	664	120	114	818	154	129	972	190	144
92	Seraaine el Gharbieh/ Hallanieh (Seraaine El Tahta)	---	---	---	---	---	---	---	---	---
93	Seraaine el Tahta	9,000	1,620	774	11,083	2,084	1,039	13,183	2,571	1,253
94	Serraain el Faouka (Seraaine El Tahta)	---	---	---	---	---	---	---	---	---
95	Sifri (Khoder (El))	---	---	---	---	---	---	---	---	---
96	Slouqi	70	13	67	86	16	68	102	20	70
97	Talia	2,393	431	251	2,947	554	305	3,505	684	362
98	Taoufiqié (Moqraq)	---	---	---	---	---	---	---	---	---
99	Taraya	5,707	1,027	513	7,028	1,321	642	8,360	1,630	778
100	Taybeh (Et)	1,933	348	214	2,380	447	258	2,831	552	304

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Required Storage (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Required Storage (m^3)
101	Temnine el Faouqa	4,567	822	423	5,624	1,057	526	6,689	1,304	635
102	Temnine el Tahta	9,621	1,732	823	11,848	2,227	1,102	14,092	2,748	1,331
103	Tfail	503	91	101	620	117	112	737	144	124
104	Wadi Faara (Faara)	---	---	---	---	---	---	---	---	---
105	Yahfoufa	685	123	115	844	159	131	1,004	196	147
106	Yammouné	2,420	436	253	2,980	560	308	3,545	691	365
107	Younine	11,661	2,099	1,046	14,360	2,700	1,310	17,080	3,331	1,587
108	Zabboud	1,199	216	156	1,477	278	183	1,757	343	212
109	Zraieb	676	122	115	832	156	130	990	193	146
110	Zrazir	2,000	360	219	2,463	463	265	2,929	571	312
	Baalbeck Total	**416,483**	**74,967**	**38,891**	**512,875**	**96,421**	**48,573**	**610,035**	**118,957**	**58,993**

3.2 Water Systems for Baalbeck Caza





PLAN 3-1: AARSAL, LABOUE, HARFOUCH, WADI FAARA AND HARBATA WATER SYSTEMS

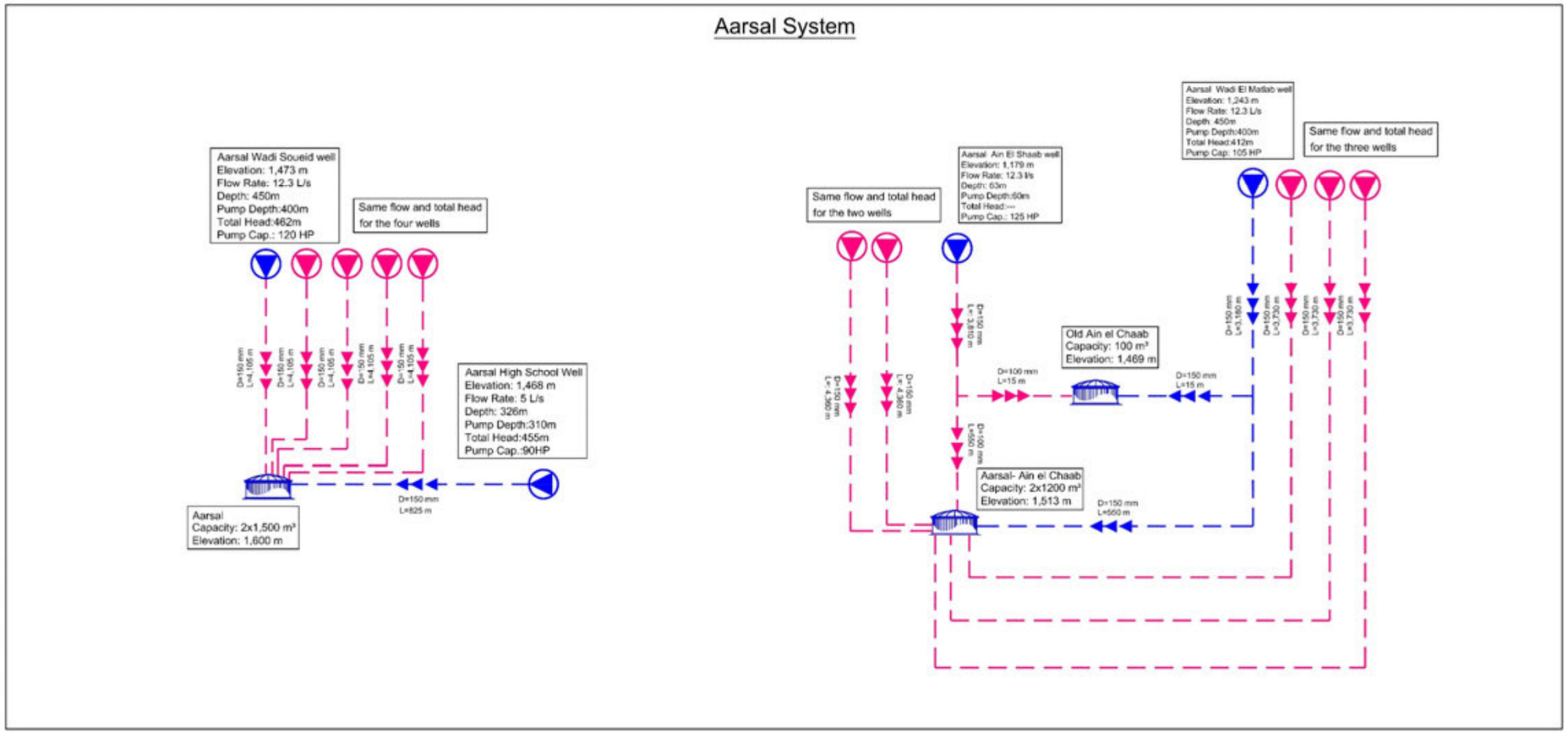


FIGURE 3-1: AARSAL SYSTEM

Aarsal system is a combined system. It supplies Aarsal existing reservoirs. The length of the existing water distribution network in Aarsal system is around 97,904m. It is in very good condition. The remaining length of proposed water distribution network will be around 9,790m.

System description:

Existing Aarsal Wadi Soueid and high school wells will pump water to Aarsal existing reservoirs (2 x 1,500 m³) through 150 mm diameter proposed and existing pipe and existing Aarsal Ain el Chaab and Wadi El Matlab wells will pump water to Aarsal-Ain el Chaab and Old Ain el Chaab existing reservoirs (2 x 1,200 m³ and 100 m³ respectively) through 150 mm and 100 mm diameters proposed and existing pipes respectively.

By the year 2035, 9 new wells with same capacities of the existing ones are needed to cover the water demand of the village. These wells will feed individually the three existing reservoirs through 150 mm proposed pipe diameter. Existing wells and reservoirs (2 x 1500 m³ and 2 x 1200 m³) are new and in good condition. Old Ain el Chaab existing reservoir (100 m³) needs rehabilitation.

TABLE 3-2: SUMMARY OF WATER FACILITIES FOR AARSAL SYSTEM BY YEAR 2035

System	Ground Reservoir			Well	Pipe Diameter		
Description	Existing 1,500m³	Existing 1,200m³	Existing 100 m³	Existing	Proposed 100mm	Proposed 150mm	Existing 150mm
Number/Length	2	2	1	4	565	44,245	4,570
Comments	---	---	Needs Rehabilitation	Drill 9 New Wells	---	---	---

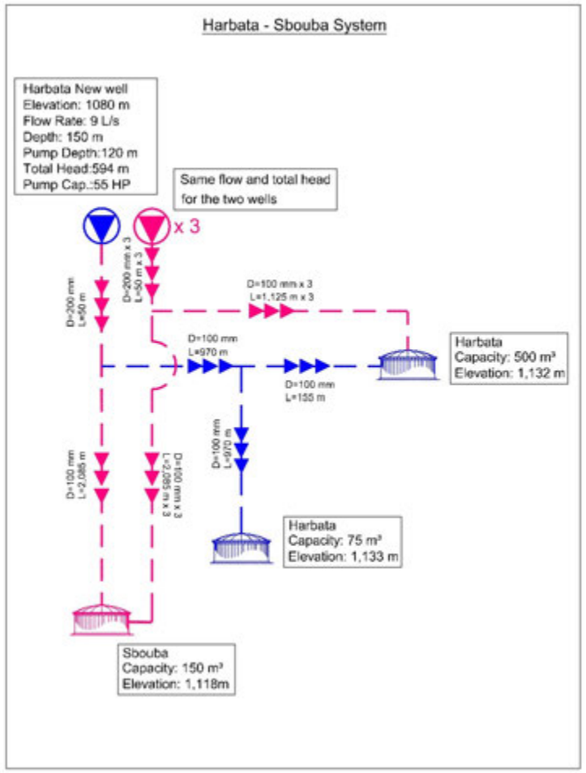


FIGURE 3-2: HARBATA – SBOUBA SYSTEM

Harbata System is a combined system. The existing water system in Harbata will be used along with the new proposed system. The length of the existing water distribution network in Harbata and Sbouba system is around 15,710 m length and it is in very good condition. The remaining length of proposed water distribution network will be around 4,917 m.

System description:

Existing Harbata well will pump water to both Harbata existing reservoirs (500m³ and 75m³ respectively) through 200mm proposed and 100 mm existing pipe diameters. This well will also pump water to Sbouba proposed reservoir (150 m³) through 200 mm and 100 mm diameters proposed pipes.

By the year 2035, 3 new wells with same capacities of the existing one are needed to cover the water demand of the village. These wells will feed individually the three reservoirs through 200 mm and 100 mm diameters proposed pipes. The existing well is in good condition. Both existing reservoirs of Harbata are in bad conditions and they need rehabilitation.

TABLE 3-3: SUMMARY OF WATER FACILITIES FOR HARBATA SYSTEM BY YEAR 2035

System	Ground Reservoir			Well	Pipe Diameter		
Description	Proposed 150m³	Existing 500m³	Existing 75m³	Existing	Proposed 100mm	Existing 100mm	Proposed 200mm
Number/Length	1	1	1	1	11,715m	2,095m	200m
Comments	---	Need Rehabilitation		Drill 3 New Wells	---	---	---

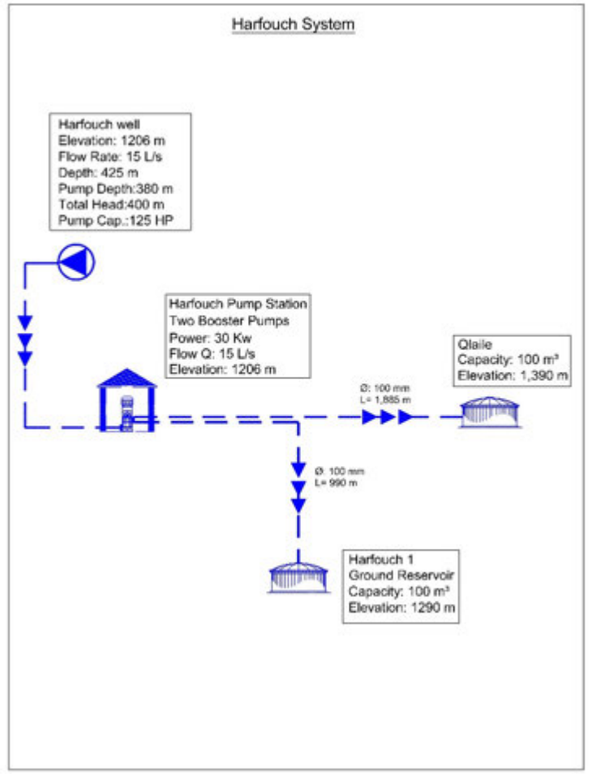


FIGURE 3-3: HARFOUCH SYSTEM

Harfouch System is an existing system. It supplies Harfouche and Qlaile existing reservoirs. The existing water transmission system in Harfouch will be adopted. The length of the proposed water distribution network in Harfouch and Qlaile system is around 4,150 m length.

System description:

Existing Harfouch well will pump water to Harfouch and Qlaile existing reservoirs (100 m³) through 100 mm diameter existing pipes.

The existing well, pump station and reservoirs are in good condition.

TABLE 3-4: SUMMARY OF WATER FACILITIES FOR HARFOUCH SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 100m³	Existing	Existing 100mm
Number/Length	2	1	2,875m
Comments	---	---	---

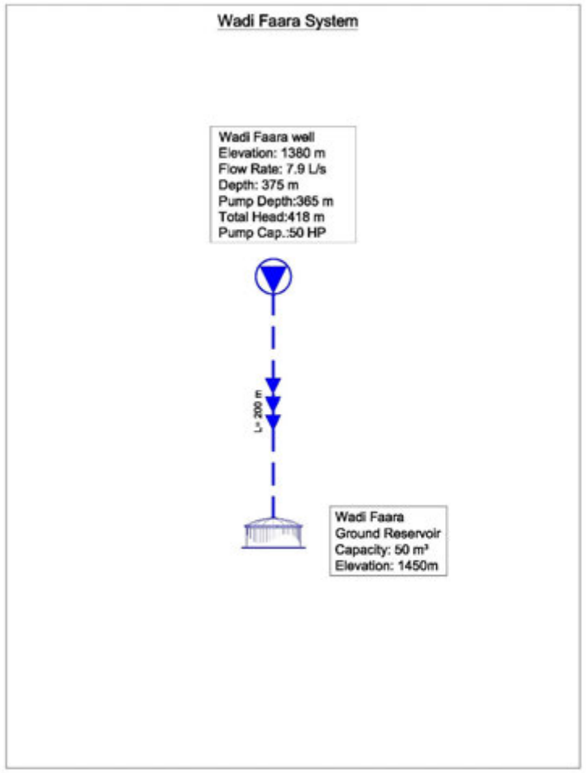


FIGURE 3-4: WADI FAARA SYSTEM

Wadi Faara System is an existing system. It supplies Wadi Faara existing reservoir. The existing water transmission system in Wadi Faara will be adopted. The length of the proposed water distribution network in Wadi Faara system is unknown. As well as the unknown seasonal population which has been accounted for in neighboring main localities. This system will not be included in the capital investment plan given its extremely small size and unknown data.

TABLE 3-5: SUMMARY OF WATER FACILITIES FOR WADI FAARA SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 50m³	Existing	---
Number/Length	1	1	50m
Comments	---	---	---

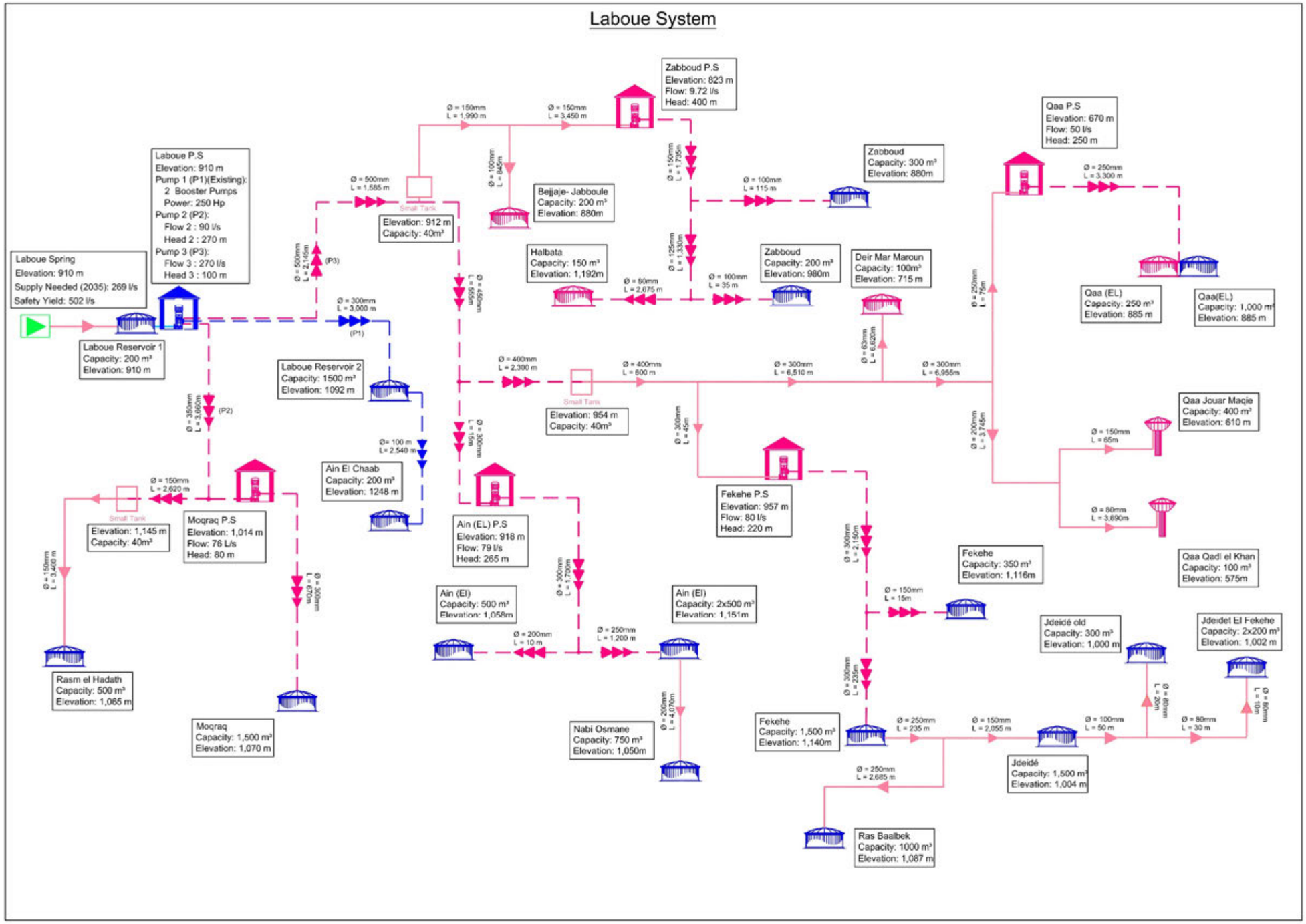


FIGURE 3-5: LABOUE SYSTEM

Laboue is a proposed system; it supplies existing and proposed reservoirs of the system's villages. The main water source for this system is Laboue spring. The water is pumped using 3 large centrifugal pumps (pumps 1, 2, and 3).

- Pump 1: Laboue existing reservoir will be fed from the existing two pumps (one operational and another standby) with a capacity of 250 Hp.

- Pump 2: Rasm el Hadath and Moqraq will be fed from the proposed pump 2 at 910 m elevation with a flow =90 l/s and Head = 270 m. 1 booster pump is needed in this sub-system which is Moqraq pump station (flow = 76 l/s and head = 80m).

- Pump 3 : Zabboud , Halbata, Bejjaje- Jabboule , Deir Mar Maroun, Qaa (EL), Qaa Jouar Maqie, Qaa Qadl el Khan, Ain (El), Nabi Osmane, Ras Baalbek, Fekehe, Jdeide, Jdeide old, and Jdeidet el Fekehe will be fed from a proposed pump 3 at 910 m elevation with a flow =270 l/s and Head = 100 m. 4 booster pumps are needed in this sub-system which are Ain (El) pump station (flow= 79 l/s and head =265m) , Fekehe pump station(flow= 80 l/s and head=220 m), Qaa pump station (flow = 50 l/s and head = 250 m), and Zabboud pump station(flow = 9.72 l/s and head = 400m).

The adopted safe yield for Laboue Spring is around 502 l/s. The supply is larger than the average daily demand of the villages served by this system in year 2035 which will be 269 l/s. Thus, the system is acceptable.

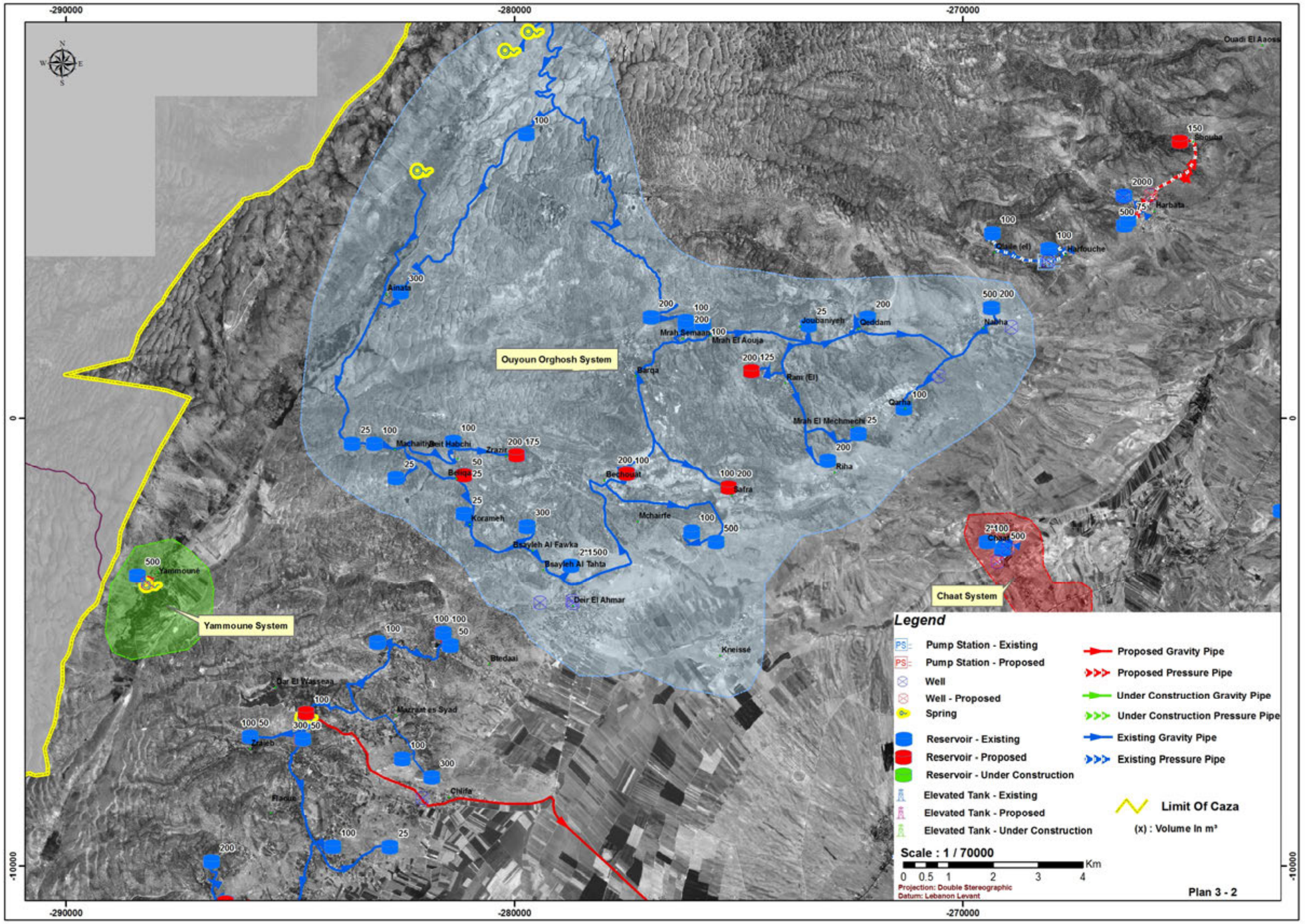
All existing small systems in the villages of Laboue system will be used as backup.

Ain (El) existing reservoir needs rehabilitation. The remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 220,563 m.

TABLE 3-6: SUMMARY OF WATER FACILITIES FOR LABOUE SYSTEM BY YEAR 2035

Laboue System							
Facility	**Status**	**Capacity (m^3)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	200	6	**Pipe**	*Gravity - Proposed*	63	6,620
		300	2			80	3,750
		350	1			100	845
		500	3			150	11,010
		750	1			200	7,545
		1,000	2			250	2,995
		1,500	3			300	13,510
	Proposed	100	1			400	600
		200	1		*Pressurized - Proposed*	80	2,675
		250	1			100	150
		500	1			125	1,330
		1,500	1			150	4,370
Elevated Tank	*Proposed*	100	1			200	10
		400	1			250	4,500
Pump Station	*Proposed*	---	8			300	6,725
						350	3,660
						400	2,300
						450	555
						500	3,730



PLAN 3-2: CHAAT, YAMMOUNEH AND OUYOUN ORGHOSH WATER SYSTEMS

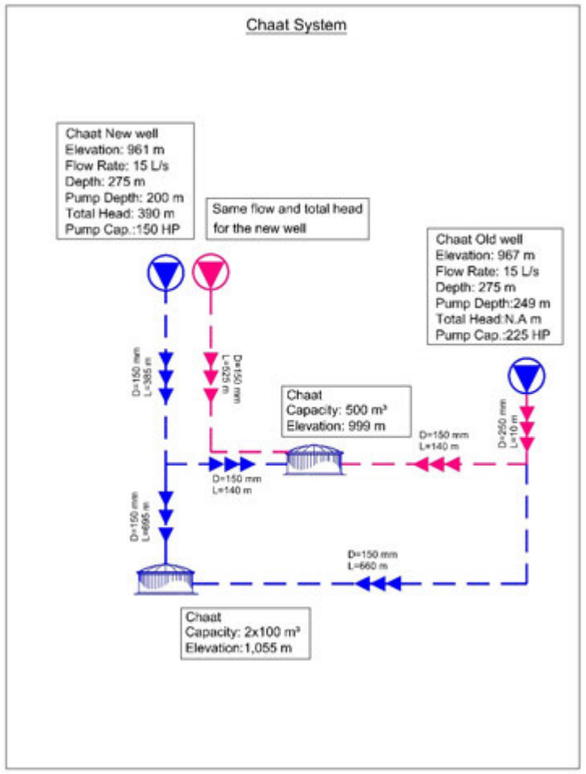


FIGURE 3-6: CHAAT SYSTEM

Chaat System is a combined system. The existing water transmission system will be used along with the new proposed system. The length of the existing water distribution network in Chaat system is around 19,598 m but these networks need replacement. The total length of proposed water distribution network will be around 24,812 m (for both Chaat and Rasm El Hadat).

System description:

Existing Chaat wells will pump water to both Chaat existing reservoirs (500 m³ and 2x100 m³) through 150 mm and 250 mm diameters existing and proposed pipes. Existing 150 mm diameter pipe will be replaced by 250 mm new one to minimize losses. By the year 2035, a new well with same capacity of the existing ones is needed to cover the water demand of the village.This well will feed individually the Chaat reservoir (500m³) through a 150 mm diameter proposed pipe. Both existing wells are in good condition. The existing reservoir (500 m³) is in good condition; however, the 200 m³ existing reservoir is old and it needs rehabilitation.

TABLE 3-7: SUMMARY OF WATER FACILITIES FOR CHAAT SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter		
Description	Existing100m³	Existing 500m³	Exsiting	Existing 150mm	Proposed 150mm	Proposed 250mm
Number/Length	2	1	2	1,880 m	665m	10m
Comments	---	Needs Rehabilitation	Drill a new well	---	---	---

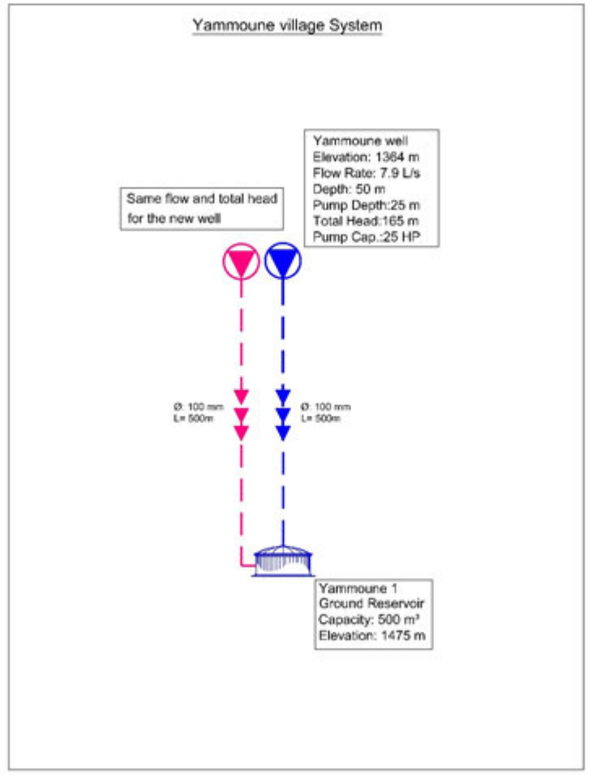


FIGURE 3-7: YAMMOUNE VILLAGE SYTEM

Yammoune village system is an existing system. The length of the existing water distribution network in Yammoune system is around 7,570 m. It is in good condition. The remaining length of proposed water distribution network will be around 760 m.

System description:

Existing Yammoune well will pump water to the existing reservoir (500m³) through a 100 mm diameter existing pipe and this reservoir will distribute water to Yammoune village. A new well needs to be drilled in year 2025 to cover the water demand of the village.

The existing well and reservoir (500m³) are in a good condition.

TABLE 3-8: SUMMARY OF WATER FACILITIES FOR YAMMOUNE VILLAGE SYSTEM BY YEAR 2035

System	Ground Reservoir	Well		Pipe Diameter	
Description	Existing (500m³)	Existing	Proposed	Existing 100 mm	Proposed 100 mm
Number/Length	1	1	1	500m	500m
Comments	---	---	---	---	---

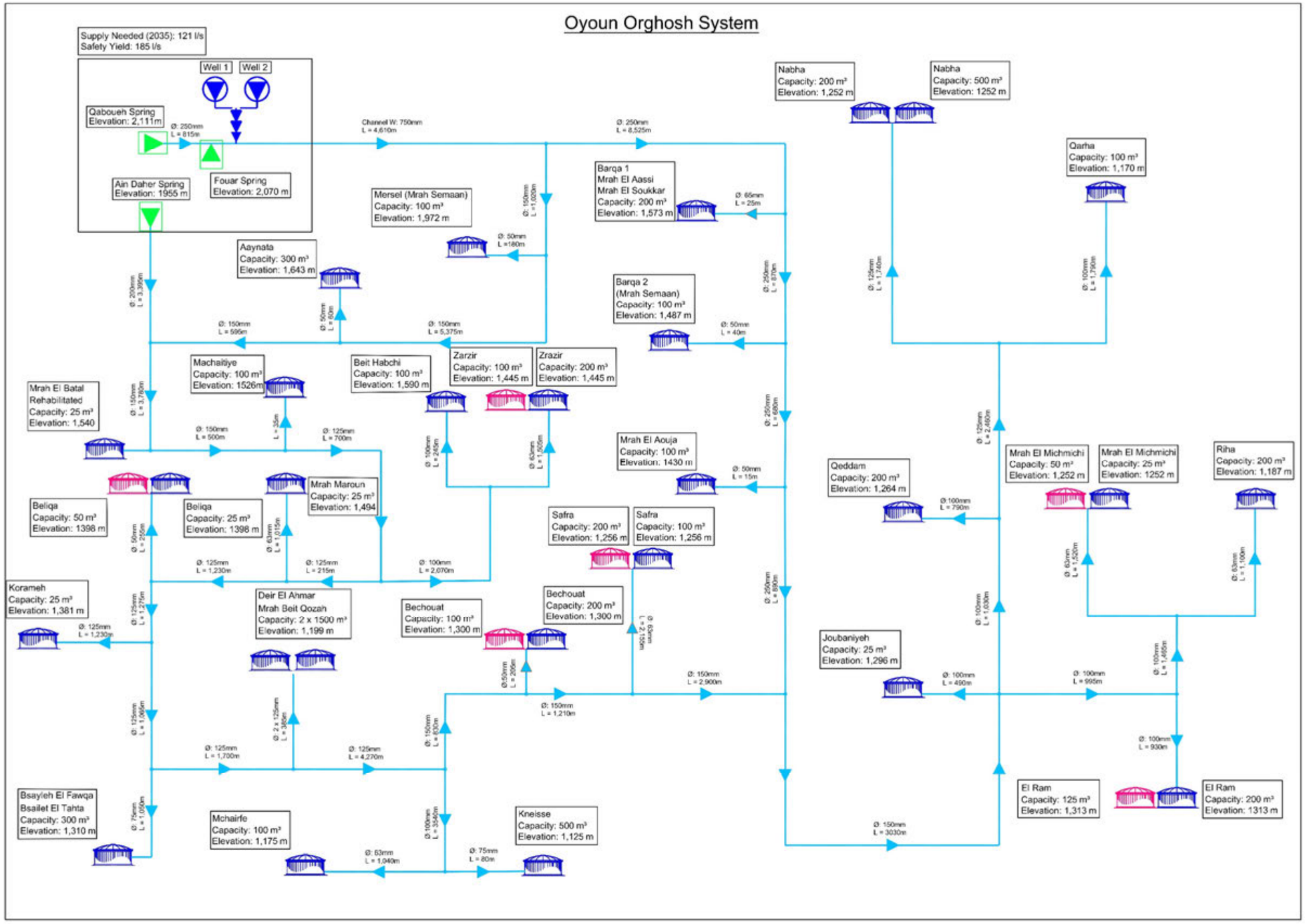


FIGURE 3-8: OUYOUN ORGHOSH SYSTEM

Oyoun Orghosh is an existing system, it will supply water by gravity to the area of north-west Baalbeck city.

Mrah Semaan, Aaynata, Machaitiye, Mrah El Batal, Beliqa, Mrah Maroun, Korameh, Deir El Ahmar, Bsayleh El Fawqa, Mchairfe, Kneisse, Bechouat, Safra, Beit Habchi, Zrazir, Barqa, Mrah El Aouja, Nabha, Qarha, Mrah El Michmichi, Qeddam, Joubaniyeh, El Ram, and Riha will be fed by gravity from Nabaa Al Qabboue, Fouar and Ain El Daher springs.

The existing transmission water system has been rehabilitated recently.

In some villages, the capacities of the reservoirs are increased to meet the population demand in year 2035.

This system is subjected to high pressure at its junctions due to the large difference in elevation between the source and the reservoirs. Thus, pressure break tanks are required for this system.

The adopted safe yield for Oyoun Orghosh springs is around 185 l/s. The supply is larger than the average daily demand of the villages served by the system in year 2035 which will be 121 l/s. Thus the system is acceptable.

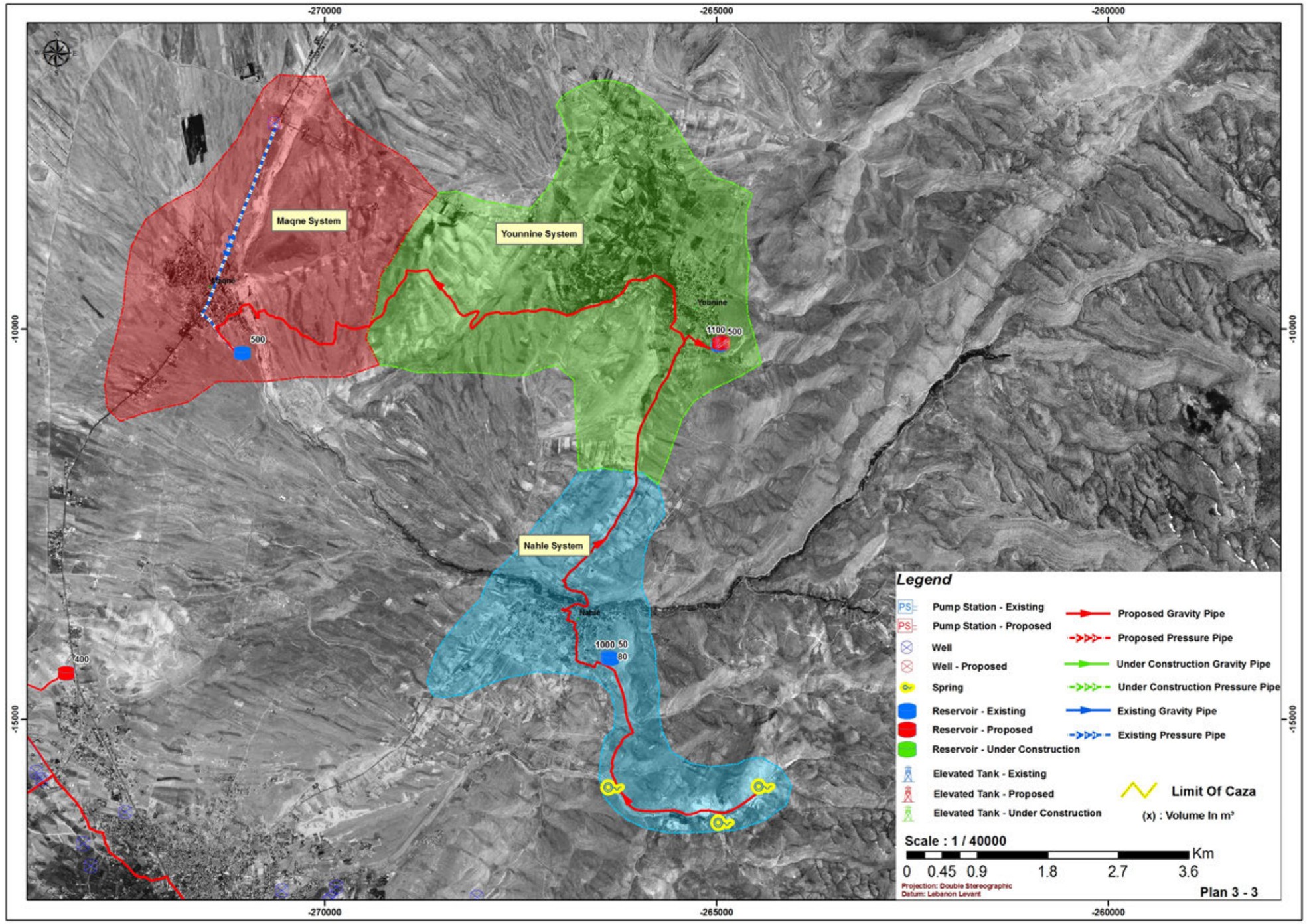
All existing small systems in the villages of Oyoun Orghosh system will be used as backup.

Aaynata and Beliqa existing reservoirs need rehabilitation; Korameh and Bechouat existing reservoirs need some minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 192,105 m.

TABLE 3-9: SUMMARY OF WATER FACILITIES FOR OYOUN ORGHOSH SYSTEM BY YEAR 2035

Oyoun Orghosh System							
Facility	**Status**	**Capacity (m^3)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	25	6	**Pipe**	*Gravity - Existing*	50	900
		100	8			63	5,740
		200	7			75	3,750
		300	2			100	13,345
		500	2			125	16,655
		1,500	2			150	19,240
	Proposed	50	2			200	3,395
		100	2			250	11,780
		125	1			750	4,610
		200	1				



PLAN 3-3: YOUNINE - MAQNE WATER SYSTEMS

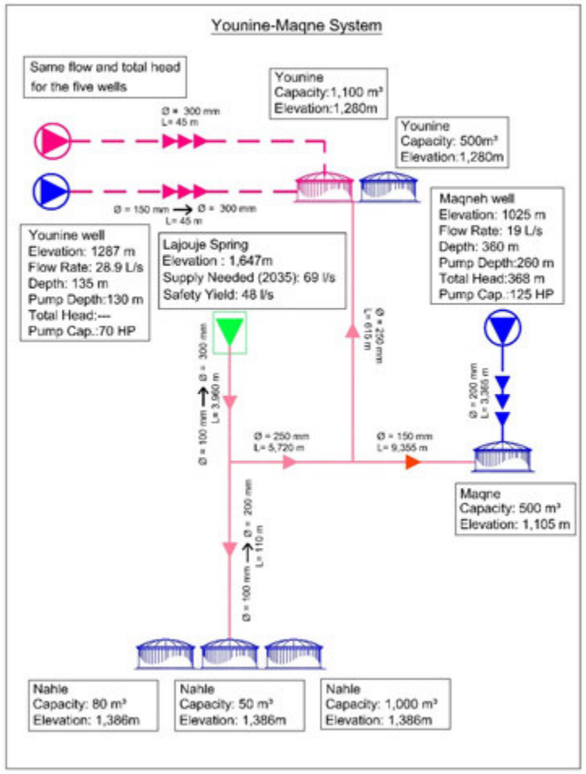


FIGURE 3-9: YOUNINE-MAQNE AND NAHLE SYSTEM

Younine-Maqne system is a combined system. It supplies Younine, Maqne and Nahle existing reservoir. The existing water system in Younine will be canceled and replaced with a new one. The existing water system in Maqne will be used alongside with the proposed system to meet the population water demand in year 2035.

The length of the existing water distribution network in Younine-Maqne system is around 55,455 m. 17,125 m length of water distribution network is in good condition but 38,333 m lengths are in bad condition and need rehabilitation. The total length of the proposed water distribution network for Younine – Maqne system will be around 64,375 m.

System description:

Existing Younine well will pump water to Younine existing and proposed reservoir (500 m^3 and 1000 m^3 respectively) through 300 mm proposed pipe diameter. Existing 150 mm pipe diameter will be replaced by 300 mm new one to minimize losses. By the year 2035, a new well with same capacity of the existing one is needed to cover the water demand of the village. This well will feed individually the proposed reservoir (1,100m^3) through a 300 mm proposed pipe diameter.

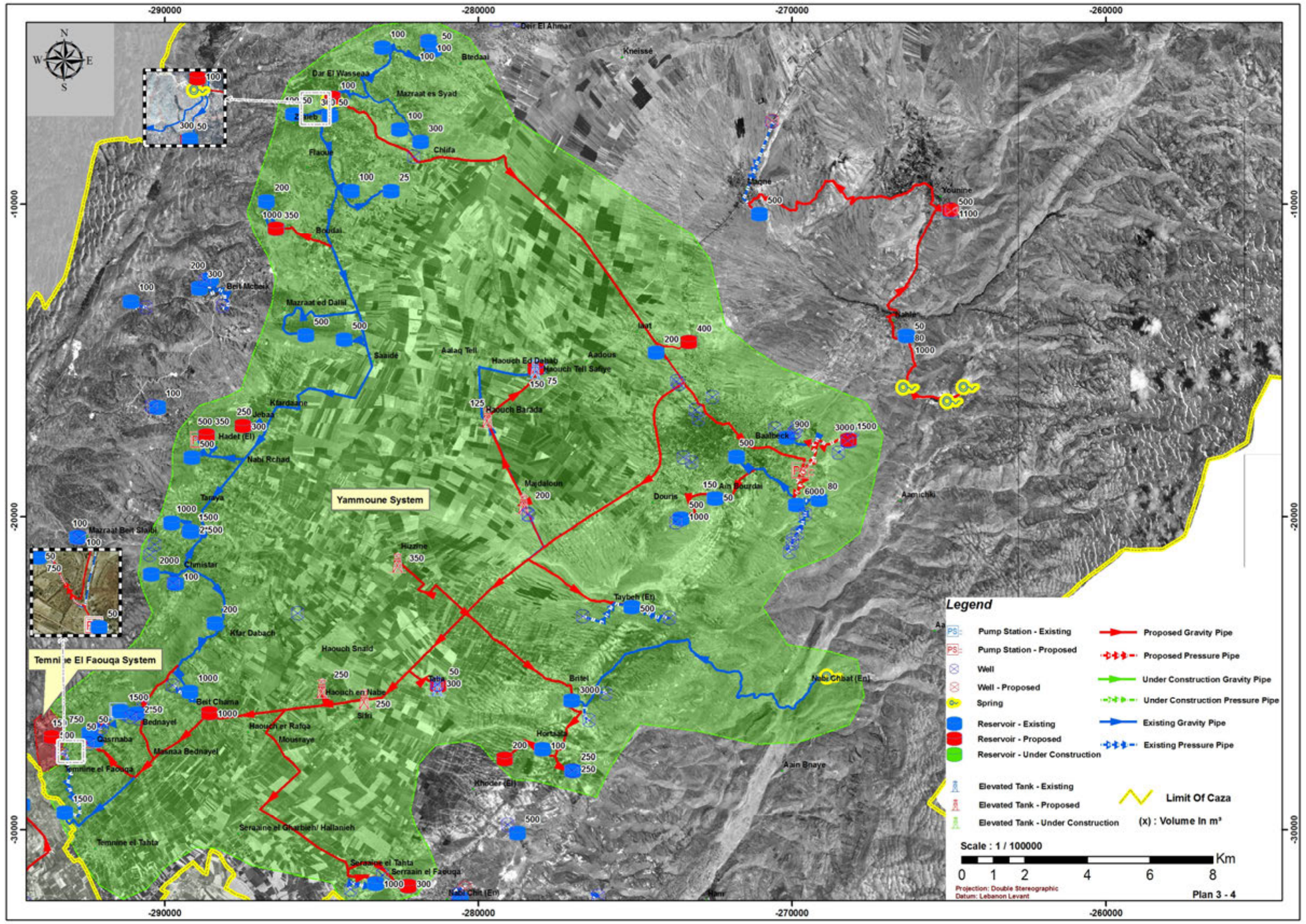
Existing Maqne well will pump water to Maqne existing reservoir (500m^3) through 200 mm diameter existing pipe.

Lajouje spring will supply water by gravity to Maqne, Younine and Nahle reservoirs (500 m^3, 500 m^3, and 1,000 m^3, 80 m^3, 50 m^3 and 1000 m^3 respectively), through 300 mm, 250 mm, 200 mm and 150 mm diameters proposed pipes. Existing 100 mm diameter pipe will be replaced by 300 mm and 200 mm new ones to minimize losses.

Existing wells are in good condition but redevelopment of existing well or drilling new well is needed to increase yield. All existing reservoirs are in good condition.

TABLE 3-10: SUMMARY OF WATER FACILITIES FOR YOUNINE-MAQNE AND NAHLE SYSTEM BY YEAR 2035

System	Ground Reservoir					Well		Pipe Diameter				
Description	Ex. 1000 m^3	Prop. 1,100 m^3	Ex. 500 m^3	Ex. 80 m^3	Ex. 50 m^3	Proposed	Ex.	Prop. 150mm	Prop. 200mm	Ex. 200mm	Prop. 250mm	Prop. 300mm
Number /Length	1	2	2	1	1	1	2	9,355 m	110m	3,365 m	6,335 m	4,050 m
Comments	---	---	---	---	---	Redevelopment or new well required	---	---	---	---	---	---



PLAN 3-4: YAMMOUNE WATER AND TEMNINE EL FAOUQA SYSTEMS

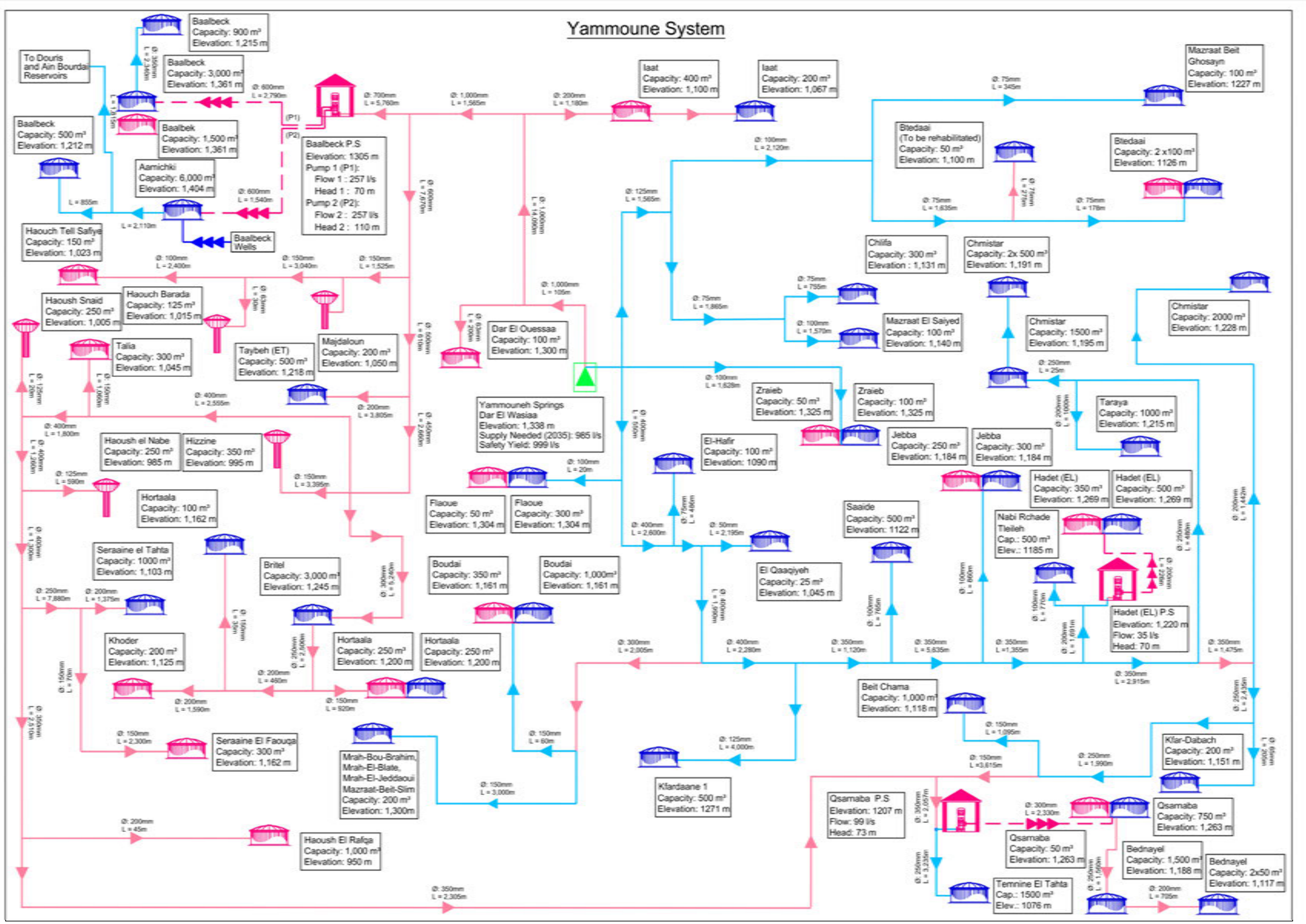


FIGURE 3-10: YAMMOUNE SYSTEM

Yammoune is a combined system, it will supply water by gravity to a large area of Baalbeck caza.

This system is divided into two large sub-systems that are connected together. The first system is the one existing with some minor proposed modifications and the second is a totally new proposed system.

Mazraat Beit Ghosayn, Btedaai, Chlifa, Chmistar, Mazraat El Saiyed, Zrayeb, Taraya, Jebaa, El Hafir, Hadet (EL), Nabi Rchade, Saaide, Qaaqiyeh, Beit Chama, Kfar-dabach, Qsarnaba, Temnine El Tahta, Bednayel, Iaat, Dar El Ouessaa, Flaoue, Boudai, Hortaala, Kfardnaane, Haouch El Rafqa, Mrah Bou Brahim, Mrah El Blat, Mrah El Jeddaoui, Mazraat Beit Slim, Seraaine El Faouqa, Khoder, Britel, Seraaine El Tahta, Haouch El Nabe, Hizzine, Taybeh (ET), Talia, Haouch Barada, Haouch Snaid, Haouch Tell Safiye, Aamichki, Majdaloun, and Baalbeck will be fed from Yammoune springs.

The existing transmission water system has been rehabilitated recently.

In some villages, the capacities of the reservoirs are increased to meet the population demand in year 2035.

Replacement of some pipes was proposed for the proper operation of the network and to avoid high losses.

Some booster pump stations were suggested to pump water to higher areas and they are the following:

- Baalbeck P.S (2 pumps, Flow 1: 257 l/s, Flow 2 : 257 l/s, Head 1: 70 m, and Head 2 : 110 m);
- Qsarnaba P.S (Flow: 99 l/s, Head: 73 m);
- Hadet (El) P.S (Flow: 35 l/s, Head: 70 m);

The adopted safe yield for Yammoune springs is around 999 l/s. The supply is larger than the average daily demand of the villages served by the system in year 2035 which will be 985 l/s. Thus the system is acceptable.

All existing small systems in the villages of Yammoune system will be used as backup.

Zraeib and Btedaii (50 m³) existing reservoirs need rehabilitation; Baalbeck (900 m³ and 500 m³) and Hortaala (250 m³) existing reservoirs need some minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 506,117 m.

TABLE 3-11: SUMMARY OF WATER FACILITIES FOR YAMMOUNE SYSTEM BY YEAR 2035

Yammoune System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number / Length (m)**
Ground Reservoir	*Existing*	25	1	**Pump Station**	*Proposed*	---	4
		50	3	**Pipe**	*Gravity - Existing*	50	2,195
		100	6			63	2,075
		200	3			75	5,539
		250	1			100	4,535
		300	3			125	5,565
		500	8			150	4,155
		750	1			200	4,133
		900	1			250	8,165
		1,000	4			350	13,365
		1,500	3			400	7,420
		2,000	1		*Gravity- Proposed*	63	230
		3,000	2			100	2,400
		6,000	1			125	610
	Proposed	50	3			150	15,960
		100	2			200	9960
		150	1			250	11,940
		200	1			300	7,245
		250	2			350	8,347
		300	2			400	6,915
		350	2			450	2,660
		400	1			500	610
						600	7,670
		1000	1			700	5,760
		1,500	1			1000	15,760
Elevated Tank	*Proposed*	125	1		*Pressurized - Existing*	350	2,340
		200	1		*Pressurized - Proposed*	200	226
		250	2			300	2,330
		350	1			600	4330

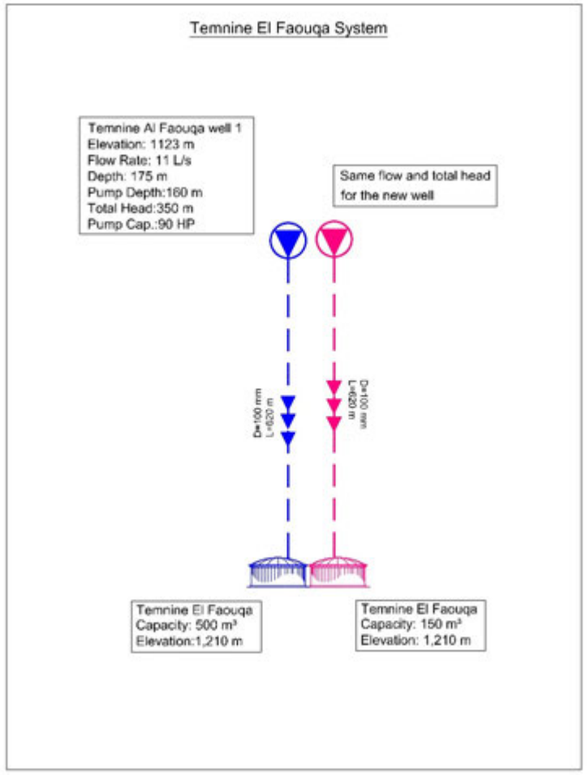


FIGURE 3-11: TEMNINE AL FAOUQA SYSTEM

Temnine Al Faouka System is a combined system. The existing water system in Temnine Al Faouka will be used alongside with the proposed system. The length of the existing water distribution network in Temnine Al Faouka system is around 16,882 m and it is in good condition. The remaining length of proposed water distribution network will be around 1,688 m.

System description:

Existing Temnine Al Faouka well will pump water to both Temnine Al Faouka existing and proposed reservoirs (500 m³ and 150 m³ respectively) through 100 mm diameter proposed pipe. By the year 2035, a new well with same capacity of the existing one is needed to cover the water demand of the village. This well will feed individually the proposed reservoir (150m³) through a 100 mm proposed pipe diameter. The existing well and reservoir are in good condition.

TABLE 3-12: SUMMARY OF WATER FACILITIES FOR TEMNINE AL FAOUKA SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter	
Description	Proposed 150m³	Existing 500m³	Existing	Proposed 100mm	Existing 100mm
Number/Length	1	1	1	620m	620m
Comments	---	---	Drill a New Well	---	---

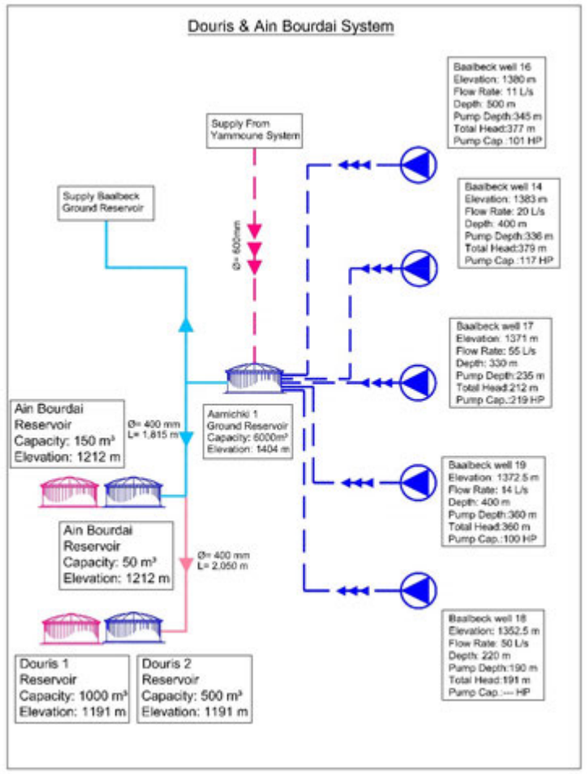


FIGURE 3-12: DOURIS AND AIN BOURDAI SYSTEM

Douris and Ain Bourdai System is an existing system. The length of the existing water distribution network in this system is around 64,300 m and it is in good condition. The remaining length of proposed water distribution network will be around 18,769 m.

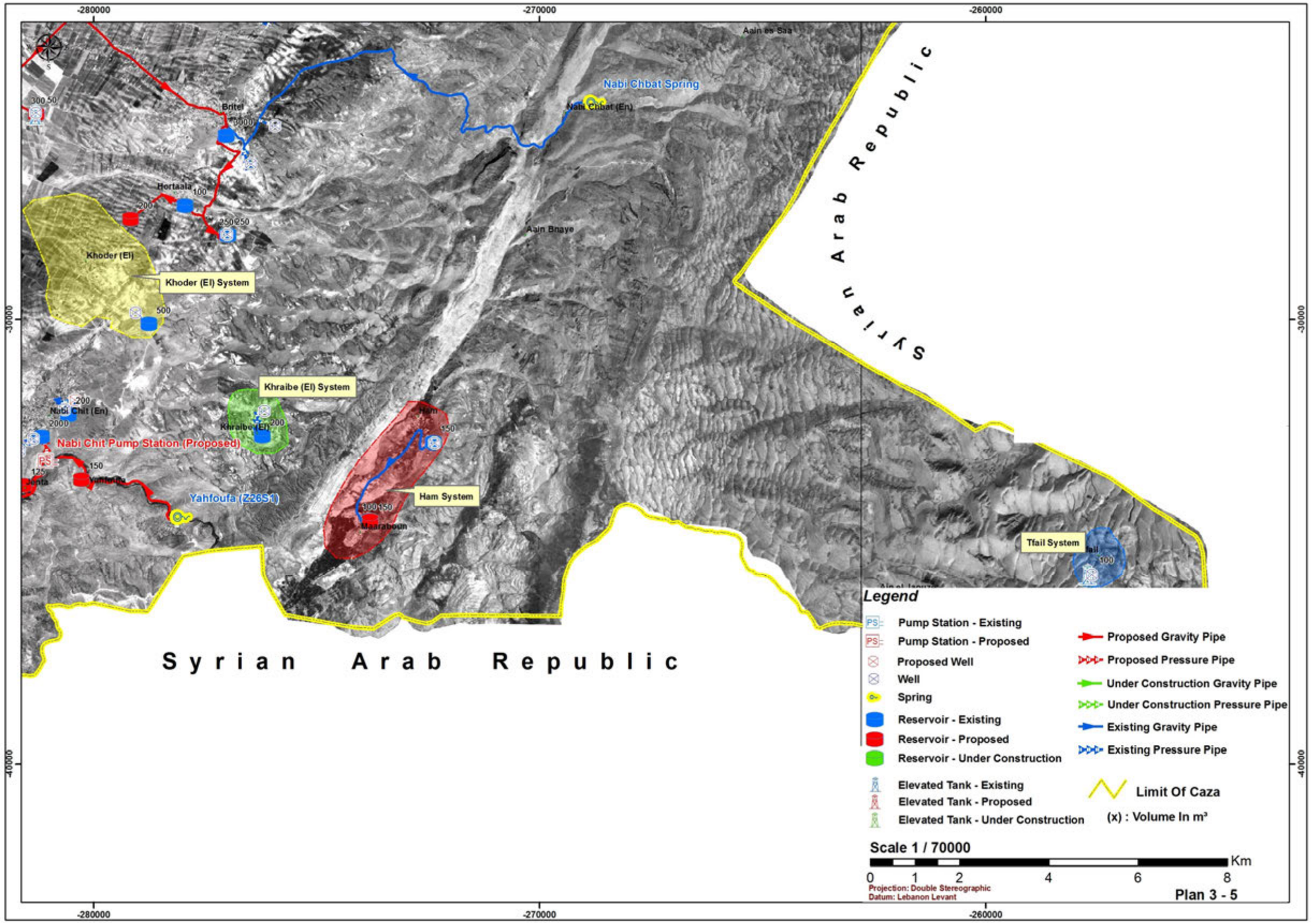
System description:

Existing Baalbeck wells will pump water to Aamichki existing reservoir and this one will distribute water to Ain Bourdai existing and proposed reservoirs (50 m³ and 150 m³ respectively) and to Douris proposed and existing reservoirs (1000 m³ and 500 m³) through a proposed and existing transmission pipe system.

The existing wells are in acceptable condition but Ain Bourdai existing reservoir is in bad condition and it needs rehabilitation.

TABLE 3-13: SUMMARY OF WATER FACILITIES FOR DOURIS AND AIN BOURDAI SYSTEM BY YEAR 2035

System	Ground Reservoir				Well	Pipe Diameter
Description	Proposed 150m³	Existing 50m³	Proposed 1000m³	Existing 500m³	Existing	Proposed
Number/Length	1	1	1	1	5	2050m
Comments	---	Needs Rehabilitation	---	---	---	---



PLAN 3-5: HAM, KHRAIBE, KHODER, AND TFAIL WATER SYSTEMS

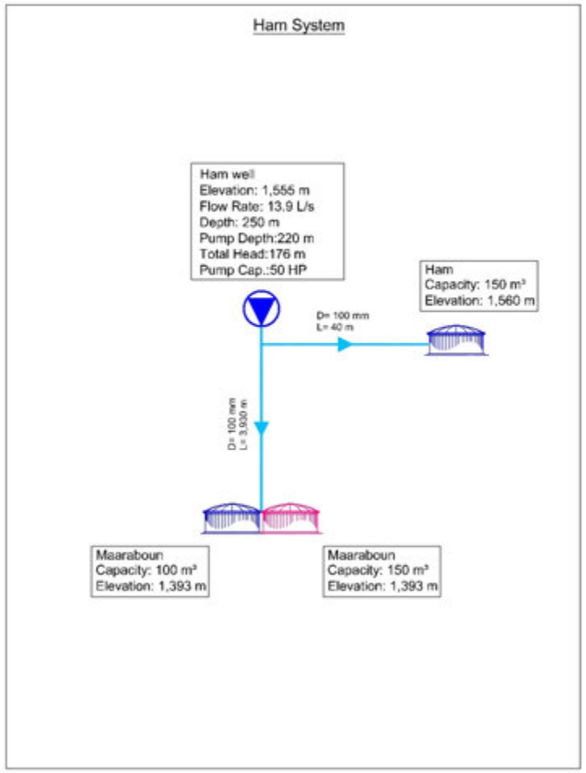


FIGURE 3-13: HAM SYSTEM

Ham System is an existing system. Ham well supplies water to Maaraboun and Ham reservoirs. The existing water transmission system in Ham will be adopted. The length of the existing water distribution network in Ham system is around 11,880 m. 4,260 m length of water distribution network is in good condition but 7,265 m length are in bad condition and need replacement. The total length of the proposed water distribution network for Ham system will be around 13,066 m.

System description:

Ham well supplies water to Maaraboun and Ham existing and proposed reservoirs (100 m³, 150 m³ and 150 m³ respectively), through 100 mm diameter existing pipe. The existing well and reservoirs are in good condition.

TABLE 3-14: SUMMARY OF WATER FACILITIES FOR HAM SYSTEM BY YEAR 2035

System	Ground Reservoir			Well	Pipe Diameter
Description	Proposed 150m³	Existing 100m³	Existing 150m³	Existing	Existing 100mm
Number/Length	1	1	1	1	3,970m
Comments	---	---	---	---	---

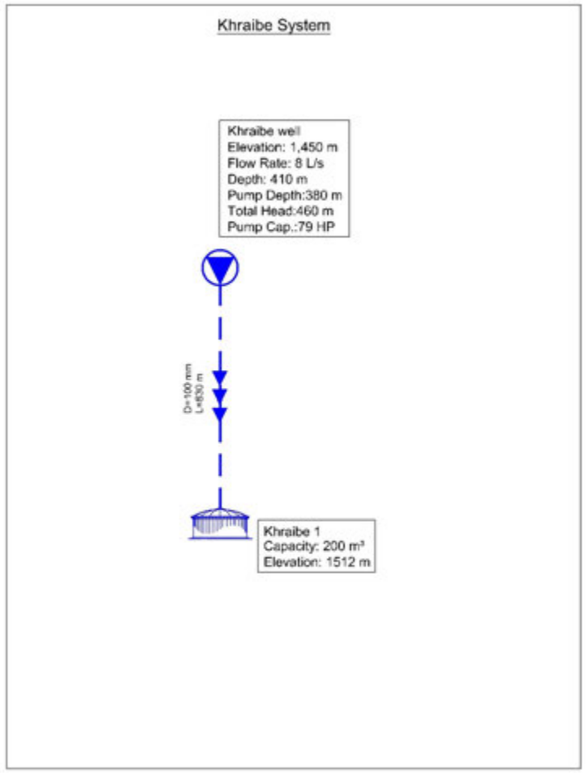


FIGURE 3-14: KHRAIBE SYSTEM

Khraibe System is an existing system. The existing water system in Khraibe will be adopted. The length of the existing water distribution network in Khraibe is around 7,395m and it is in bad condition. The total length of proposed water distribution network for Khraibe will be around 8,134 m.

System description:

Existing Khraibe well will pump water to Khraibe existing reservoir (200 m³) through 100 mm diameter existing pipe. The existing well and reservoir are in good condition.

TABLE 3-15: SUMMARY OF WATER FACILITIES FOR KHRAIBE SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 200m³	Existing	Existing 100mm
Number/Length	1	1	830m
Comments	---	---	---

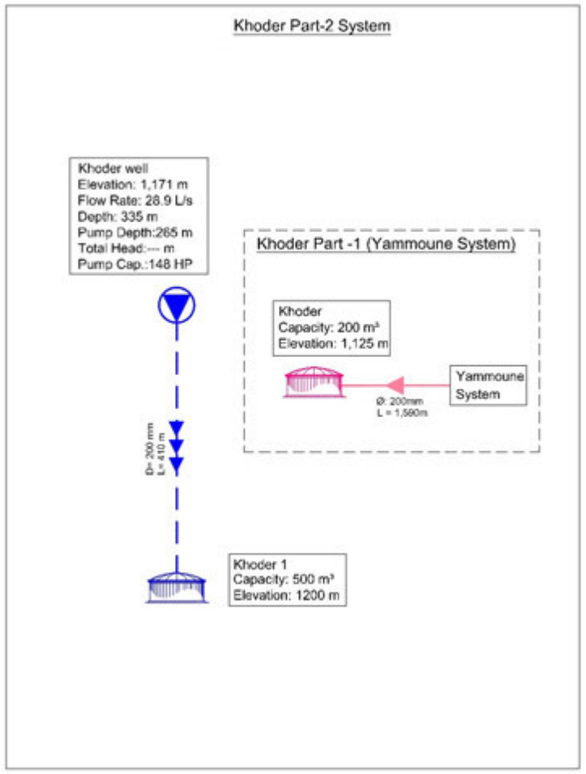


FIGURE 3-15: KHODER PART-2 SYSTEM

Khoder Part -2 System is an existing system. The existing water transmission system in Khoder will be adopted. The length of the existing water distribution network in Khoder is around 10,473 m length and it is in good condition. The remaining length of proposed water distribution network will be around 1,047 m (for Both Khoder part 1 and 2 systems).

System description:

Existing Khoder well will pump water to Khoder existing reservoir (500 m³) through 200 mm diameter existing pipe. The existing well and reservoir are in good condition.

TABLE 3-16: SUMMARY OF WATER FACILITIES FOR KHODER PART – 2 SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 500m³	Existing	Existing 200mm
Number/Length	1	1	410m
Comments	---	---	---

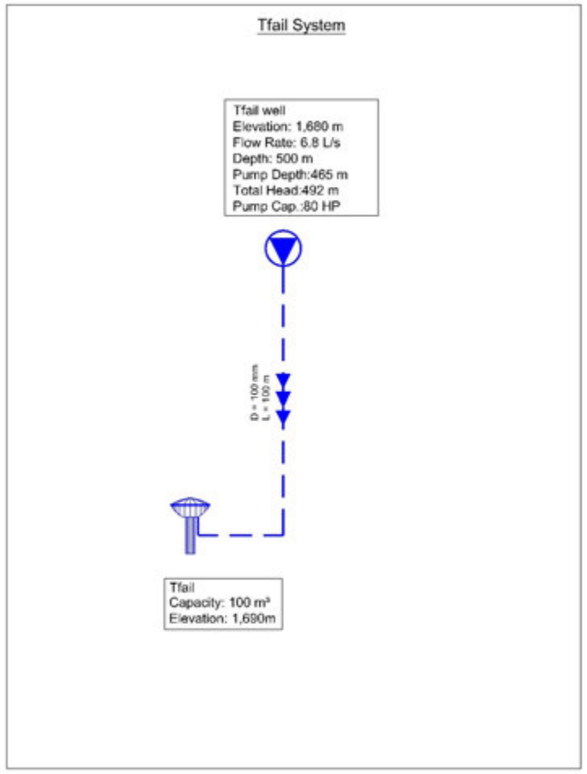


FIGURE 3-16: TFAIL SYSTEM

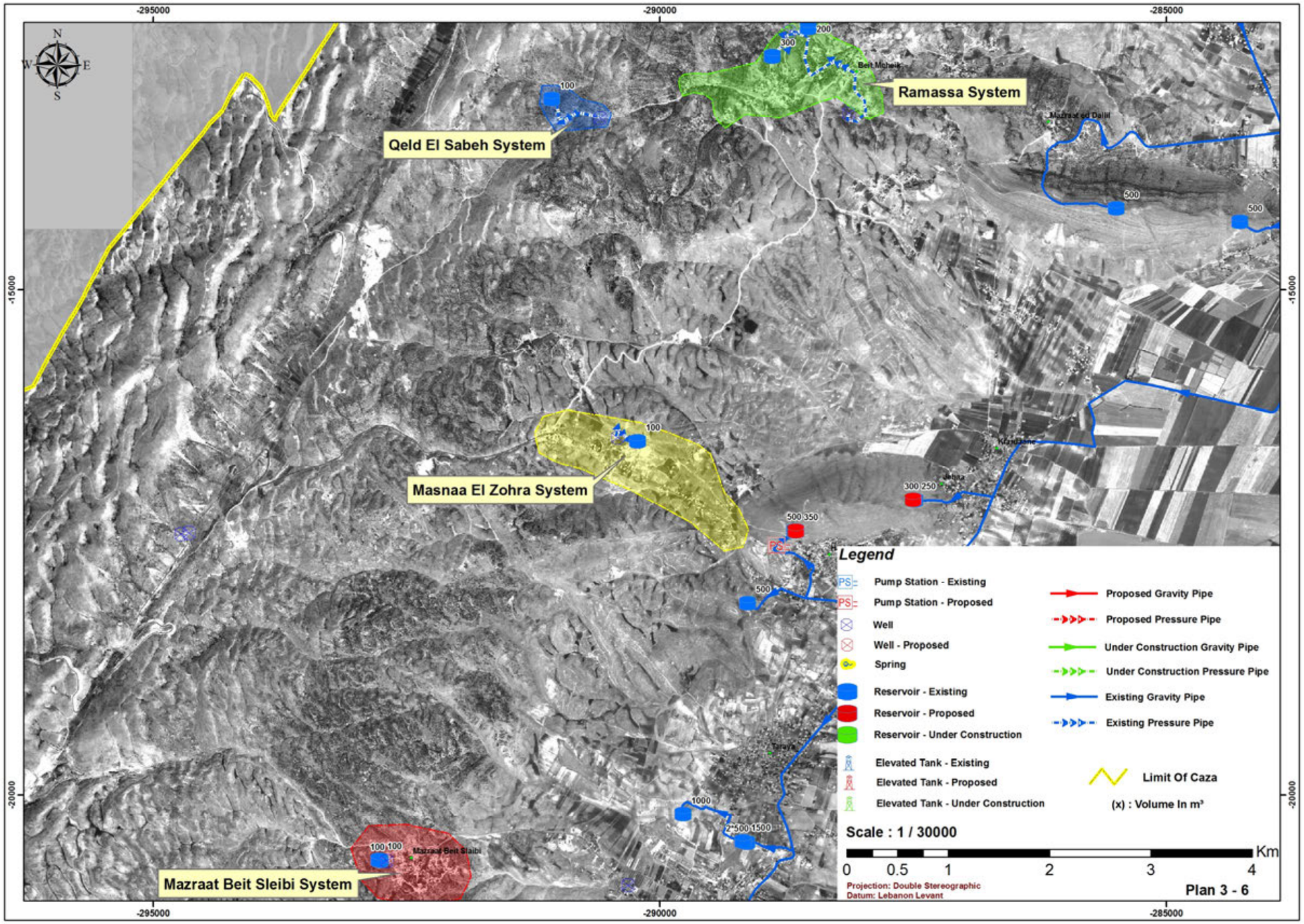
Tfail System is an existing system. The existing water transmission system in Tfail will be adopted. The length of the existing water distribution network in Tfail is around 5,988 m and it is in bad condition. The total length of proposed water distribution network for Tfail will be around 6,587 m.

System description:

Existing Tfail well will pump water to Tfail existing elevated tank (100 m³) through a 100 mm diameter existing pipe. The existing well and elevated tank are in good condition.

TABLE 3-17: SUMMARY OF WATER FACILITIES FOR TFAIL SYSTEM BY YEAR 2035

System	Elevated Tank	Well	Pipe Diameter
Description	Existing 100m³	Existing	Existing 100mm
Number/Length	1	1	100m
Comments	---	---	---



PLAN 3-6: MASNAA EL ZOHRA, MAZRAAT BEIT SLEIBI, QELD EL SABEH AND RAMASSA WATER SYSTEMS

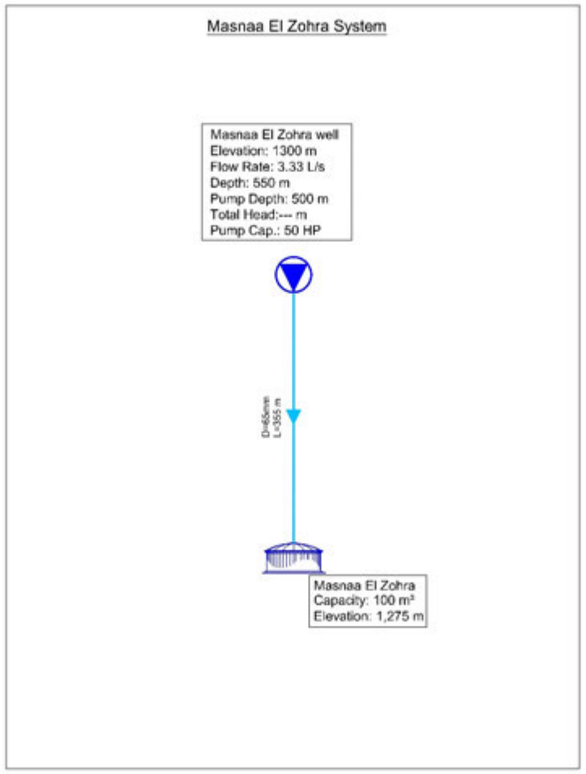


FIGURE 3-17: MASNAA EL ZOHRA SYSTEM

Masnaa El Zohra System is an existing system. Masnaa El Zohra village is inside the cadastral area of Hadet (El) village; the total length of proposed water distribution network for Hadet (El) will be around 36,635 m (for both Hadet (El) and Masnaa El Zohra localities).

System description:

The existing well will be equipped to supply water to Masnaa El Zohra existing reservoir (100 m³) through 65 mm diameter existing pipe. The existing well and reservoir are in good condition.

TABLE 3-18: SUMMARY OF WATER FACILITIES FOR MASNAA EL ZOHRA SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 100m³	Existing	Existing 65mm
Number/Length	1	1	355m
Comments	---	---	---

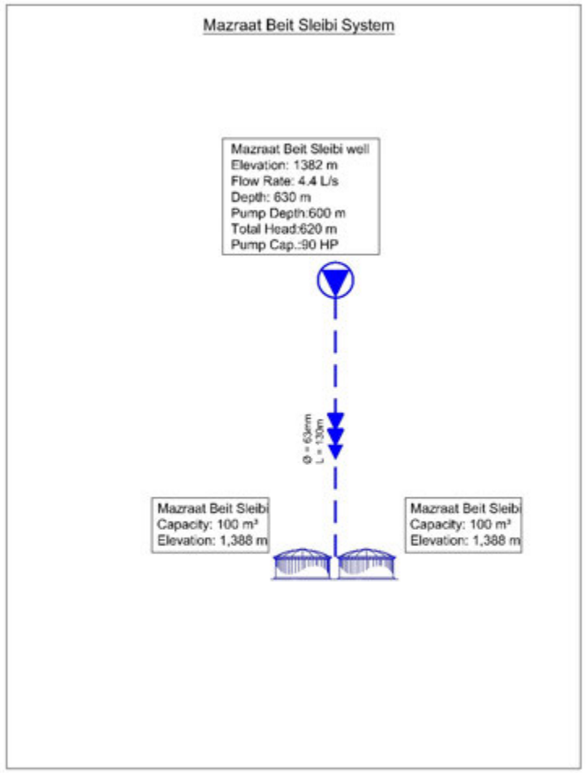


FIGURE 3-18: MAZRAAT BEIT SLEIBI SYSTEM

Mazraat Beit Sleibi system is an existing system. The length of the existing water distribution network of Mazraat Beit Sleibi is around 9,306 m but its condition is unknown. The total length of proposed water distribution network for Mazraat Beit Sleibi will be around 10,237 m.

System description:

Mazraat Beit Sleibi existing well will pump water to Mazraat Beit Sleibi existing reservoirs (100 m³) through 63 mm diameter proposed pipe. The existing well and reservoir are in good condition.

TABLE 3-19: SUMMARY OF WATER FACILITIES FOR MAZRAAT BEIT SLEIBI SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 100m³	Existing	Existing 63mm
Number/Length	2	1	130m
Comments	---	---	---

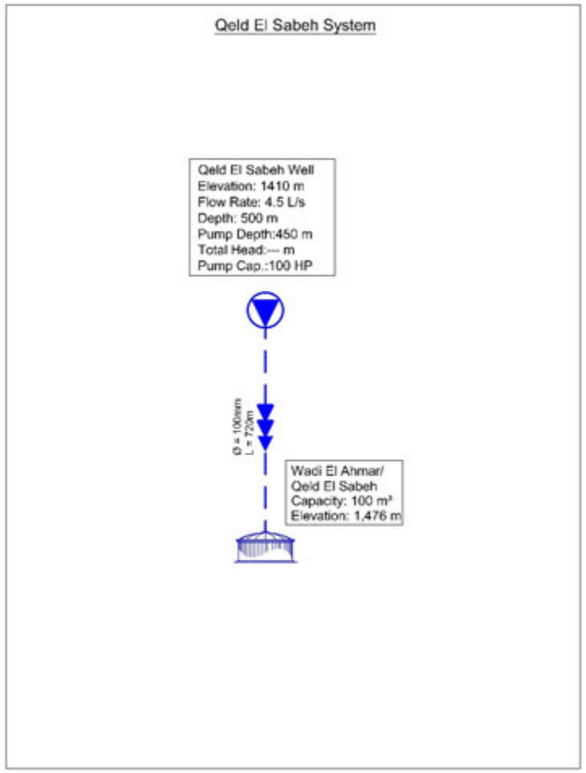


FIGURE 3-19: QELD EL SABEH SYSTEM

Qeld El Sabeh System is an existing system. The existing water transmission system in Qeld El Sabeh will be adopted. Qeld El Sabeh village is inside the cadastral area of Hadet (El) village; thus its length of proposed distribution network is counted with Hadet (El). The total length of proposed water distribution network for Qeld El Sabeh will be around 2,558 m.

System description:

Existing Qeld El Sabeh well will pump water to Wadi El Ahmar and Qeld el Sabeh existing reservoir (100 m³) through 100 mm diameter existing pipe. The existing well and reservoir are in good condition.

TABLE 3-20: SUMMARY OF WATER FACILITIES FOR QELD EL SABEH SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 100m³	Existing	Existing 100mm
Number/Length	1	1	720m
Comments	---	---	---

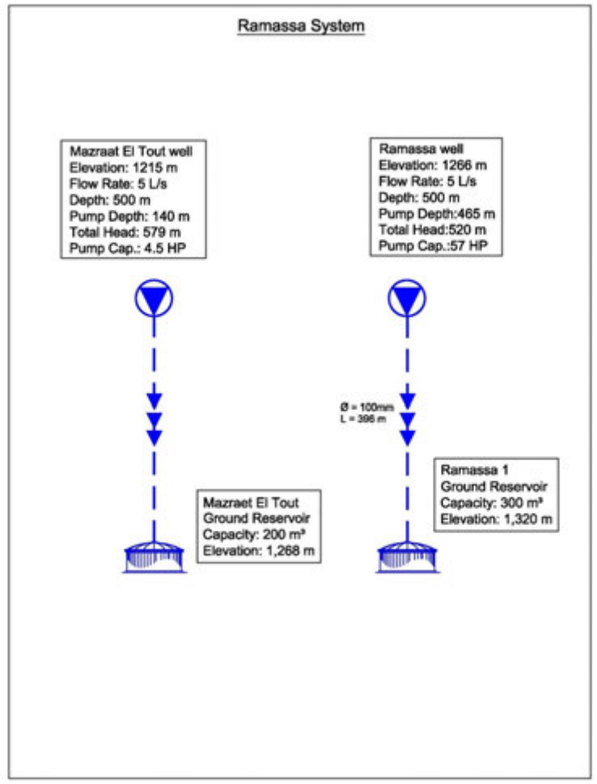


FIGURE 3-20: RAMASSA SYSTEMS

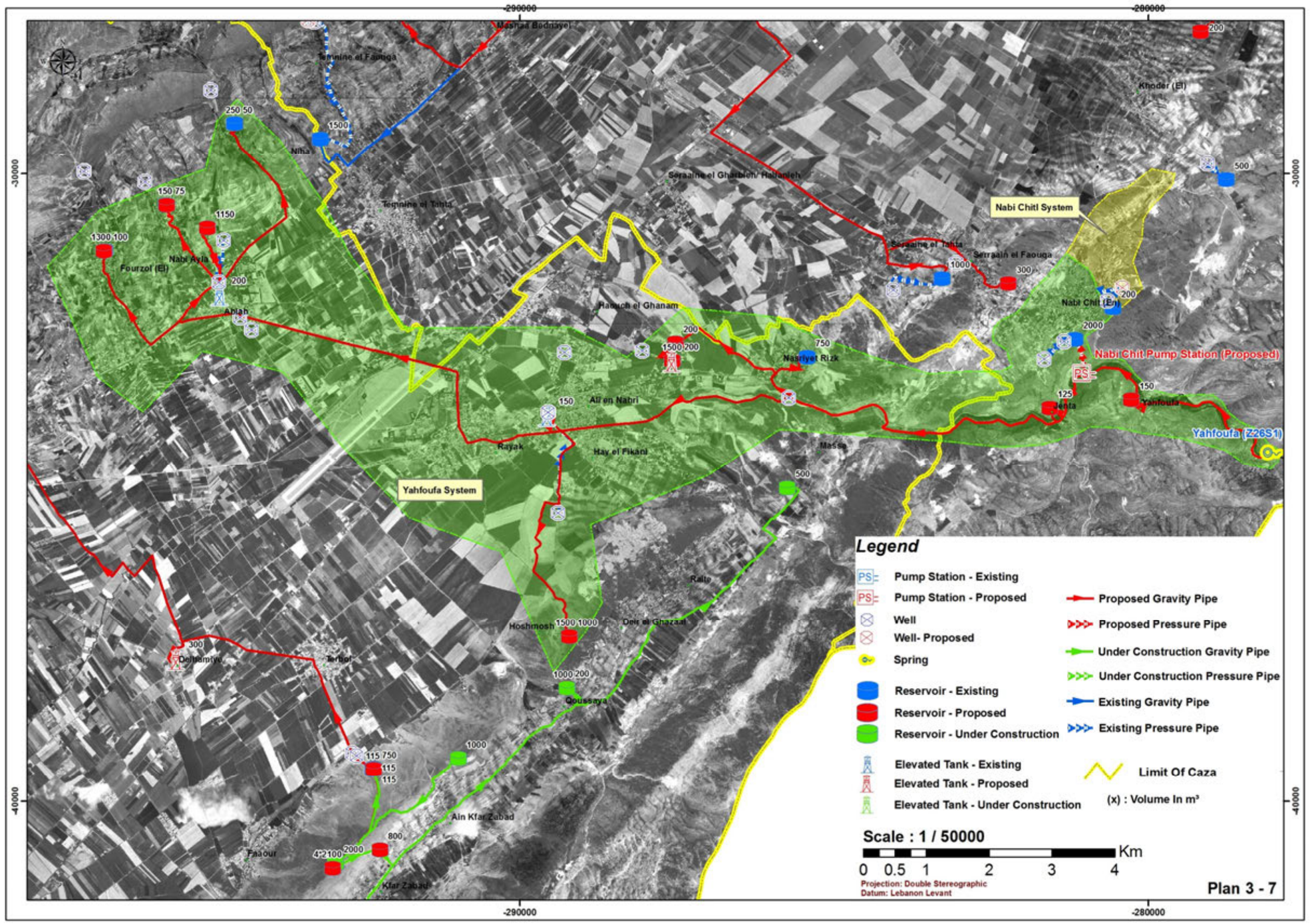
Ramassa System is an existing system. The existing water transmission system in Ramassa will be adopted. Ramassa village is inside the cadastral area of Boudai village; thus its length of proposed distribution network is counted with Boudai. The total length of proposed water distribution network for Ramassa will be around 2,558 m.

System description:

Existing Ramassa and Mazraat el Tout wells will pump water to Ramassa and Mazraat el Tout existing reservoirs (300 m³ and 200 m³ respectively) through 100 mm diameter existing pipe. The existing wells and reservoirs are in good condition.

TABLE 3-21: SUMMARY OF WATER FACILITIES FOR RAMASSA SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter
Description	Existing 200m³	Existing 300m³	Existing	Existing 100mm
Number/Length	1	1	2	396m
Comments	---	---	---	Mazraat El Tout Transmission Line is unknown



PLAN 3-7: YAHFOUFA AND NABI CHIT WATER SYSTEMS

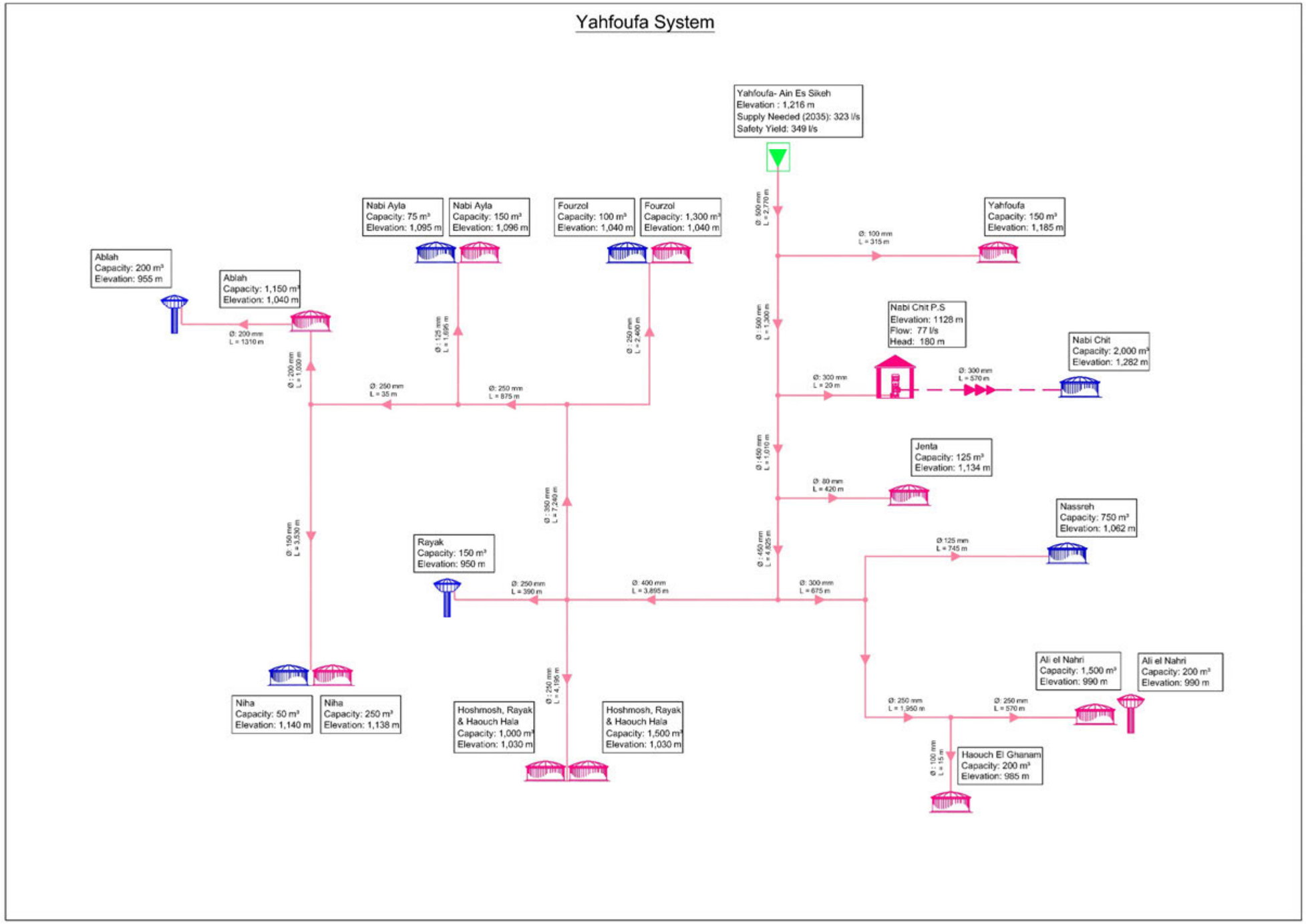


FIGURE 3-21: YAHFOUFA SYSTEM

Yahfoufa is a proposed system; it will supply water by gravity to an area of south Baalbeck and north Zahle cazas.

The main water source for this system is Yahfoufa- Ain Es Sikeh spring.

It will supply water by gravity to Yahfoufa, Nabi Chit, Jenta, Nassreh, Ali el Nahri, Haouch El Ghanam, Rayak, Hoshmosh and Haouch Hala, Niha, Fourzol, Nabi Ayla, and Ablah.

One booster pump is needed in this system which is Nabi Chit pump station (flow = 77 l/s and head = 180 m).

The adopted safe yield for Yahfoufa- Ain Es Sikeh Spring is around 349 l/s. The supply is larger than the average daily demand of the villages served by this system in year 2035 which will be 323 l/s. Therefore, the system is acceptable.

All existing small systems in the villages of Yahfoufa system will be used as backup.

Ablah existing elevated tank and Nassreh existing reservoir need rehabilitation; Rayak existing elevated tank needs minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 114,937m.

TABLE 3-22: SUMMARY OF WATER FACILITIES FOR YAHFOUFA SYSTEM BY YEAR 2035

Yahfoufa System							
Facility	**Status**	**Capacity (m^3)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	50	1	**Pump Station**	*Proposed*	---	1
		75	1	**Pipe**	*Gravity - Proposed*	80	420
		100	1			100	330
		750	1			125	2,440
		2,000	1			150	3,530
	Proposed	125	1			200	2,340
		150	2			250	10,055
		200	1			300	695
		250	1			350	7,630
		1000	1			400	3,895
		1,150	1			450	5,835
		1,300	1			500	4,070
		1,500	2		*Pressurized - Proposed*	300	570
Elevated Tank	*Existing*	150	1				
		200	1				
	Proposed	200	1				

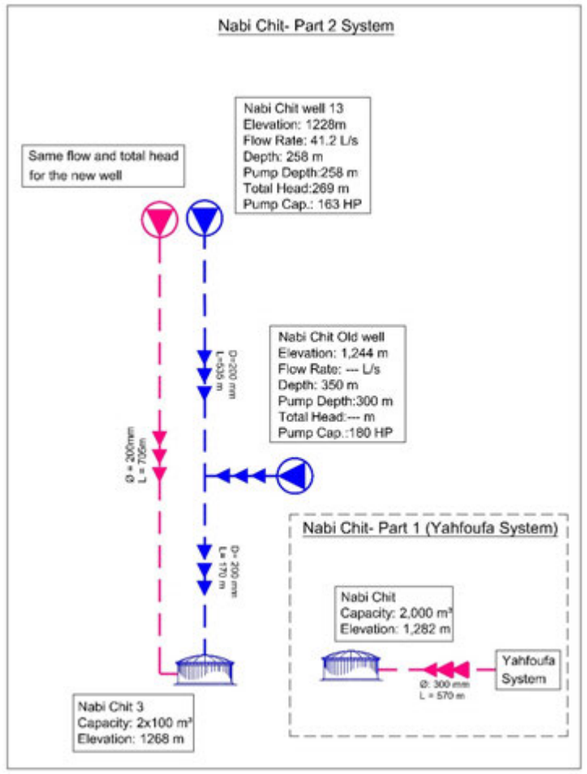


FIGURE 3-22: NABI CHIT PART- 2 SYSTEM

Nabi Chit Part -2 System is a combined system. The existing water transmission system in Nabi Chit will be adopted. The length of the existing water distribution network in Nabi Chit system is around 34,325 m and it is in good condition. The remaining length of proposed water distribution network will be around 3,434 m for both systems Nabi Chit 1 and 2.

System description:

Existing Nabi Chit well 13 and Nabi Chit Old well will pump water to Nabi Chit existing reservoir (2x100m^3) through 200 mm diameter existing pipe. By the year 2035, a new well with same capacity of the existing ones is needed to cover the water demand of the village. This well will feed individually the existing reservoir through a 200 mm diameter proposed pipe. The existing well Nabi Chit 13 is in good condition. However, the existing reservoir is in bad condition and it needs reconstruction or rehabilitation.

TABLE 3-23: SUMMARY OF WATER FACILITIES FOR NABI CHIT PART -2 SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter	
Description	Existing 100m^3	Existing	Proposed 200mm	Existing 200mm
Number/Length	2	2	705m	705m
Comments	Need rehabilitation	Drill a New Well	---	---

3.3 Spring Water Supply vs Demand for Baalbeck Regional Systems

TABLE 3-24: SPRING WATER SUPPLY VS DEMAND FOR REGIONAL SYSTEMS IN BAALBECK CAZA

System	Average Demand Flow (Year 2013) (l/s)	Average Demand Flow (Year 2025) (l/s)	Average Demand Flow (Year 2035) (l/s)	Average Yearly Flow (Reference) (l/s)	Adopted Safe (Dry Year) Yield Flow (l/s)	System Status	Comments
Yahfoufa System	221	272	323	940 (LRA [2002-2013])	**349**	Proposed	Adopted water quantity is more than water demand - System is Ok
Younine-Maqne System	47	58	69	95 (LRA)	**48**	Proposed / Existing	Adopted water quantity is less than water demand - System is not OK - Extra needed value can be supplied from Wells
Laboue System	180	222	269	1,005 (LRA [1960-1968])	**502**	Proposed	Adopted water quantity is more than water demand - System is Ok
Yammoune System	678	835	993	1,998 (LRA)	**999**	Proposed / Existing	Adopted water quantity is more than water demand - System is Ok
Oyoun Orghosh System	83	102	121	369 (LRA)	**185**	Existing	Adopted water quantity is more than water demand - System is Ok

* The adopted safe (dry year) yield flow is the average yearly flow / 2.

3.4 Summary of Water Facilities for the Systems of Baalbeck Caza by Year 2035

TABLE 3-25: NUMBER OF RESERVOIRS IN CAZA OF BAALBECK

Reservoir Facility	Volume (m^3)																									Total	Total Storage (m^3)
	25	50	75	80	100	125	150	200	250	300	350	400	500	750	900	1000	1100	1150	1200	1250	1300	1500	2000	3000	6000		
Reservoir - Existing	7	7	2	1	27	-	1	18	1	8	1	-	22	3	1	7	-	-	2	-	-	11	2	2	1	124	66,255
Reservoir - Proposed	-	5	-	-	5	2	7	4	4	2	2	1	-	-	-	3	2	1	-	-	1	3	-	-	-	42	17,700
Elevated Tank - Existing	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	450
Elevated Tank - Proposed	-	-	-	-	1	1	-	2	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1,875
Total	**7**	**12**	**2**	**1**	**34**	**3**	**9**	**25**	**7**	**10**	**4**	**2**	**22**	**3**	**1**	**10**	**2**	**1**	**2**	**-**	**1**	**14**	**2**	**2**	**1**	**177**	**86,280**

TABLE 3-26: NUMBER OF WELLS USED IN CAZA OF BAALBECK

Village Name	Existing well	Proposed well
Aarsal	4	9
Harbata and Sbouba	1	2
Harfouch and Qlaile	1	---
Chaat	2	1
Temnine Al Faouka	1	1
Ham and Maaraboun	1	---
Khraibe	1	---
Khoder	1	---
Tfail	1	---
Masnaa El Zohra	1	---
Mazraat Beit Sleibi	1	---
Qeld El Sabeh	1	---
Ramassa	2	---
Nabi Chit	1	1
Douris and Ain Bourdai	5	---
Yammoune	1	1
Wadi Faara	1	---
Total	**26**	**15**

TABLE 3-27: CHARACTERISTICS OF PROPOSED PUMP STATIONS IN CAZA OF BAALBECK

Pump Station Name	Status	Ground Elevation (m)	Capacity Needed in year 2035 (L/s)	Total Head Needed (m)
Laboue	Proposed- Booster set 2	910	90	270
	Proposed- Booster set 3		270	100
Ain (EL)	Proposed- Booster	918	79	265
Moqraq	Proposed- Booster	1014	76	80
Fekehe	Proposed- Booster	957	80	220
Qaa	Proposed- Booster	670	50	250
Hadet (EL)	Proposed- Booster	1,220	35	70
Qsarnaba	Proposed- Booster	1,207	99	73
Baalbeck	Proposed- Booster - Set 1	1,305	257	70
	Proposed- Booster - Set 2	1,305	257	110
Nabi Chit	Proposed- Booster	1,128	77	180

TABLE 3-28: LENGTHS OF PROPOSED TRANSMISSION PIPE SYSTEMS IN CAZA OF BAALBECK

Type	Diameter (mm)	Total length (m)
Ductile Iron	63	6,850
	80	6,845
	100	13,710
	125	4,380
	150	89,135
	200	21,046
	250	35,835
	300	33,170
	350	19,637
	400	15,760
	450	9,050
	500	8,410
	600	12,000
	700	5,760
	1000	15,760

TABLE 3-29: LENGTHS OF EXISTING AND PROPOSED WATER DISTRIBUTION NETWORK FOR BAALBECK CAZA

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Aain Bnayé *	---	---	---	---	---	---
Aamichki (Baalbeck)	---	---	---	---	---	---
Aaqidieh*	---	---	---	---	---	---
Aarsal	107,694	97,904	V.G	W.C	None	9790
Ain (El)	50,691	46,082	V.G	W.C	None	4,609
Ain Bourdai	16,671	15,155		W.C	None	1,516
Ain el Jaouzé*	---	---	---	---	---	---
Ain Es Saouda *	---	---	---	---	---	---
Ainata	15,676	14,251	B	W.C	Replacement	1,425
Amhazié *	---	---	---	---	---	---
Baalbeck	294,433	267,667	V.G	W.C	None	26,766
Bajjajé (El)	5,246	4,769	---	W.C	Rehabilitation	477
Barqa	18,427	4,269	B	P.C	Replacement	14,158
Bechouat	22,025	16,803	M	M.C	Rehabilitation	5,222
Bednayel	28,894	26,267	---	W.C	Rehabilitation	2,627
Beit Chama	16,767	15,243	---	W.C	Rehabilitation	1524
Beit Mcheik (Rammasa & Qeld El Sabeh)	5,114	4,649	---	W.C	Rehabilitation	465
Beliqa	1,233	1,121	---	W.C	Rehabilitation	112
Boudai (Aalaq Tell)	64,426	43,848	---	M.C	Rehabilitation	20,578
Britel	121,056	102,969	V.G	W.C	None	18,087
Btedaai	13,241	7,294	B	M.C	Replacement	5,947
Chaaibé *	---	---	---	---	---	---
Chaat	24,812	19,598	B	M.C	Replacement	5,214
Chlifa	10,259	9,326	V.G	W.C	None	933
Chmistar	60,034	54,576	B	W.C	Replacement	5,458
Dar el Wasseaa	4,830	---	---	---	---	4,830
Deir el Ahmar	44,244	34,765	M	M.C	Rehabilitation	9,479
Deir Mar Maroun	1,980	---	---	---	---	1,980
Douris	66,404	49,144	G	M.C	None	17,260
Fekehe	54,212	49,284	G	W.C	None	4,928
Flaoue	9,810	8,918	---	W.C	Rehabilitation	892
Hadet (El)	36,635	19,903	M	M.C	Rehabilitation	16,732
Halbata	5,133	---	---	---	---	5,133

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Ham	7,990	7,264	---	W.C	Rehabilitation	726
Haouch Barada	5,213	4,739	V.G	W.C	None	474
Haouch ed Dahab	---	---	---	---	---	---
Haouch en Nabe	9,277	8,434	---	W.C	Rehabilitation	843
Haouch er Rafqa (Mousraye)	17,298	14,022	M	M.C	Rehabilitation	3,276
Haouch Snaid	16,363	14,876	G	W.C	None	1,487
Haouch Tell Safiyé (Aaddous)	13,901	11,252	---	W.C	Rehabilitation	2,649
Harbata	17,280	15,710	V.G	W.C	None	1,570
Harfouche (Qlaile (el))	4,150	---	---	---	---	4,150
Hizzine	15,740	14,309	V.G	W.C	None	1,431
Hortaala	46,889	42,626	---	W.C	Rehabilitation	4,263
Iaat	35,735	32,487	V.G	W.C	None	3,248
Jabboulé (Bajjajé (El))	7,698	6,998	V.G	W.C	None	700
Jdeidé (Fekehe)	8,389	---	---	---	---	8,389
Jebaa	6,222	5,656	M	W.C	Rehabilitation	566
Jenta	1,508	---	---	---	---	1,508
Kfar Dabach	7,960	7,236	---	W.C	Rehabilitation	724
Kfardaane (Mazraat ed Dallil)	29,504	16,733	---	M.C	Rehabilitation	12,771
Kharayeb	---	---	---	---	---	---
Khoder (El)	11,520	10,473	G	W.C	None	1,047
Khraibé (El)	8,134	7,395	B	W.C	Replacement	739
Kneissé	7,475	6,795	---	W.C	Rehabilitation	680
Laboué	64,690	58,809	---	W.C	Rehabilitation	5,881
Maaraboun	5,076	4,614	B	W.C	Replacement	462
Machaitiye	6,782	6,165	---	W.C	Rehabilitation	617
Majdaloun	4,688	4,262	G	W.C	None	426
Maqné	20,496	---	---	---	---	20,496
Masnaa Bednayel (Bednayel)	---	---	---	---	---	---
Mazraat Beit Ghousain (Btedaii)	---	---	---	---	---	---
Mazraat Beit Slaibi	10,237	9,306	---	W.C	Rehabilitation	931
Mazraat es Syad	11,245	10,223	---	W.C	Rehabilitation	1,022
Moqraq (Taoufiqié)	34,460	31,325	---	W.C	Rehabilitation	3,135
Nabha	44,981	40,892	M	W.C	Rehabilitation	4,089
Nabi Chbat (En) *	---	---	---	---	---	---

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Nabi Chit (En)	37,758	34,325	G	W.C	None	3,433
Nabi Osmane (En)	25,796	23,451	V.G	W.C	None	2,345
Nabi Rchad	18,881	7,889	---	M.C	Rehabilitation	10,992
Nahlé	18,835	17,123	G	W.C	None	1,712
Ouadi el Aaoss *	---	---	---	---	---	---
Qaa (El)	36,708	33,371	---	W.C	Rehabilitation	3,337
Qaa Baayoun (Qaa (El))	---	---	---	---	---	---
Qaa Jouar Maqiye	3,200	---	---	---	---	3,200
Qaa Ouadi El Khanzer	5,300	---	---	---	---	5,300
Qarha	6,498	3,636	M	M.C	Rehabilitation	2,862
Qasrnaba	17,994	16,358	M	W.C	Rehabilitation	1,636
Qeddam	5,797	5,270	---	W.C	Rehabilitation	527
Qlaile (el) (Harfouche)	---	---	---	---	---	---
Ram (El)	10,659	5,467	G	M.C	None	5,192
Ras Baalbeck	22,342	20,311	B	W.C	Replacement	2,031
Ras el Aassi *	---	---	---	---	---	---
Riha	4,223	3,839	---	W.C	Rehabilitation	384
Saaidé	16,753	15,230	G	W.C	None	1,523
Safra	3,872	3,520	---	W.C	Rehabilitation	352
Sbouba	3,347	---	---	---	Rehabilitation	3,347
Seraaine el Gharbieh/ Hallanieh (Seraaine El Tahta)	15,508	14,098	---	W.C	Rehabilitation	1,410
Seraaine el Tahta	75,666	68,787	G	W.C	None	6,879
Serraain el Faouka (Seraaine El Tahta)	---	---	---	---	---	---
Sifri (Khoder (El))	---	---	---	---	---	---
Slouqi	---	---	---	---	---	---
Talia	20,911	19,010	V.G	W.C	None	1,901
Taraya	30,508	27,734	G	W.C	None	2,774
Taybeh (Et)	22,300	20,273	---	W.C	Rehabilitation	2,027
Temnine el Faouqa	18,570	16,882	G	W.C	None	1,688
Temnine el Tahta	19,050	17,318	G	W.C	None	1,732
Tfail	6,587	5,988	---	W.C	Rehabilitation	599
Wadi Faara (Faara)	---	---	---	---	---	---
Yahfoufa	2,330	---	---	---	---	2,330
Yammouné	8,328	7,571		W.C	None	757

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Younine	42,167	38,333	---	W.C	Rehabilitation	3,834
Zabboud	8,128	---	---	---	---	8,128
Zraieb	4,633	4,212	---	W.C	Rehabilitation	421
Zrazir	5,680	---	---	---	---	5,680
TOTAL	**2,099,177**	**1,736,402**	---	---	---	**362,775**

4 ZAHLE CAZA

The water demand projections and the required storage for the different villages and localities of Zahle are presented in tabular form in section 4.1 for the study year and the design horizons of 2025 and 2035. The schematics or functional diagrams for the supply systems are presented in section 4.2 with the existing infrastructure in blue, the proposed infrastructure in red, and the infrastructure under construction in green.

Each system is described and its components sized up. All systems are shown on the attached plans showing their geographic extent in the caza.

Section 4.3 compares the demand over the design horizons with the average yield and the adopted safe yield for each spring supplying a system.

Section 4.4 summarizes all the facilities and infrastructure components that the systems serving the caza in question will be composed of; namely the:

- Reservoirs,
- Wells,
- Pumping/boosting stations,
- Transmission lines,
- Distribution networks.

The total length of distribution networks required by the design horizon is presented. The length and status of the existing networks is also presented. The total length proposed for construction is then calculated based on the need for extension and replacement.

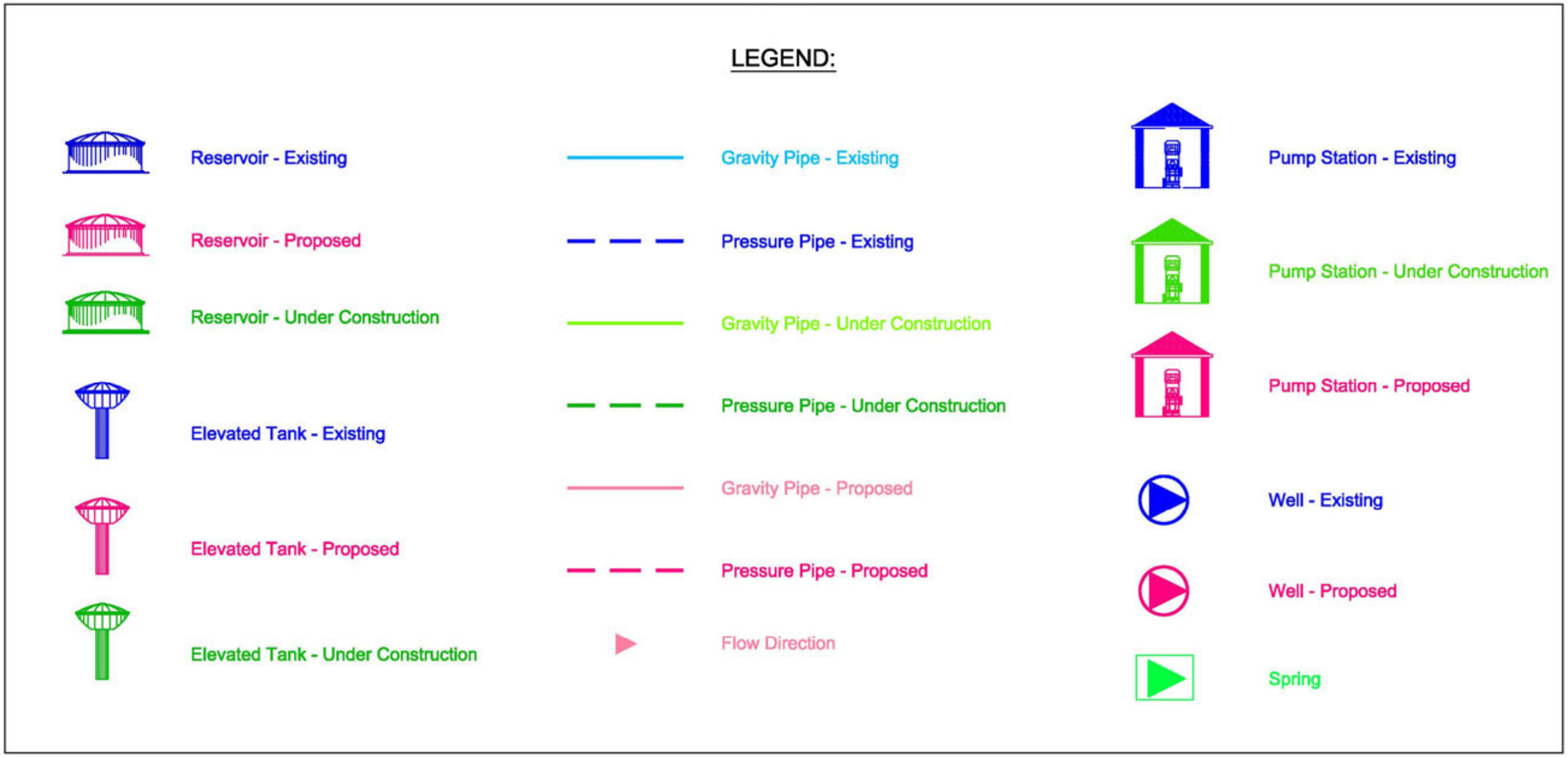
4.1 Water Demand for Zahle Caza

TABLE 4-1: WATER DEMAND AND REQUIRED STORAGE FOR ZAHLE CAZA

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)
1	Aanjar/Haouch Moussa	11,409	2,054	1,026	14,050	2,641	1,284	16,712	3,259	1,556
2	Ablah	9,653	1,738	826	11,887	2,235	1,105	14,139	2,757	1,335
3	Ain Kfar Zabad	3,245	584	318	3,995	751	391	4,752	927	469
4	Ali en Nahri	12,603	2,269	1,120	15,520	2,918	1,406	18,460	3,600	1,706
5	Barr Elias	23,070	4,153	1,949	28,410	5,341	2,472	33,792	6,589	3,021
6	Betyas *	---	---	---	---	---	---	---	---	---
7	Bouarej	3,009	542	299	3,705	697	368	4,407	859	439
8	Chebrqieh	27	5	63	33	6	64	39	8	64
9	Chtaura	4,407	793	410	5,428	1,020	510	6,456	1,259	615
10	Deir el Ghazal	1,446	260	175	1,780	335	208	2,117	413	243
11	Deir Zanoun (Barr Elias)	---	---	---	---	---	---	---	---	---
12	Delhamiye	1,756	316	200	2,163	407	240	2,572	502	282
13	Faaour	3,200	576	253	3,941	741	326	4,687	914	463
14	Fourzol (El)	10,435	1,878	948	12,850	2,416	1,185	15,284	2,980	1,433
15	Haouch el Ghanam	990	178	139	1,220	229	162	1,451	283	185
16	Haouch es Siyadi	27	5	63	33	6	64	39	8	64
17	Haouch Handari *	---	---	---	---	---	---	---	---	---
18	Haouch Qaissar	27	5	63	33	6	64	40	8	64
19	Hay el Fikani (Raite)	---	---	---	---	---	---	---	---	---
20	Hazerta	5,400	972	489	6,650	1,250	611	7,910	1,542	740
21	Hoshmosh	214	39	78	264	50	83	314	61	88
22	Jdita	10,392	1,871	945	12,797	2,406	1,181	15,222	2,968	1,428
23	Kfar Zabad	6,178	1,112	550	7,608	1,430	690	9,050	1,765	837
24	Ksara	471	85	98	580	109	109	690	135	120
25	Maallaqa	10,511	1,892	954	12,943	2,433	1,193	15,395	3,002	1,443
26	Maallaqa Aradi	25,281	4,551	2,124	31,132	5,853	2,697	37,029	7,221	3,299
27	Majdel Aanjar	23,675	4,262	1,997	29,155	5,481	2,534	34,678	6,762	3,097
28	Maksé	3,352	603	326	4,127	776	402	4,909	957	482
29	Massa	2,126	383	229	2,617	492	278	3,113	607	328
30	Mazraa (El)	525	94	103	646	121	114	769	150	127
31	Mraijat (El)	2,896	521	290	3,567	671	356	4,243	827	425
32	Nabi Ayla	1,585	285	187	1,952	367	222	2,321	453	260

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)	Estimated Population	Average Daily Demand (m^3/d)	Required Storage (m^3)
33	Nasireh (Nasriyet Rizk)	---	---	---	---	---	---	---	---	---
34	Nasriye	64	12	66	79	15	68	94	18	69
35	Nasriyet Rizk	1,499	270	180	1,846	347	214	2,196	428	249
36	Niha	2,008	361	220	2,472	465	266	2,941	573	313
37	Ouadi Ed Dellem	2,056	370	224	2,532	476	270	3,011	587	319
38	Qaa er Rim	3,336	600	325	4,107	772	401	4,886	953	480
39	Qabb Elias	21,625	3,892	1,835	26,629	5,006	2,325	31,674	6,176	2,840
40	Qoussaya	1,500	270	180	1,847	347	214	2,197	428	250
41	Quommol	92	16	7	113	21	9	134	26	12
42	Raite	5,000	900	457	6,157	1,158	570	7,324	1,428	689
43	Ramtaineh	70	13	67	86	16	68	102	20	70
44	Rayak- Haouch Hala	19,274	3,469	1,649	23,735	4,462	2,085	28,232	5,505	2,544
45	Saadnayel	16,540	2,977	1,432	20,368	3,829	1,807	24,226	4,724	2,201
46	Taalabaya - Jalala	27,244	4,904	2,280	33,550	6,307	2,897	39,905	7,782	3,546
47	Taanayel (Deir)	1,778	320	202	2,189	412	242	2,604	508	284
48	Tell el Akhdar	123	22	71	152	29	74	180	35	76
49	Terbol	7,860	1,415	683	9,679	1,820	862	11,512	2,245	1,110
50	Touaite	819	147	126	1,009	190	144	1,200	234	164
51	Zahlé	74,618	13,431	6,094	91,887	17,275	7,785	109,295	21,312	9,561
52	Zebdol	733	132	119	903	170	136	1,074	210	153
	Zahle Total	**364,149**	**65,547**	**32,439**	**448,426**	**84,304**	**40,756**	**533,377**	**104,009**	**49,543**

4.2 Water Systems for Zahle Caza



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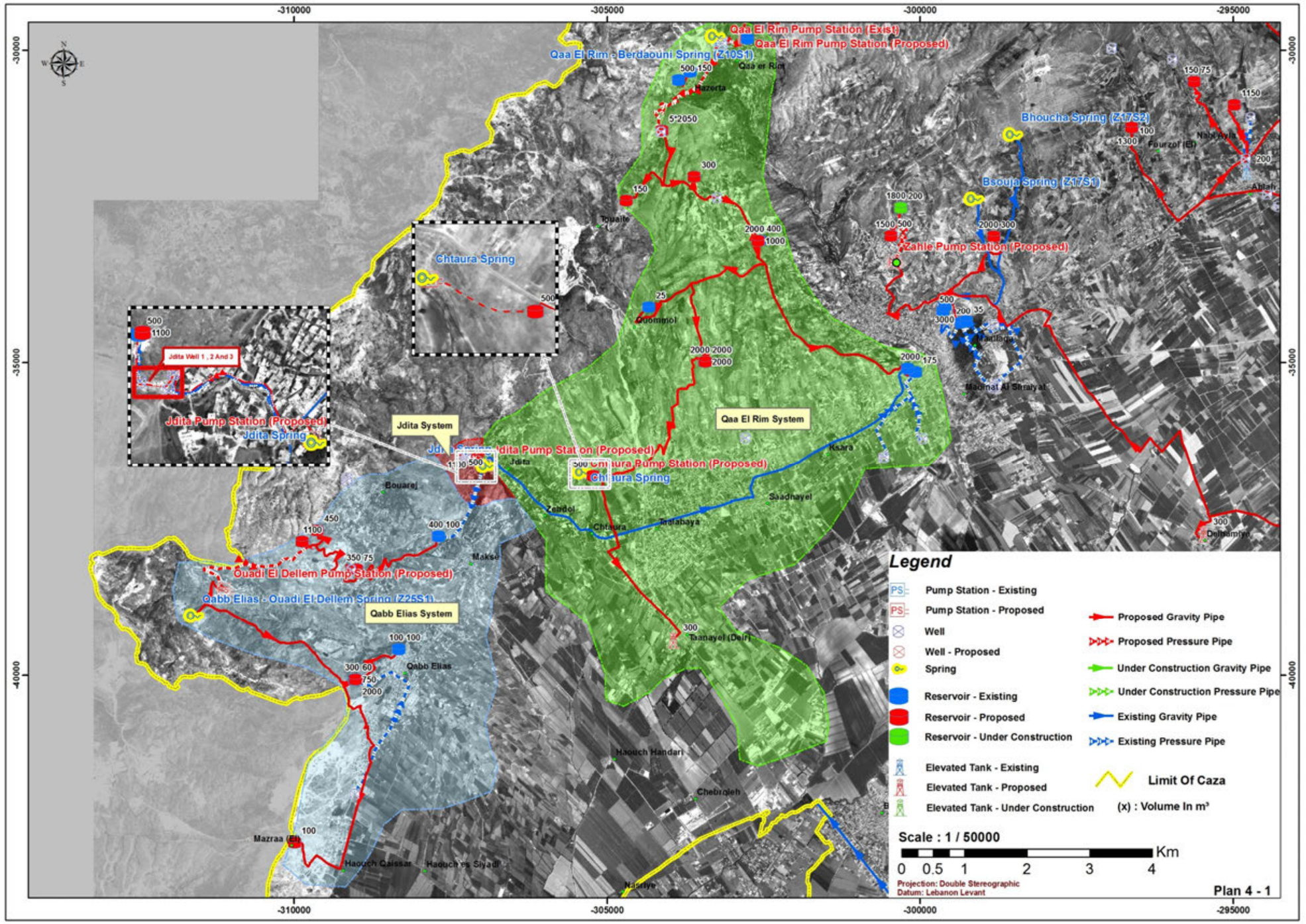


PLAN 4-1: QABB ELIAS, QAA EL RIM AND JDITA SYSTEMS

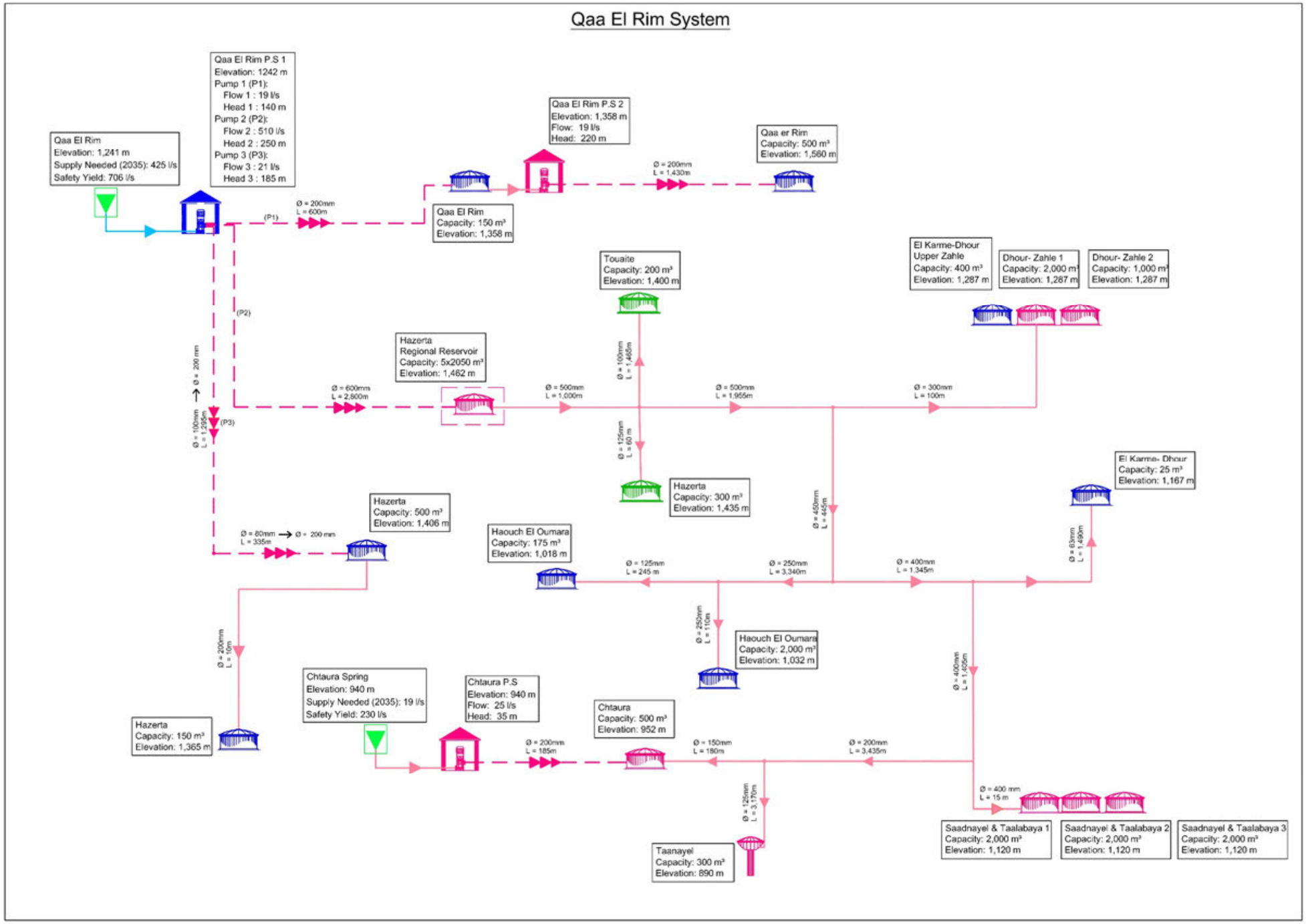


FIGURE 4-1: QAA EL RIM SYSTEM (PROPOSED)

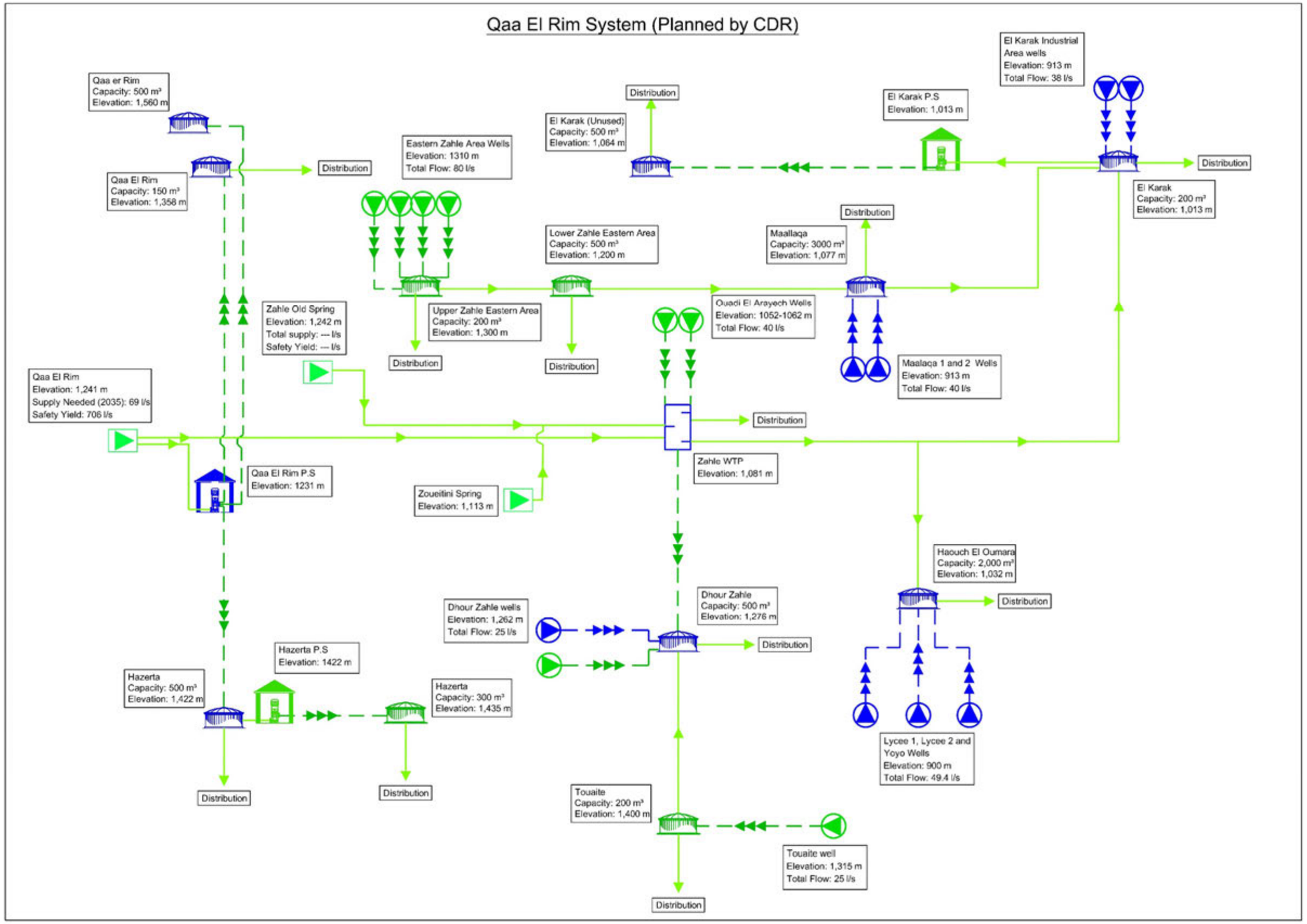


FIGURE 4-2: QAA EL RIM SYSTEM (PLANNED BY CDR)

The CDR is currently in the process of rehabilitating and extending the networks in Zahle with the additions of wells. Figure 4-2 presents this extended system. This rehabilitation system will eventually be integrated in the Qaa El Rim larger scheme and the wells shall be maintained as backup.

Qaa El Rim is a proposed system; it supplies a part of Zahle city and some other areas in Zahle caza.

The main water source for this system is Qaa El Rim spring. The water is pumped using 3 large centrifugal pumps (pump 1, 2, and 3).

- Pump 1: Qaa El Rim will be fed from a proposed pump 1 at 1,242 m elevation with a flow = 19 l/s and Head = 140 m. One booster pump is needed in this sub-system which is Qaa El Rim pump station at 1,358 m elevation (flow= 19 l/s and head =220 m).

- Pump 2: Hazerta Regional proposed reservoir will be fed from the proposed pump 2 at 1,242m elevation with a flow =510 l/s and Head = 250 m. The regional reservoir will supply water by gravity to Touaite, Hazerta, Dhour - Zahle, El Karme-Dhour, Haouch El Oumara, Saadnayel & Taalabaya, Taanayel and Chtaura. Chtaura proposed reservoir will be also fed by Chtaura Spring through Chtaura proposed pump station at 940 m elevation with a flow =25 l/s and head = 35m.

- Pump 3: Hazerta will be fed from the proposed pump 3 at 1,242 m elevation with a flow =21 l/s and Head = 185 m.

The adopted safe yield for Qaa El Rim Spring is around 706 l/s. The supply is larger than the average daily demand of the villages served by this system in year 2035 which will be 425 l/s. Therefore, the system is acceptable.

All existing small systems in the villages of Qaa El Rim system will be used as backup.

Haouch El Oumara (2,000 m³), El Karme- Dhour (400 m³) and Qaa EL rim (500 m³) existing reservoirs need rehabilitation; Qaa EL rim (150 m³) existing reservoir needs some minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 189,402 m.

TABLE 4-2: SUMMARY OF WATER FACILITIES FOR QAA EL RIM SYSTEM BY YEAR 2035

Qaa El Rim System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	25	1	**Pump Station**	*Existing*	---	3
		150	2		*Proposed*	---	2
		175	1	**Pipe**	*Gravity - Proposed*	63	1,490
		400	1			100	1,468
		500	2			125	3,475
		2,000	1			150	180
	Under construction	200	1			200	3,445
		300	1			250	3,450
	Proposed	500	1			300	100
		1,000	1			400	2,765
		2,000	4			450	445
		2,050	5			500	2,955
Elevated Tank	*Proposed*	300	1		*Pressurized - Proposed*	80	335
						100	1,295
						200	2215
						600	2,800

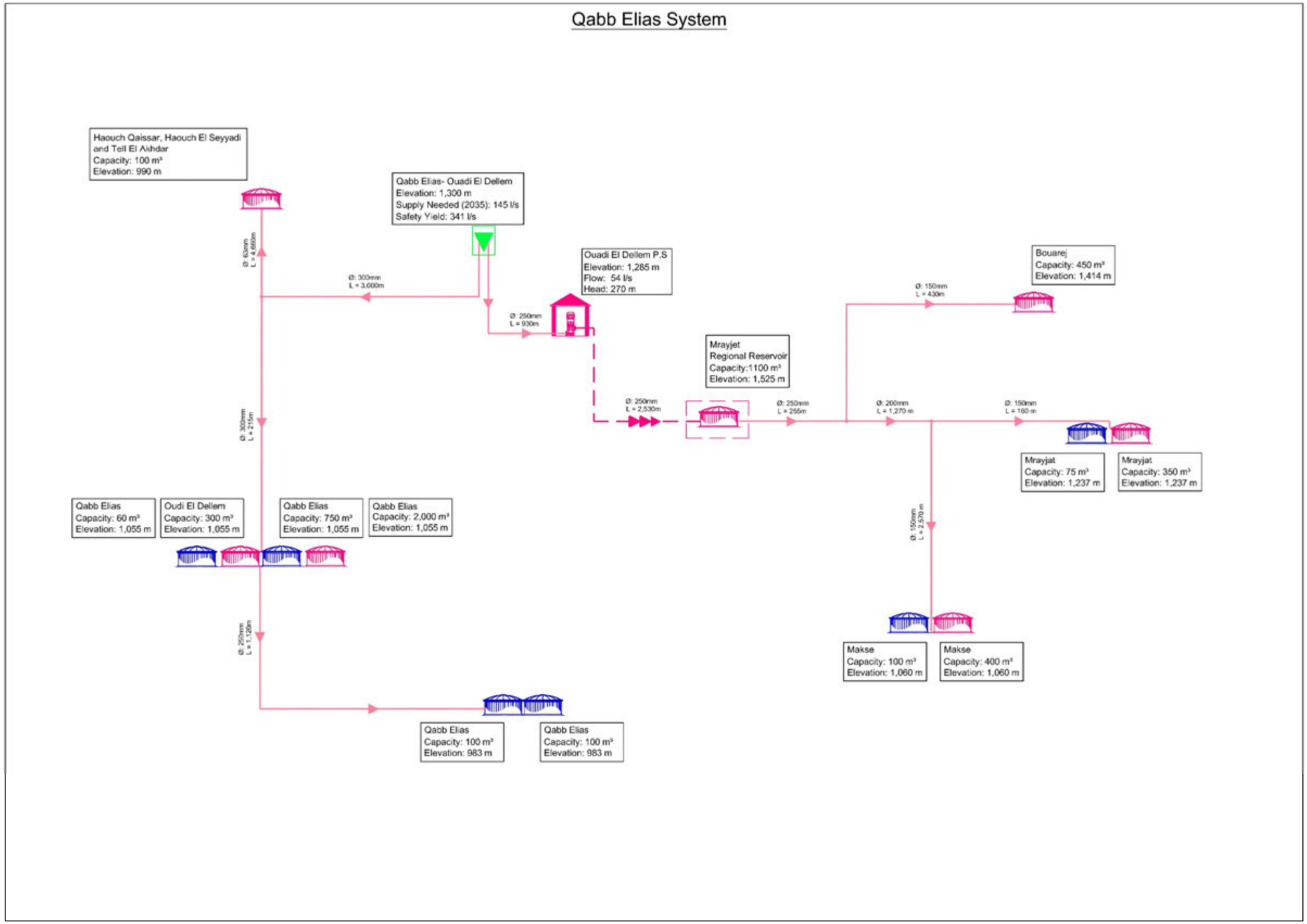


FIGURE 4-3: QABB ELIAS SYSTEM

Qabb Elias is a proposed system; it supplies some areas in the South- West of Zahle caza through a regional reservoir Mrayjet (1,100 m³) and gravity transmission pipes. The main water source for this system is Qabb Elias- Ouadi El Delem spring.

- *Mrayjet Regional Resrvoir*

Bouarej, Mrayjat, and Makse will be fed from the proposed Mrayjet regional reservoir. Water will be pumped through a proposed pump of elevation 1,250 m, flow 54 l/s and head 270 m to a regional reservoir Mrayjet of elevation 1525 m and capacity (1,100 m³).

Qabb Elias – Ouadi El Delem will also supply water by gravity to Haouch Qaissar, Haouch El Seyyadi, Oudi El Dellem and Qabb Elias.

The adopted safe yield for Qabb Elias- Ouadi El Delem Spring is around 341 l/s. The supply is larger than the average daily demand of the villages served by this system in year 2035 which will be 145 l/s. Therefore, the system is acceptable.

All existing small systems in the villages of Qabb Elias system will be used as backup.

Makse existing reservoir needs maintenance and rehabilitation; Qabb Elias (60 m³) existing reservoir needs maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 52,058m.

TABLE 4-3: SUMMARY OF WATER FACILITIES FOR QABB ELIAS SYSTEM BY YEAR 2035

Qabb Elias System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	60	1	**Pump Station**	*Proposed*	---	1
		75	1				
		100	3				
		750	1				
	Proposed	100	1				
		300	1	**Pipe**	*Gravity - Proposed*	63	4,660
		350	1			150	3,160
		400	1			200	1,270
		450	1			250	2,305
		1,100	1			300	3,215
		2,000	1		*Pressurized- Proposed*	250	2,530

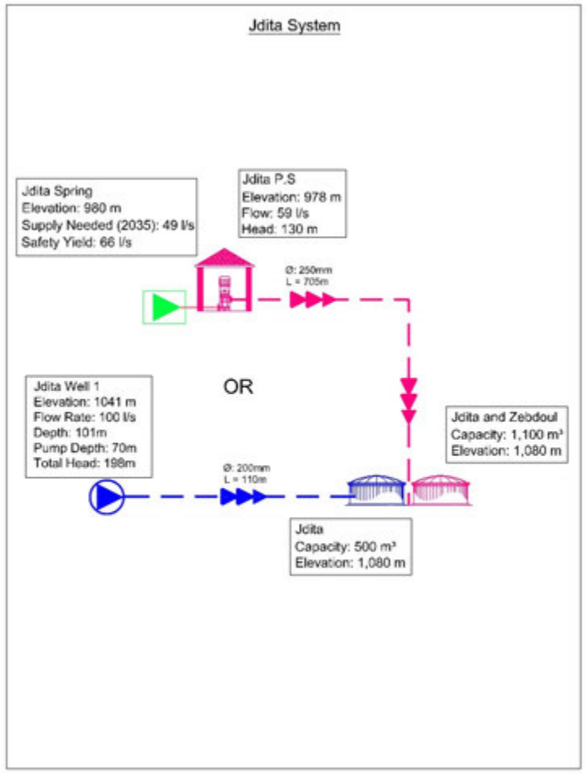


FIGURE 4-4: JDITA SYSTEM

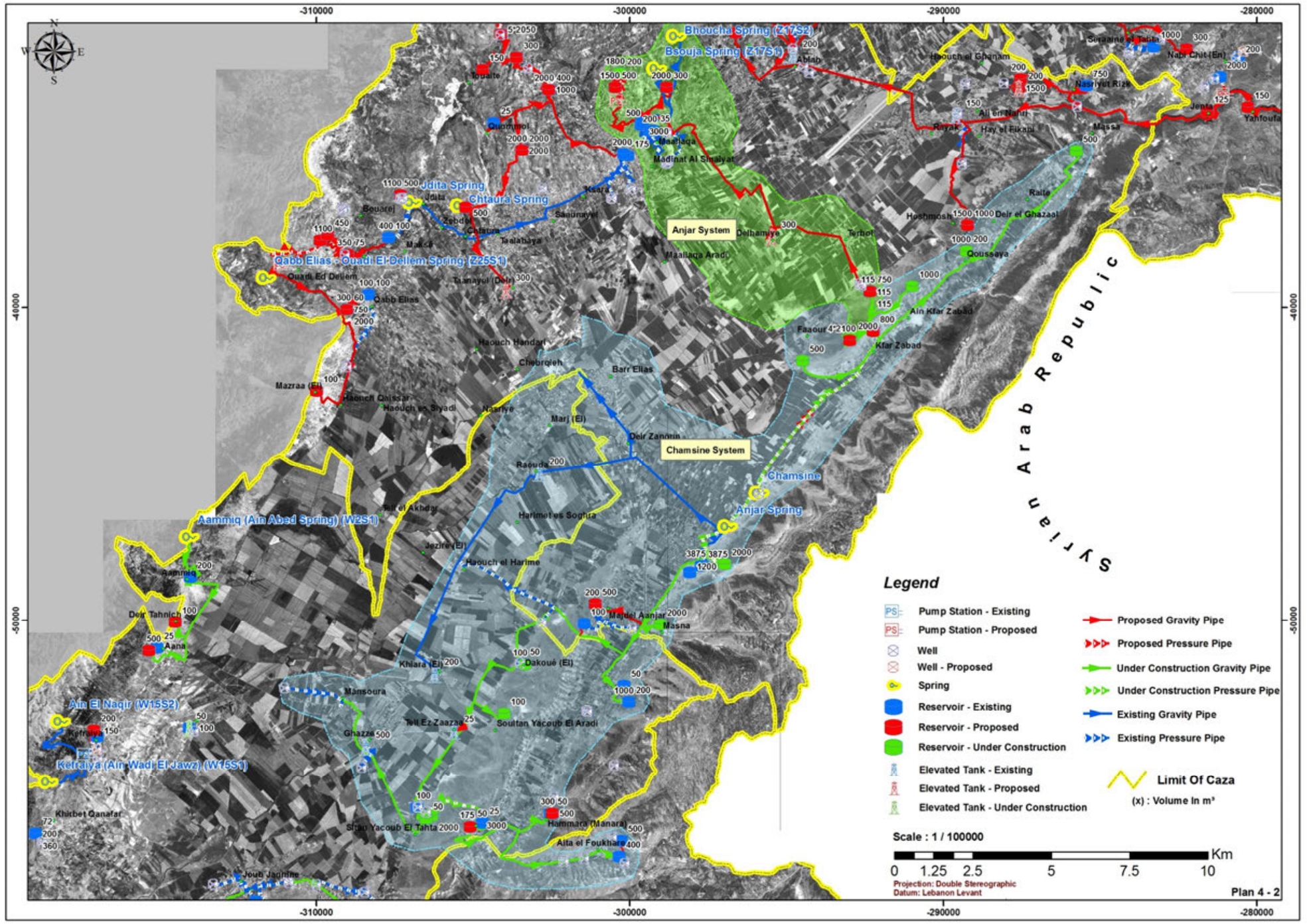
Jdita system is a proposed system. Existing water transmission system will be used as a backup system. The existing length of water distribution network for Jdita and Zebdol is around 23,815 m but this network needs replacement since it is in bad condition. The total length of the proposed water distribution network will be around 25,267 m.

System description:

A proposed water pump station will pump water from Jdita spring to Jdita existing and proposed reservoirs (500m³ and 1,100 m³ respectively) through a 250 mm diameter proposed pipe and these reservoirs will distribute water to Jdita and Zebdoul villages. Alternatively, one of the existing wells may be used as regular supply instead of backup depending on the result of a detailed feasibility study. The existing reservoir (500 m³) is in an acceptable condition but it needs some minor maintenance.

TABLE 4-4: SUMMARY OF WATER FACILITIES FOR JDITA SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pump Station	Pipe Diameter
Description	Proposed (1100 m³)	Existing (500m³)	Existing	Proposed	Proposed 250 mm
Number/Length	1	1	1	1	705m
Comments	---	Needs Minor Maintenance	---	---	---



PLAN 4-2: ANJAR AND CHAMSINE SYSTEMS

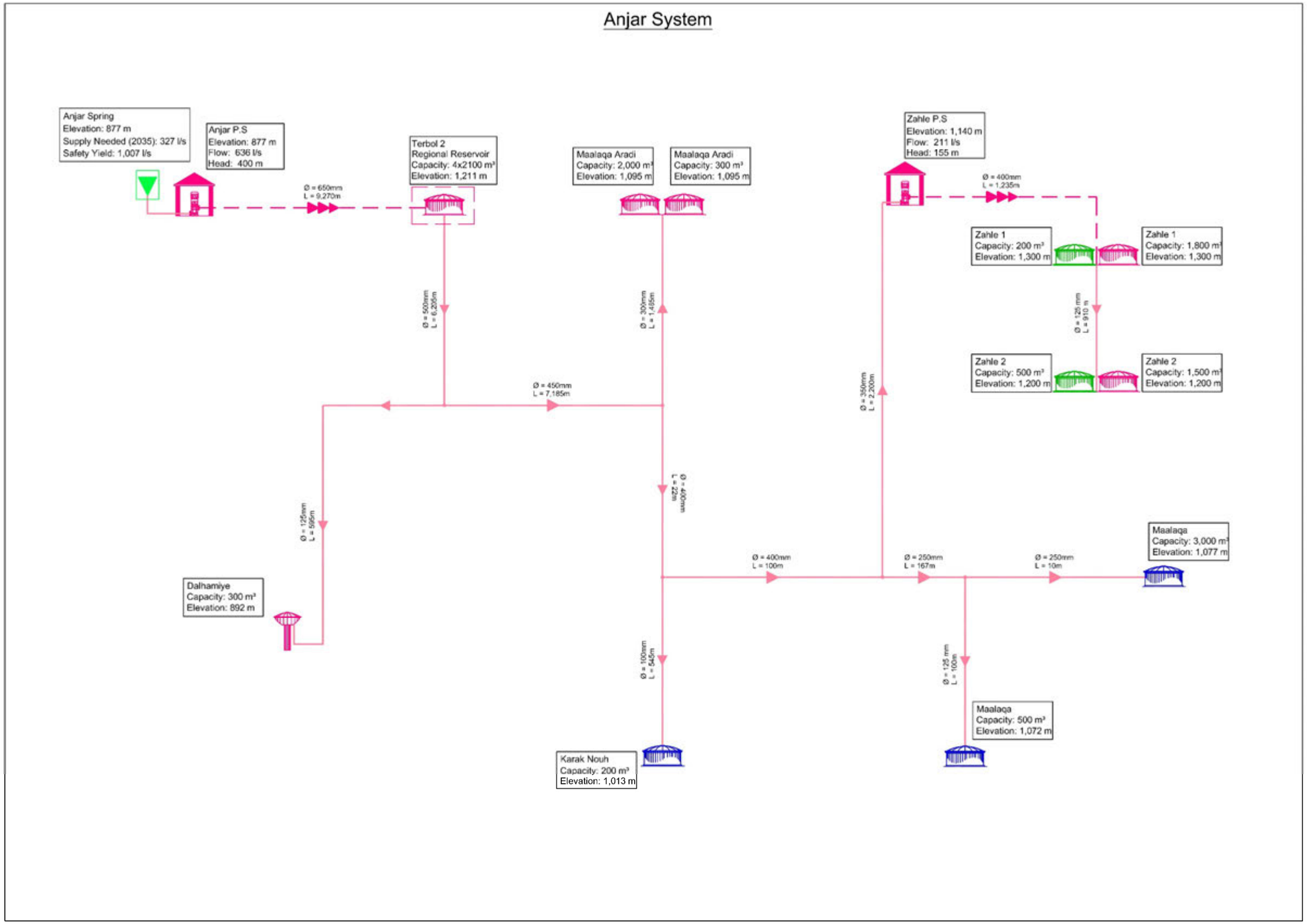


FIGURE 4-5: ANJAR SYSTEM

Anjar is a proposed system; it supplies a part of Zahle city and some other areas in Zahle caza through a regional reservoir Terbol 2. The main water source for this system is Anjar spring.

- *Terbol 2 Regional Reservoir*

  Dalhamiye, Karak Nouh, Maalaqa, Zahle 1 & 2, and Maalaqa Aradi will be fed from the proposed Terbol 2 regional reservoir. Water is pumped through a proposed pump of elevation 877 m, flow 636 l/s and head 400 m to a regional reservoir Terbol 2 of elevation 1,211 m and capacity 8400 m^3(4 x 2,100 m^3).

  One booster pump is needed in this system which is Zahle pump station of elevation 1,112 m (flow = 211 l/s and head = 155m).

The adopted safety yield for Anjar Spring is around 1007 l/s. The supply is larger than the average daily demand of the villages served by this system in year 2035 which will be 327 l/s. Therefore, the system is acceptable.

All existing small systems in the villages of Anjar system will be used as backup.

Karak Nouh and Maalaqa existing reservoirs need rehabilitation. The remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 135,023 m.

TABLE 4-5: SUMMARY OF WATER FACILITIES FOR ANJAR SYSTEM BY YEAR 2035

Anjar System							
Facility	**Status**	**Capacity (m^3)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	200	1	**Pipe**	*Gravity - Proposed*	100	545
		500	1			125	1,605
		3,000	1			250	180
	Under construction	200	1			300	1,465
		500	1			350	2,200
	Proposed	300	1			400	125
		1500	1			450	7,185
		1800	1			500	6,205
		2,000	1		*Pressurized - Proposed*	400	1,235
		2,100	4			650	9,270
Elevated Tank	*Proposed*	300	1				
Pump Station	*Proposed*	---	2				

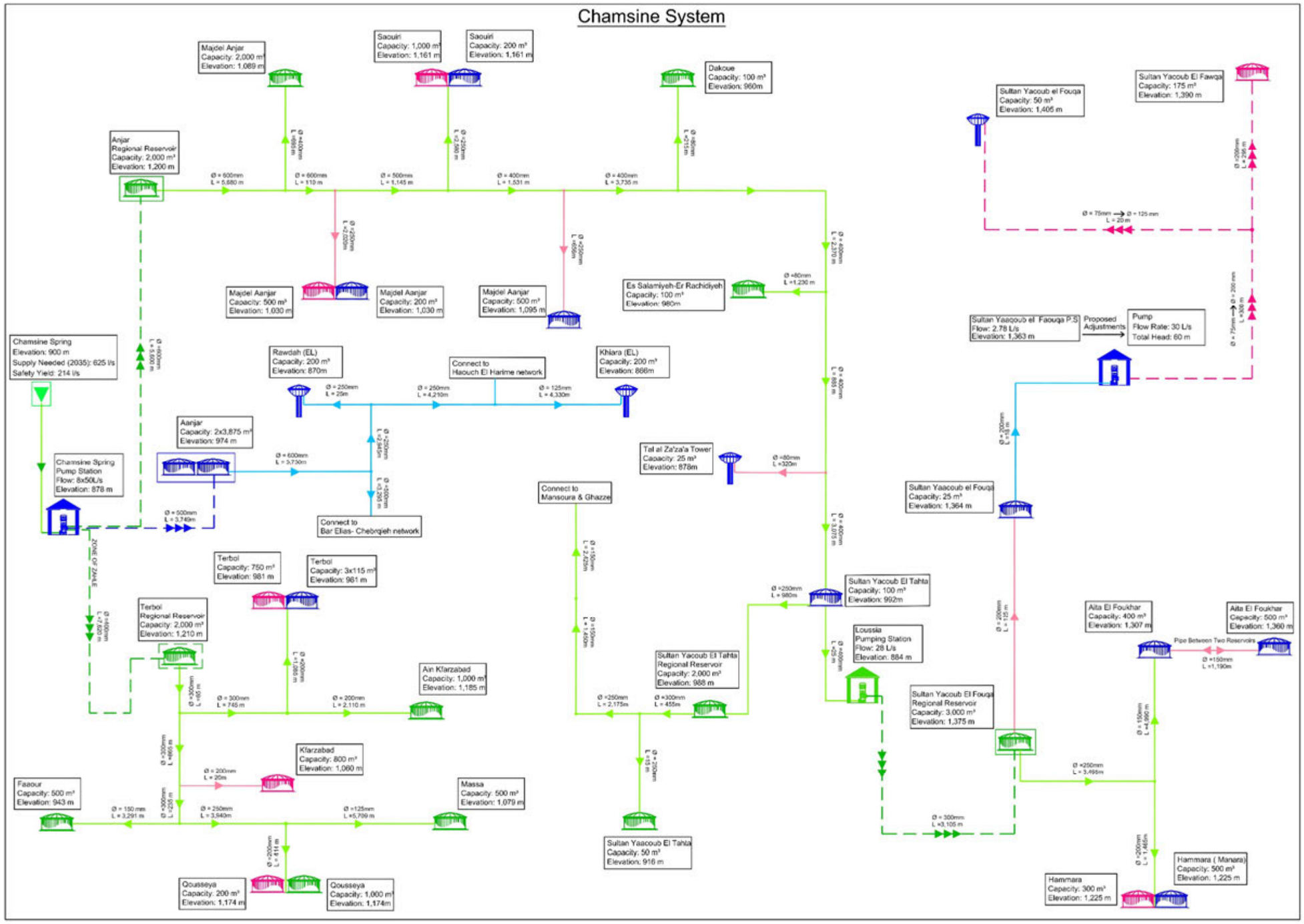


FIGURE 4-6: CHAMSINE SYSTEM

Chamsine is a system that is under construction by CDR. Chamsine spring and wells will supply east area of Zahle Caza and some areas in West Bekaa caza through three regional reservoirs respectively Anjar (2 x 3 875 m³), Anjar (2,000 m³) and Terbol 1 (2,000 m³).

- Anjar regional reservoir (2 x 3,875 m³): Anjar, Rawda (El), Barr Elias, Cheberqieh, Haouch El Harime and Khiara will be fed from the proposed Aanjar regional reservoir at 1045m. Water will be pumped from Chamsine spring open bottom catchment structure to Anjar reservoir at an elevation of 1045m with a capacity of 7,750 m³, (2 x 3,875 m³).

- Anjar regional reservoir (2,000 m³): Majdel Anjar, Saouiri, Dakoue, Es Salamiyeh –Er Rachidiyeh, Tal El Za'za'a, Sultan Yacoub El Tahta, Mansoura, Ghazze, Sultan Yacoub El Faouqa, Aita El Foukhar, and Hammara (Manara) will be fed from the regional reservoir of Aanjar (2,000 m³). Water will be pumped from Chamsine wells to the proposed Aanjar Regional reservoir at an elevation of 1,200 m with a capacity of 2,000 m³. Seven wells (Six duties and one stand by) are proposed to be dug to satisfy the demand up to the year 2035. The flow from each well is assumed to be 34 l/sec. An existing well already operating in Manara is to be used to supply the reservoir of Manara in addition to the supply from Aanjar (2000 m³) regional reservoir.

- Terbol 1 (2,000 m³): Terbol, Ain Kfarzabad, Kfarzabad, Massa, Faaour and Qousseya will be fed from the proposed regional reservoir of Terbol. Water will be pumped from Chamsine wells to Terbol regional reservoir at an elevation of 1,220 m with a capacity of 2,000 m³. Three wells are proposed by CDR to be dug during the year 2008 – 2015. In 2015 a new well is proposed also by CDR to be dug to satisfy the demand up to the year 2035. The flow from each well is assumed to be 34 l/sec.

- A stand by well is to be dug in Kfar Zabad and is to be used for emergency only to supply a proposed Terbol regional reservoir where deficiency is observed from the Chamsine wells.

In some villages, the capacities of the reservoirs are increased to meet the population demand in year 2035.

The adopted safe yield for Chamsine Spring is around 214 l/s. The supply is much lower than the average daily demand of the villages served by this system in year 2035 which will be 625 l/s. On the other hand, Chamsine comprises several collection wells for which data is unknown and they may be able to compensate this difference. Otherwise, Anjar spring can be a good solution.

All existing small systems in the villages of Chamsine system will be used as backup.

Rawda (El), Terbol (3 x 115 m³), Tal El Za'za'a, Majdel Anjar (500m³) and Hammara (Manara) existing reservoirs need rehabilitation; Saouiri, Sultan Yaacoub El Faouqa (25 m³) and Aita El Foukhar (400 m³) existing reservoirs need minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 81,771 m.

TABLE 4-6: SUMMARY OF WATER FACILITIES FOR CHAMSINE SYSTEM BY YEAR 2035

Chamsine System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	25	1	**Pipe**	*Gravity - Existing*	125	4,330
		100	1			200	20
		115	3			250	7,180
		200	2			500	3,295
		400	1			600	5,750
		500	3		*Gravity -Under Construction*	80	1,445
		3,875	2			125	5,710
	Under Construction	50	1			150	12,155
		100	2			200	5,075
		500	2			250	11,010
		1,000	2			300	2,165
		2,000	4			400	9,240
		3,000	1			500	1,145
	Proposed	175	1			600	5,790
		200	1		*Gravity - Proposed*	80	320
		300	1			150	1,190
		500	1			200	145
		750	1			250	2,675
		800	1		*Pressurized - Existing*	500	3750
		1,000	1		*Pressurized - Under Construction*	300	3,105
Elevated Tank	*Existing*	25	1			400	7,620
		50	1			600	5,600
		200	2		*Pressurized - Proposed*	80	320
Pump Station	*Under Construction*	---	2			200	295
	Proposed	---	1				

4.3 Spring Water Supply vs Demand for Zahle Regional Systems

TABLE 4-7: SPRING WATER SUPPLY VS DEMAND FOR REGIONAL SYSTEMS IN ZAHLE CAZA

System	Average Demand Flow (Year 2013) (l/s)	Average Demand Flow (Year 2025) (l/s)	Average Demand Flow (Year 2035) (l/s)	Average Yearly Flow (Reference) (l/s)	Adopted Safe (Dry Year) Yield Flow (l/s)	System Status	Comments
Jdita System	33	41	49	131 (LRA [1961-1967])	**66**	Proposed	Adopted water quantity is more than water demand - System is Ok
Qabb Elias , Ouadi El dellem System	99	121	145	682 (LRA [1961-1968])	**341**	Proposed	Adopted water quantity is more than water demand - System is Ok
Anjar System	223	275	327	2,014 (LRA [1961-1968])	**1,007**	Proposed	Adopted water quantity is more than water demand - System is Ok
Qaa Rim System	290	357	425	1,411 (LRA [1952-1968])	**706**	Proposed/ Existing	Adopted water quantity is more than water demand - System is Ok
Chamsine System	427	525	625	429 (LRA [1962-1971])	**214**	Existing/ Under Construction	Adopted water quantity is less than water demand - System is not OK - Extra needed value can be supplied by Anjar source
Chtaura System	13	16	19	459 (LRA [1961-1968])	**230**	Proposed	Adopted water quantity is more than water demand - System is Ok

* The adopted safe (dry year) yield flow is the average yearly flow / 2.

4.4 Summary of Water Facilities for Systems of Zahle Caza by Year 2035

TABLE 4-8: NUMBER OF RESERVOIRS IN CAZA OF ZAHLE

Reservoir Facility	Volume (m^3)																								Total	Total Storage (m^3)
	25	50	60	75	100	115	150	175	200	300	350	400	450	500	750	800	1000	1100	1500	1800	2000	2050	2100	3000	3875	
Reservoir - Existing	2	-	1	1	4	3	2	1	3	-	-	2	-	7	1	-	-	-	-	-	1	-	-	1	2	31	19,805
Reservoir - Under Construction	-	1	-	-	2	-	-	-	2	1	-	-	-	3	-	-	2	-	-	-	4	-	-	1	-	16	15,450
Reservoir - Proposed	-	-	-	-	1	-	-	1	1	3	1	1	1	2	1	1	2	2	1	1	6	5	4	-	-	34	43,275
Elevated Tank - Existing	1	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	475
Elevated Tank - Proposed	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	600
Total	**3**	**2**	**1**	**1**	**7**	**3**	**2**	**2**	**8**	**6**	**1**	**3**	**1**	**12**	**2**	**1**	**4**	**2**	**1**	**1**	**11**	**5**	**4**	**2**	**2**	**87**	**79,605**

TABLE 4-9: CHARACTERISTICS OF PROPOSED PUMP STATIONS IN CAZA OF ZAHLE

Pump Station Name	Status	Ground Elevation (m)	Capacity Needed in year 2035 (L/s)	Total Head Needed (m)
Qaa El Rim 1	Proposed- Booster	1,358	19	220
Chtaura	Proposed- Booster	940	25	35
Qaa el Rim 2	Proposed- Booster Set 1	1,242	19	140
	Proposed- Booster Set 2		510	250
	Proposed- Booster Set 3		21	185
Anjar	Proposed- Booster	877	636	400
Zahle	Proposed- Booster	1,140	211	155
Jdita	Proposed- Booster	978	59	130
Ouadi El Dellem	Proposed- Booster	1,285	54	270
Sultan Yaaqoub el Faouqa	Proposed- Booster	1,363	30	60

TABLE 4-10: NUMBER OF WELLS USED IN CAZA OF ZAHLE

Village Name	Existing well	Proposed well
Jdita	1	---
Total	**1**	**---**

TABLE 4-11: LENGTHS OF PROPOSED TRANSMISSION PIPE SYSTEMS IN CAZA OF ZAHLE

Type	Diameter (mm)	Total length (m)
Ductile Iron	63	6,150
	80	975
	100	3,308
	125	5,080
	150	4,530
	200	7,370
	250	11,845
	300	4,780
	350	2,200
	400	4,123
	450	7,630
	500	9,160
	600	2,800
	650	9,270

TABLE 4-12: LENGTHS OF EXISTING AND PROPOSED WATER DISTRIBUTION NETWORK FOR ZAHLE CAZA

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Aanjar/Haouch Moussa	29,603	26,912	V.G	W.C	None	2,691
Ablah	14,417	8,777	---	M.C	Rehabilitation	5,640
Ain Kfar Zabad	14,037	12,761	V.G	W.C	None	1,276
Ali en Nahri	17,114	15,558	---	W.C	Rehabilitation	1,556
Barr Elias (Deir Zanoun)	89,870	81,695	V.G	W.C	None	8,175
Betyas *	---	---	---	---	---	---
Bouarej	8,140	---	---	---	---	8,140
Chebrqieh *	---	---	---	---	---	---
Chtaura	6,921	6,292	---	W.C	Rehabilitation	629
Deir el Ghazal	13,521	12,292	V.G	W.C	None	1,229
Delhamiye	7,754	---	---	---	---	7,754
Faaour	14,894	13,540	V.G	---	---	1,354
Fourzol (El)	21,173	---	---	---	---	21,173
Haouch el Ghanam	427	---	---	---	---	427
Haouch es Siyadi	1,134	970	---	W.C	Rehabilitation	164
Haouch Handari *	---	---	---	---	---	---
Haouch Qaissar	611	---	---	---	---	611

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Hazerta	19,902	18,093	B	W.C	Replacement	1,809
Hoshmosh	3,123	---	---	---	---	3,123
Jdita	15,953	14,503	B	W.C	Replacement	1,450
Kfar Zabad	41,244	37,495	V.G	W.C	None	3,749
Maallaqa	19,943	---	---	---	---	19,943
Maallaqa Aradi (Mallaqa)	---	---	---	---	---	---
Majdel Aanjar	84,872	77,156	V.G	W.C	None	7,716
Maksé	4,664	4,240	G	W.C	None	424
Massa	24,044	21,858	V.G	W.C	None	2,186
Mazraa (El) (Tell El Akhdar, Haouch El Siyadi)	---	---	---	---	---	---
Mraijat (El)	9,479	---	---	---	---	9,479
Nabi Ayla	4,486	1,426	---	P.C	Rehabilitation	3,060
Nasriye *	---	---	---	---	---	---
Nasriyet Rizk (Nasireh)	13,287	12,079	---	W.C	Rehabilitation	1,208
Niha	11,125	---	---	---	---	11,125
Ouadi Ed Dellem	5,010	---	---	---	---	5,010
Qaa er Rim	10,708	9,735	B	W.C	Replacement	973
Qabb Elias	27,260	3,486	B	W.C	Replacement	23,774
Qoussaya	11,354	10,322	V.G	W.C	None	1,032
Quommol (Zahle)	---	---	---	---	---	---
Raite (Hay el Fikani)	24,926	20,786	V.G	W.C	None	4,140
Ramtaineh *	---	---	---	---	---	---
Rayak- Haouch Hala	24,230	12,726	---	M.C	Rehabilitation	11,504
Saadnayel	13,815	12,559	B	W.C	Replacement	1,256
Taalabaya - Jalala	19,933	18,121	---	W.C	Rehabilitation	1,812
Taanayel (Deir)	2,781	2,528	---	W.C	Rehabilitation	253
Tell el Akhdar (Haouch El Siyadi)	---	---	---	---	---	---
Terbol	7,856	7,142	M	W.C	Rehabilitation	714
Touaite	4,766	4,333	---	W.C	Rehabilitation	433
Zahlé (Ksara)	217,901	---	---	---	---	217,901
Zebdol	9,314	7,267	---	M.C	Rehabilitation	2,047
Total	**871,592**	**474,652**				**396,940**

5 WEST BEKAA CAZA

The water demand projections and the required storage for the different villages and localities of West Bekaa are presented in tabular form in section 5.1 for the study year and the design horizons of 2025 and 2035.

The schematics or functional diagrams for the supply systems are presented in section 5.2 with the existing infrastructure in blue, the proposed infrastructure in red, and the infrastructure under construction in green.

Each system is described and its components sized up. All systems are shown on the attached plans showing their geographic extent in the caza.

Section 5.3 compares the demand over the design horizons with the average yield and the adopted safe yield for each spring supplying a system.

Section 5.4 summarizes all the facilities and infrastructure components that the systems serving the caza in question will be composed of; namely the:

- Reservoirs,
- Wells,
- Pumping/boosting stations,
- Transmission lines,
- Distribution networks.

The total length of distribution networks required by the design horizon is presented. The length and status of the existing networks is also presented. The total length proposed for construction is then calculated based on the need for extension and replacement.

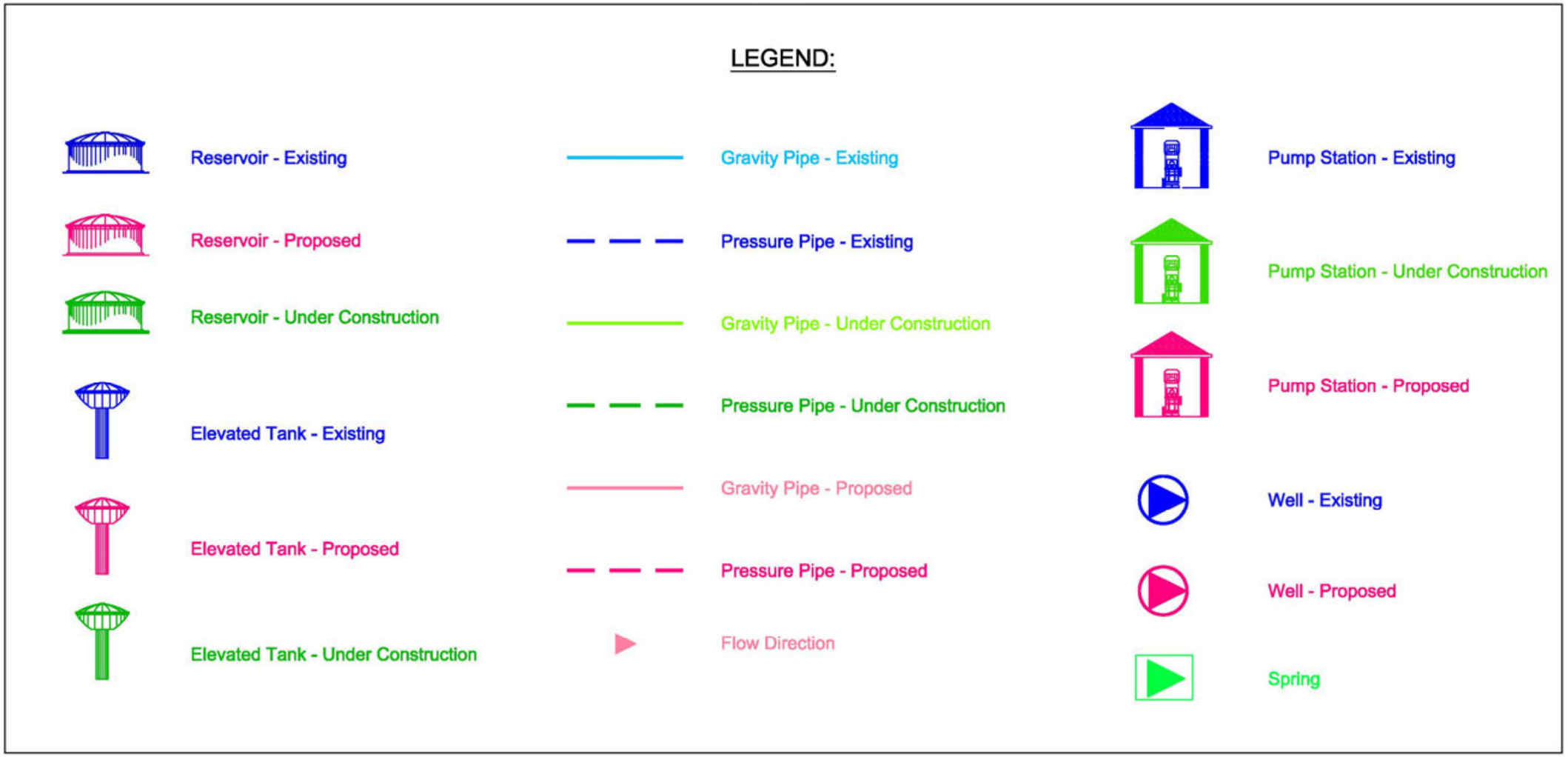
5.1 Water Demand for West Bekaa Caza

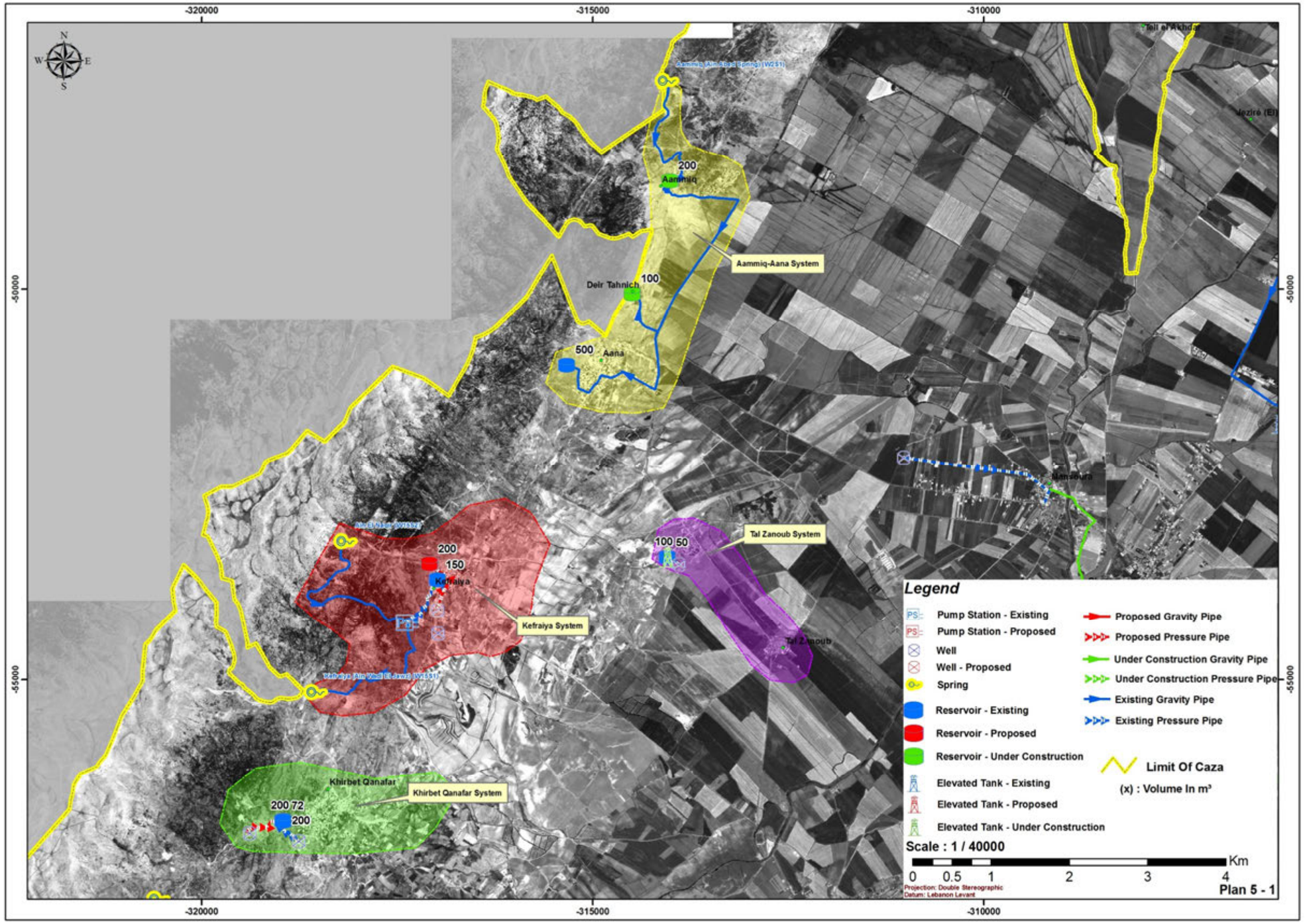
TABLE 5-1: WATER DEMAND AND REQUIRED STORAGE FOR WEST BEKAA CAZA

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)
1	Ain El Tine	3,303	595	323	4,067	765	397	4,838	943	476
2	Ain Zebdé	1,076	194	146	1,325	249	171	1,576	307	196
3	Aaitanit	1,151	207	152	1,417	266	178	1,686	329	206
4	Aammiq	1,103	199	148	1,358	255	173	1,616	315	200
5	Aana	2,100	378	227	2,586	486	275	3,076	600	325
6	Baaloul	2,886	519	290	3,554	668	355	4,227	824	424
7	Bab Mareh	493	89	100	607	114	111	722	141	123
8	Dakoué (El) (Salmiyeh El Rachidiye)	626	113	111	771	145	125	917	179	140
9	Deir Ain ej Jaouzé	27	5	63	33	6	64	40	8	64
10	Deir Tahnich	75	14	67	92	17	69	110	21	70
11	Fadar El Faouka *	---	---	---	---	---	---	---	---	---
12	Fadar El Tahta *	---	---	---	---	---	---	---	---	---
13	Ghazze	6,949	1,251	611	8,557	1,609	769	10,178	1,985	995
14	Hammara (Manara)	---	---	---	---	---	---	---	---	---
15	Harimet es Soghra	112	20	70	138	26	72	164	32	75
16	Haouch El Harime	2,115	381	229	2,604	490	276	3,098	604	327
17	Jeziré (El)	246	44	80	303	57	86	360	70	92
18	Joubb Jannine	10,016	1,803	915	12,334	2,319	1,142	14,671	2,861	1,381
19	Kamed el Loz	10,000	1,800	914	12,314	2,315	1,141	14,647	2,856	1,379
20	Kefraiya	2,441	439	254	3,006	565	310	3,575	697	368
21	Khiara (El)	1,300	234	164	1,601	301	193	1,904	371	224
22	Khirbet Qanafar	4,500	810	417	5,541	1,042	519	6,591	1,285	627
23	Lala	7,000	1,260	615	8,620	1,621	774	10,253	1,999	1,002
24	Libbaya	4,754	856	438	5,854	1,101	545	6,963	1,358	658
25	Loussa *	---	---	---	---	---	---	---	---	---
26	Machghara	15,655	2,818	1,362	19,278	3,624	1,717	22,930	4,471	2,089
27	Maidoun	958	172	137	1,180	222	159	1,403	274	181
28	Manara	4,600	828	425	5,665	1,065	530	6,738	1,314	639
29	Mansoura	3,000	540	299	3,694	695	367	4,394	857	438
30	Marj (El)	7,324	1,318	641	9,019	1,696	807	10,728	2,092	1,042
31	Ouaqf (El) *	---	---	---	---	---	---	---	---	---

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)
32	Qaraaoun (El)	6,500	1,170	576	8,004	1,505	723	9,521	1,857	878
33	Qelia	1,767	318	201	2,176	409	241	2,588	505	283
34	Raouda	3,000	540	299	3,694	695	367	4,394	857	438
35	Saghbine	3,828	689	364	4,714	886	451	5,607	1,093	542
36	Sohmor	7,902	1,422	687	9,731	1,829	866	11,574	2,257	1,115
37	Saouiri	8,026	1,445	697	9,884	1,858	879	11,756	2,292	1,131
38	Sltan Yaqoub El Aradi	54	10	65	66	13	67	79	15	68
39	Sltan Yacoub el Fouqa	4,310	776	402	5,308	998	500	6,313	1,231	603
40	Sltan Yaqoub el Tahta (Sltan Yacoub el Fouqa)	---	---	---	---	---	---	---	---	---
41	Tell Ez Zaazaa (Khiara)	---	---	---	---	---	---	---	---	---
42	Tell Znoub	830	149	127	1,022	192	146	1,216	237	165
43	Yohmor el Beqaa	4,214	759	395	5,189	976	490	6,172	1,204	591
44	Zellaya	557	100	105	686	129	118	816	159	131
	West Bekaa Total	**134,798**	**24,264**	**13,116**	**165,992**	**31,206**	**16,173**	**197,441**	**38,501**	**19,686**

5.2 Water Systems for West Bekaa Caza





PLAN 5-1: AANA-AAMMIQ, TAL ZANOUB, KEFRAIYA AND KHIRBET QANAFAR WATER SYSTEMS

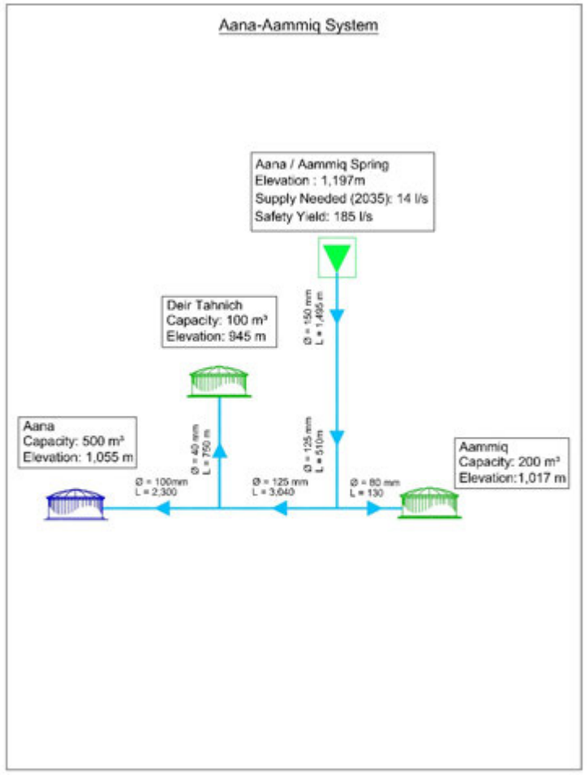


FIGURE 5-1: AANA AAMMIQ SYSTEM

Aana-Aammiq system is under construction by CDR. The existing length of water distribution network systems in Aana, Aammiq and Deir Tahnich is around 17,550 m but these networks need replacement since they are in bad condition. The total length of the proposed water distribution network will be around 1,754 m.

System description:

Aana and Aammiq spring will supply water by gravity to Aana, Aammiq and Deir Tahnich reservoirs (500 m^3, 200 m^3, and 100m^3 respectively), that are under construction, through 150, 125, 100, 80, and 40 mm diameters pipes and these reservoirs will distribute water to Aana, Aammiq and Deir Tahnich villages.

TABLE 5-2: SUMMARY OF WATER FACILITIES FOR AANA AAMMIQ SYSTEM BY YEAR 2035

System	Ground Reservoir			Pipe Diameter				
Description	Existing 500 m^3	Under.Const. 200 m^3	Under.Const. 100m^3	Ex. 150 mm	Ex. 125 mm	Ex. 100 mm	Ex 80 mm	Ex. 40 mm
Number/Length	1	1	1	1,495	3,550	2,300	130	750
Comments	---	---	---			---	---	---

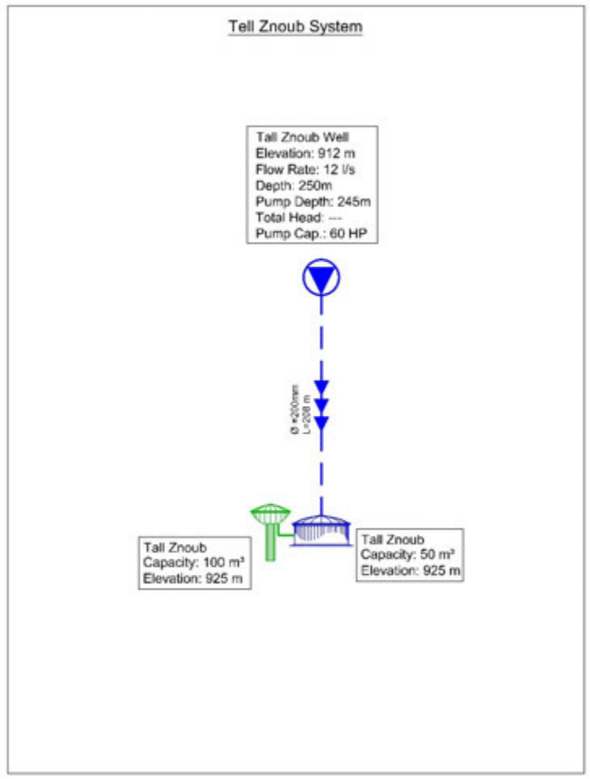


FIGURE 5-2: TELL ZNOUB SYSTEM

Tell Znoub system is an existing system.The existing length of water distribution network system in Tell Znoub is around 3,625 m but this networks needs replacement since it is in bad condition. The total length of the proposed water distribution network will be around 2,557 m.

System description:

Tell Znoub existing well will pump water to Tell Znoub existing ground reservoir (50 m^3) and elevated tank (100 m^3) ,that is under construction, through a 200 mm diameter existing pipe and this elevated tank will distribute water to Tell Znoub village. The existing well is in an acceptable condition; however, the existing ground reservoir (50 m^3) is in bad condition and it is subjected to leakage. This reservoir needs rehabilitation.

TABLE 5-3: SUMMARY OF WATER FACILITIES FOR TELL ZNOUB SYSTEM BY YEAR 2035

System	Ground Reservoir	Elevated Tank	Well	Pipe Diameter
Description	Existing 50 m^3	Under Const. 100 m^3	Existing	Existing 200 mm
Number/Length	1	1	1	208m
Comments	Needs Rehabilitation	---	---	---

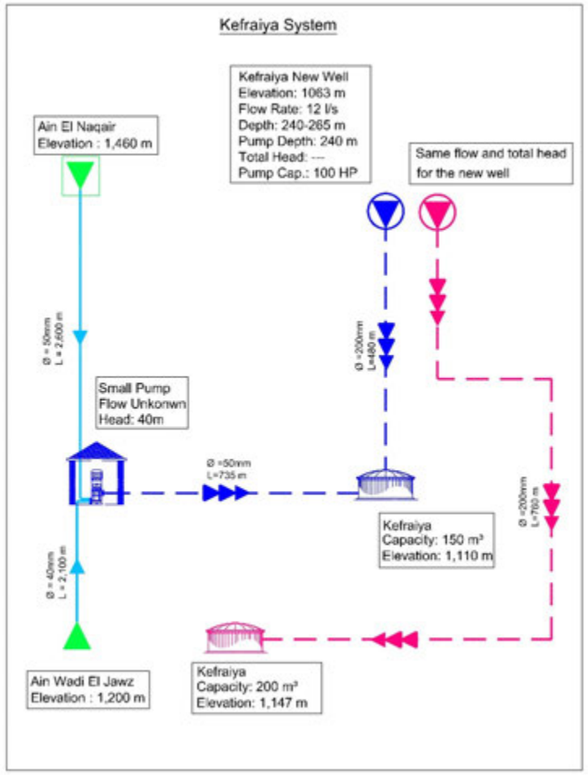


FIGURE 5-3: KEFRAIYA SYSTEM

Kefraiya system is a combined system. Existing water transmission system will be used along with a new system. The existing length of water distribution network system in Kefraiya is around 20,875 m but this networks needs replacement since it is in bad condition. The total length of the proposed water distribution network will be around 2,088 m.

System description:

Kefraiya existing well will pump water to Kefraiya existing (150 m³) and a new well with same capacity as the existing well will pump water to a proposed (200m³) reservoirs through 200 mm diameter proposed and existing pipes and these reservoirs will distribute water to Kefraiya village. Ain Wadi El Jawz and Ain el Naqair spring systems will be used to help supply water to the reservoirs. The existing ground reservoir (150 m³) is in good condition.

TABLE 5-4: SUMMARY OF WATER FACILITIES FOR KEFRAIYA SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter			
Description	Existing 150 m³	Proposed 200 m³	Existing	Existing 40 mm	Existing 50 mm	Proposed 200mm	Existing 200 mm
Number/Length	1	1	1	2,100m	3,335m	760m	480m
Comments	---	---	Drills a New Well	---	---	---	---

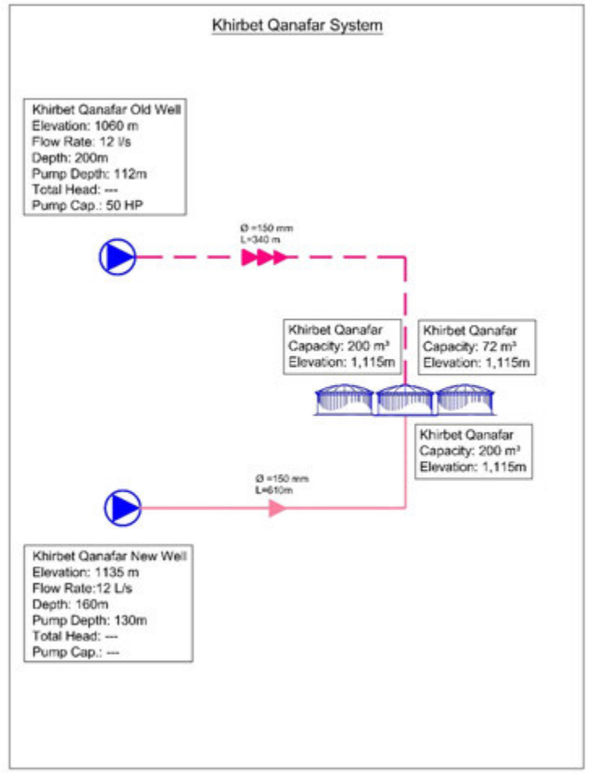


FIGURE 5-4: KHIRBET QANAFAR SYSTEM

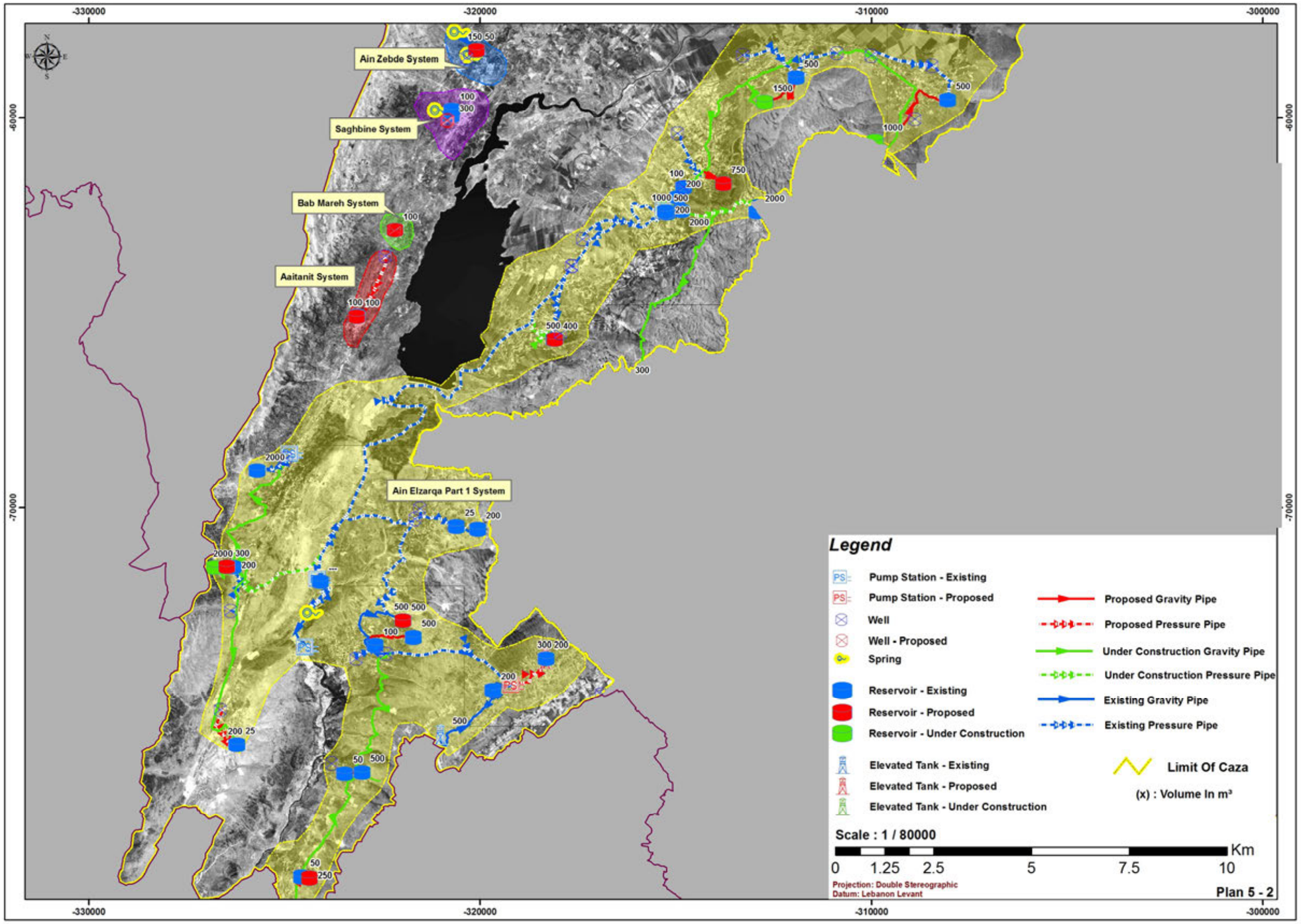
Khirbet Qanafar system is a combined system. Khirbet Qanafar spring system will be used as a backup due to the absence of relevant data regarding the system and springs. The existing length of water distribution network system is unknown. The total length of the proposed water distribution network will be around 20,285 m.

System description:

Khirbet Qanafar existing wells will pump water to Khirbet Qanafar existing reservoirs (200 m³, 200 m³ and 72 m³) through 150 mm diameter proposed pipe and these reservoirs will distribute water to Khirbet Qanafar village. Existing 75 mm diameter pipe will be replaced by a 150 mm new one to minimize losses. The existing ground reservoirs (200 m³, 200 m³ and 72 m³) are all in good condition.

TABLE 5-5: SUMMARY OF WATER FACILITIES FOR KHIRBET QANAFAR SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter
Description	Existing 72m³	Existing 200m³	Existing	Proposed 150 mm
Number/Length	1	2	2	950m
Comments	---	---	---	---



PLAN 5-2: AIN ZEBDE, BAB MAREH, AAITANIT, SAGHBINE AND AIN EL ZARQA PART 1 WATER SYSTEMS

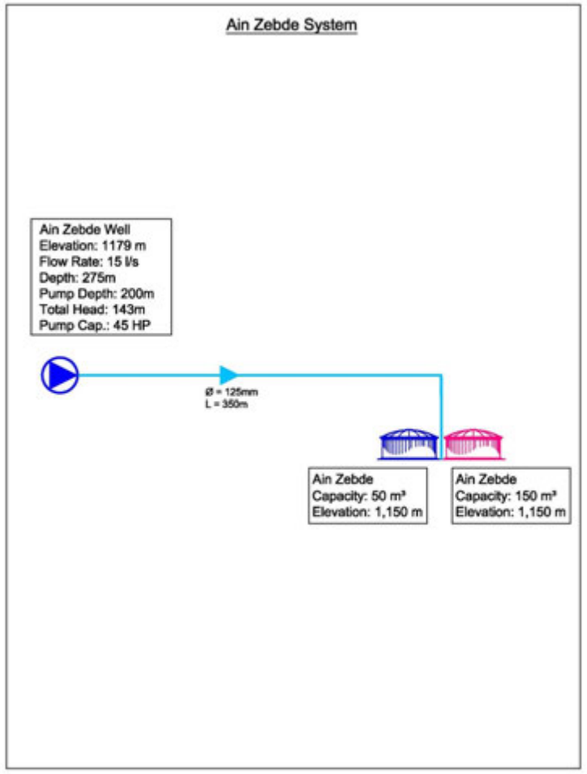


FIGURE 5-5: AIN ZEBDE SYSTEM

Ain Zebde system is an existing system. Existing water transmission system of Ain zebde well will be maintained; however, the Nabeh Al Asaffir and Nabeh Beit Faraj existing spring system will be used as backup due to the absence of relevant data regarding the system and springs. The existing length of water distribution network system in Ain Zebde is around 9,580 m but this networks needs replacement since it is in bad condition. The total length of the proposed water distribution network will be around 958 m.

System description:

Ain Zebde existing well will supply water by gravity to Ain Zebde existing (50 m³) and proposed (150 m³) reservoirs through 125 mm diameter existing pipe and these reservoirs will distribute water to Ain Zebde village. The existing ground reservoir (50 m³) is in acceptable condition. It needs some minor maintenance.

TABLE 5-6: SUMMARY OF WATER FACILITIES FOR AIN ZEBDE SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter
Description	Existing 50 m³	Proposed 150 m³	Existing	Existing 125 mm
Number/Length	1	1	1	350m
Comments	Needs Some Minor Maintenance	---	---	---

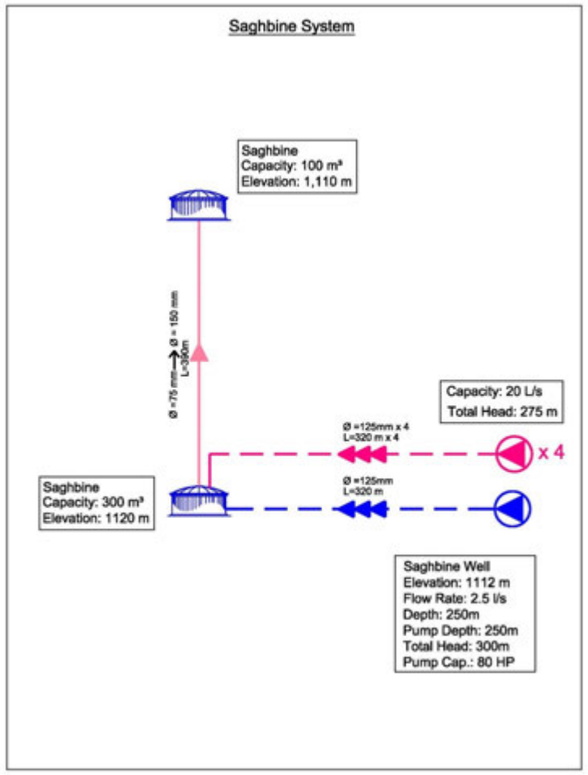


FIGURE 5-6: SAGHBINE SYSTEM

Saghbine system is a combined system. Existing water transmission system of Saghbine well will be adopted; however, the Ain Rmail existing spring system will be used as backup due to the absence of relevant data regarding the spring. The existing length of water distribution network system in Saghbine is around 11,920 m but this networks needs replacement since it is in bad condition. The total length of the proposed water distribution network will be around 1,192 m.

System description:

Saghbine existing well will pump water to Saghbine existing reservoir (300 m³) through a 125 mm diameter existing pipe and this reservoir is connected by gravity to another existing reservoir (100 m³) through a 150 mm diameter proposed pipe and they will distribute water to Saghbine village. Existing 75 mm diameter pipe will be replaced by a 150 mm diameter pipe to minimize losses. By the year 2035, four new wells shall be drilled with a total capacity of 20 l/s to cover the village demand. The existing ground reservoirs (300 m³ and 100 m³) are in acceptable condition. They need some minor maintenance. The existing well needs rehabilitation.

TABLE 5-7: SUMMARY OF WATER FACILITIES FOR SAGHBINE SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter		
Description	Existing 100 m³	Existing 300 m³	Existing	Existing 125 mm	Proposed 125 mm	Proposed 150 mm
Number/Length	1	1	1	320m	1,280m	390m
Comments	---	---	Drills Four New Wells	---	---	---

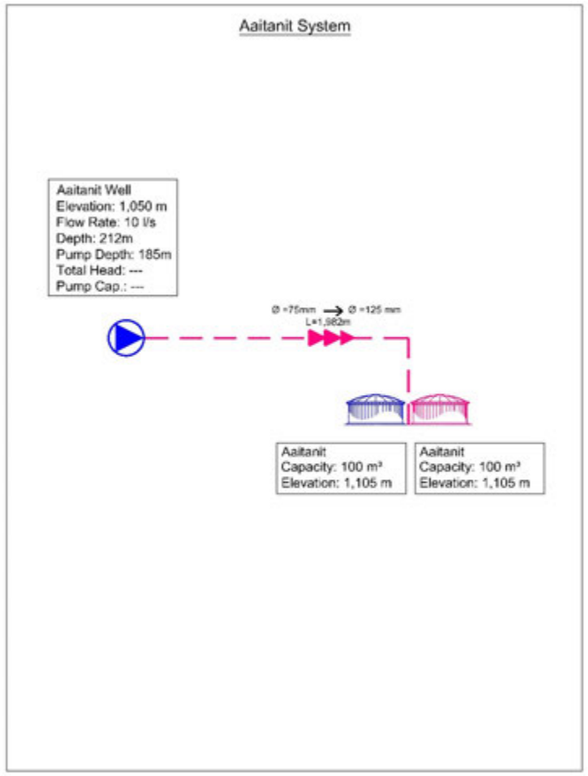


FIGURE 5-7: AAITANIT SYSTEM

Aaitanit system is a proposed system. Existing water transmission system of Aaitanit well will be replaced by a new one. The existing length of water distribution network system in Aaitatni is around 5,530 m and this network is in good condition. The total length of the proposed water distribution network will be around 2,655 m.

System description:

Aaitanit existing well will pump water to Aaitanit existing (100 m³) and proposed (100 m³) reservoirs through 125 mm diameter existing pipe and these reservoirs will distribute water to Aaitanit village. Existing 75 mm diameter pipe will be replaced by a 125 mm new one to minimize losses. The existing ground reservoir (100 m³) is in good condition. The existing well is very old and it is in bad condition. It needs rehabilitation

TABLE 5-8: SUMMARY OF WATER FACILITIES FOR AAITANIT SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter
Description	Existing 100 m³	Proposed 100 m³	Existing	Proposed 125 mm
Number/Length	1	1	1	1,982m
Comments	---	---	---	---

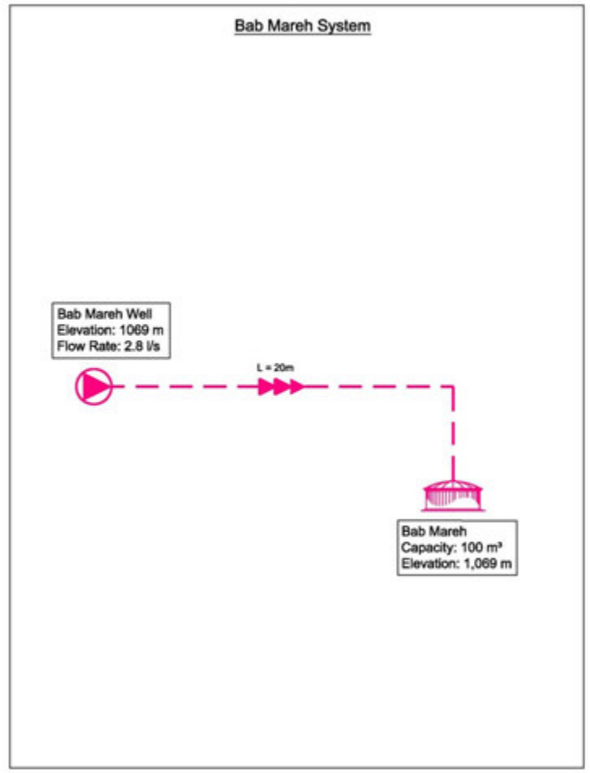


FIGURE 5-8: BAB MAREH SYSTEM

Bab Mareh system is a proposed system. Existing water transmission system of Rass El Nabeh and Ain El Saiedeh will be used as backup will be used as backup due to the absence of relevant data regarding the spring. The existing length of water distribution network system in Bab Mareh is unknown. The total length of the proposed water distribution network will be around 3,840 m.

System description:

Bab mareh proposed well will pump water to Bab Mareh proposed reservoir (100 m³). This reservoir will distribute water to Bab Mareh village. Location of this well shall be selected based on local hydrogeological data.

TABLE 5-9: SUMMARY OF WATER FACILITIES FOR BAB MAREH SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Proposed 100 m³	Proposed Well	TBD
Number/Length	1	1	20m
Comments	---	Needs Hydrogeological Analysis	Based on Pump Head and Flow

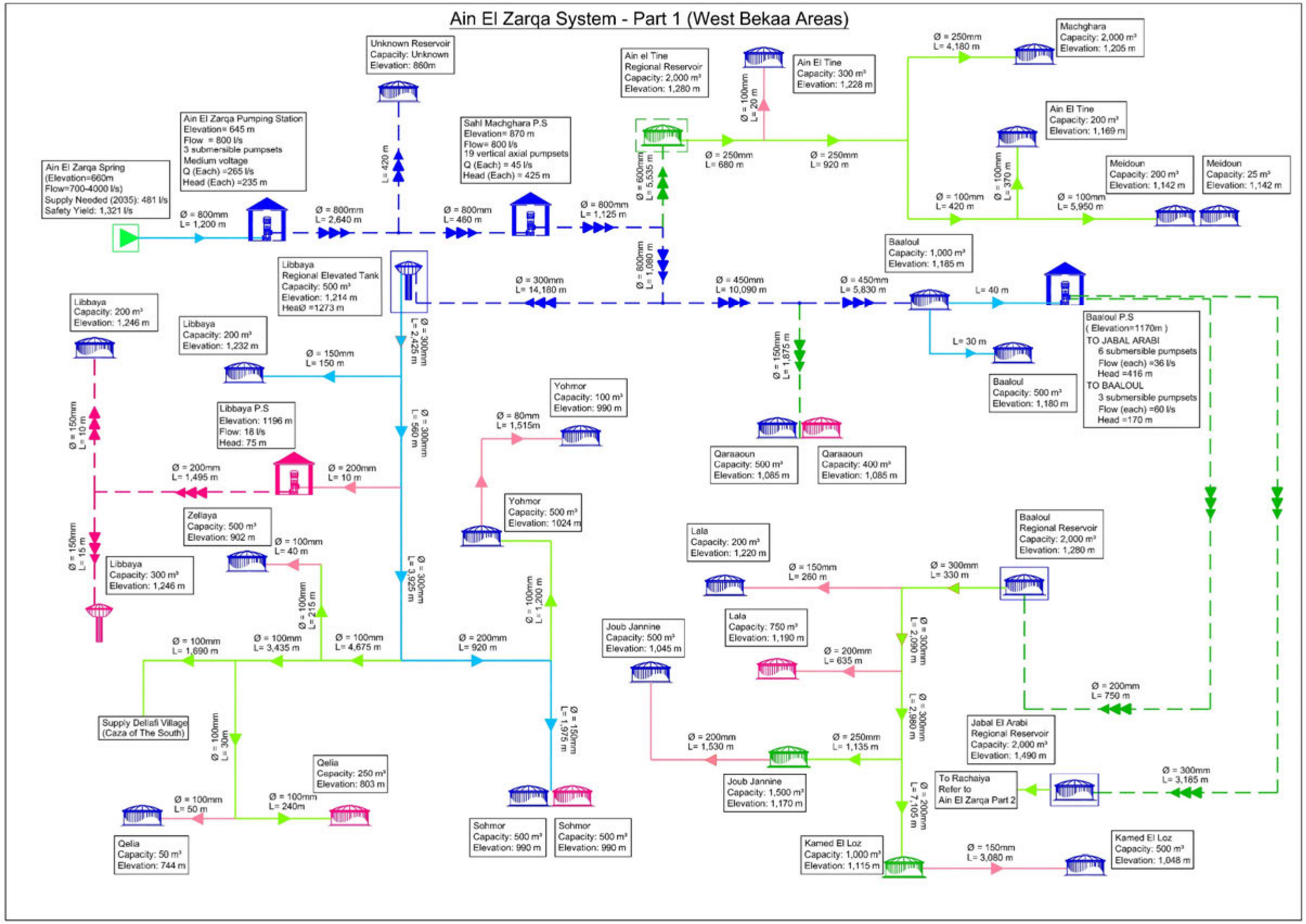


FIGURE 5-9: AIN EL ZARQA- PART 1 SYSTEM

Ain Ez Zarqa is a combined system, it currently supplies for regional reservoirs in the areas of West Bekaa and Rachaya cazas through four regional reservoirs Libbaya (500 m³), Baaloul (1,000 m³), Jabal El Arabi (2000 m³) and Ain El Tine (Not constructed yet) (2,000 m³)

- *Libbaya regional reservoir (500 m³):*

  Libbaya, Zellaya, Dellafi, Qelia, Yohmor and Sohmor will be fed from the proposed Libbaya regional reservoirs at an elevation of 1,214 m. An existing pump station is taking water from Ain El Zarqa spring bottom catchment structure and it is pumping water to Sahl Machghara pump station.

  Water is pumped from proposed Sahl Machghara pump station to Libbaya, Baaloul and Ain El Tine (in the future) regional reservoirs with a capacity of 500 m³, 1,000 m³ and 2,000 m³ respectively.

- *Baaloul regional reservoir (2000 m³):*

  Baaloul, Lala, Kamed El Loz and Joub Jannine will be fed from the regional reservoir of Baaloul (2000 m³). Water will be pumped from baaloul existing reservoir (1,000 m³) to the Baaloul existing regional reservoir, through a pump station, at an elevation 1,285 m with a capacity of 2,000 m³.

- *Ain El Tine regional reservoir (2000 m³, Not constructed yet):*

  Ain El Tine, Machghara, Meidoun will be fed from the proposed Ain el Tine regional reservoirs at an elevation of 1,280 m. Water will be pumped from Sahl Machghara pump station to Ain El Tine regional reservoir at an elevation 1,280 m with a capacity of 2,000 m³.

- *Jabal El Arabi regional reservoir (2000 m³):*

  It will be discussed under Ain El Zarqa system Part 2 in Rachaiya Caza

Qaaraoun village will be fed directly from Ain El Zarqa spring through Sahl Machghara pump station.

The adopted safe yield for Ain El Zarqa spring is around 1321 l/s. The supply is larger than the average daily demand of the villages served by the system in year 2035 which will be 481 l/s. Thus the system is acceptable.

All existing small systems in the villages of Ain El Zarqa system will be used as backup.

In some villages, the capacities of the reservoirs are increased to meet the population demand in year 2035.

Libbaya (200m³), Kamed El Loz (500 m³) and Joub Jannine (500 m³) existing reservoirs need rehabilitation; Libbaya (200 m³), Zellaya (500 m³), Qelia (50m³), Lala (200 m³), Qaraoun (500 m³), Baaloul (500 m³), Machghara (2,000 m³), Ain El Tine (200 m³) and Maidoun (200 m³) existing reservoirs need some minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 184,515 m.

TABLE 5-10: SUMMARY OF WATER FACILITIES FOR AIN EL ZARQA- PART 1 SYSTEM BY YEAR 2035

Ain El Zarqa - Part 1 (West Bekaa) System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	unknown	1	**Pipe**	*Gravity - Existing*	150	2,125
		25	1			200	920
		50	1			300	6,910
		100	1		*Gravity - Under Construction*	100	18,225
		200	5			200	7,105
		300	1			250	6,915
		500	7			300	5,400
		1,000	1		*Gravity - Proposed*	80	1,515
		2,000	3			100	110
	Under Construction	1,000	1			150	3,350
		1,500	1			200	2,175
		2,000	1			300	14,180
	Proposed	250	1		*Pressurized - Existing*	450	15,920
		400	1			800	6,505
		500	1			150	1,875
		750	1		*Pressurized - Under Construction*	200	750
Elevated Tank	*Existing*	500	1			300	3,185
	Proposed	300	1			600	5,535
Pump Station	*Existing*	---	3		*Pressurized - Proposed*	150	15
	Proposed	---	1			200	1,495

5.3 Spring Water Supply vs Demand for West Bekaa Regional Systems

TABLE 5-11: SPRING WATER SUPPLY VS DEMAND FOR REGIONAL SYSTEMS IN WEST BEKAA CAZA

System	Average Demand Flow (Year 2013) (l/s)	Average Demand Flow (Year 2025) (l/s)	Average Demand Flow (Year 2035) (l/s)	Average Yearly Flow (Reference) (l/s)	Adopted Safe (Dry Year) Yield Flow (l/s)	System Status	Comments
Ain El Zarqa System	328	404	481	2,642 LRA (2009-2013)	1,321	Existing/ Under Construction	Adopted water quantity is more than water demand - System is Ok
Aana/ Aammiq System	10	12	14	370 LRA (2009-2013)	185	Under Construction	Adopted water quantity is more than water demand - System is Ok

* The adopted safe (dry year) yield flow is the average yearly flow/ 2.

5.4 Summary of Water Facilities for Systems of West Bekaa Caza by Year 2035

TABLE 5-12: NUMBER OF RESERVOIRS IN CAZA OF WEST BEKAA

Reservoir Facility	Volume (m^3)														Total	Total Storage (m^3)
	25	50	75	100	150	200	250	300	400	500	750	1000	1500	2000		
Reservoir - Existing	1	3	1	3	1	7	-	2	-	8	-	1	-	3	30	13,700
Reservoir - Under Construction	-	-	-	1	-	1	-	-	-	-	-	1	1	1	5	4,800
Reservoir - Proposed	-	-	-	2	1	1	1	-	1	1	1	-	-	-	8	2,450
Elevated Tank - Existing	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	500
Elevated Tank - Under Construction	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	100
Elevated Tank - Proposed	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	300
Total	**1**	**3**	**1**	**7**	**2**	**9**	**1**	**3**	**1**	**10**	**1**	**2**	**1**	**4**	**46**	**21,850**

TABLE 5-13: NUMBER OF WELLS USED IN WEST BEKAA CAZA

Village Name	Existing well	Proposed well
Tall Znoub	1	---
Kefraiya	1	1
Khirbet Qanafar	2	---
Ain Zebde	1	---
Saghbine	1	2
Aaitanit	1	---
Bab Mareh	0	1
Total	**7**	**4**

TABLE 5-14: CHARACTERISTICS OF PROPOSED PUMP STATIONS IN CAZA OF WEST BEKAA

Pump Station Name	Status	Ground Elevation (m)	Capacity Needed in year 2035 (L/s)	Total Head Needed (m)
Libbaya	Proposed- Booster	1,196	18	75

TABLE 5-15: LENGTHS OF PROPOSED TRANSMISSION PIPE SYSTEMS IN CAZA OF WEST BEKAA

Type	Diameter (mm)	Total length (m)
Ductile Iron	80	1,515
	100	110
	125	3,262
	150	4,705
	200	4,430

TABLE 5-16: LENGTHS OF EXISTING AND PROPOSED WATER DISTRIBUTION NETWORK FOR WEST BEKAA CAZA

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Ain El Tine	9,411	---	---	---	---	9,411
Ain Zebdé	10,537	9,579	V.G	W.C	None	958
Aaitanit	8,183	5,529	V.G	M.C	None	2,654
Aammiq	5,961	5,419	V.G	W.C	None	542
Aana	10,409	9,463	V.G	W.C	None	946
Baaloul	16,590	---	---	---	---	16,590
Bab Mareh (Deir Ain ej Jaouzé)	5,011	586	---	---	---	4,425
Dakoué (El) (Salmiyeh El Rachidiye)	10,201	9,273	V.G	W.C	None	928
Deir Tahnich	2,929	2,663	V.G	W.C	None	266
Fadar El Faouka *	---	---	---	---	---	---
Fadar El Tahta *	---	---	---	---	---	---
Ghazze	35,233	32,030	V.G	W.C	None	3,203
Hammara (Manara)	31,098	28,271	V.G	W.C	None	2,827
Haouch El Harime (Jeziré (El) ,Harimet es Soghra)	26,570	24,155	V.G	W.C	None	2,415
Joubb Jannine	50,544	45,949	V.G	W.C	None	4,595
Kamed el Loz	38,377	34,889	V.G	W.C	None	3,488
Kefraiya	22,965	20,877	V.G	W.C	None	2,088
Khiara (El)	9,935	9,032	V.G	W.C	None	903
Khirbet Qanafar	20,284	---	---	---	---	20,284
Lala	12,489	---	---	---	---	12,489
Libbaya	17,716	---	---	---	---	17,716
Loussa *	---	---	---	---	---	---
Machghara	26,241	23,855	---	W.C	Rehabilitation	2,386
Maidoun	8,769	---	---	---	---	8,769
Manara (Hammara)	---	---	---	---	---	---
Mansoura	11,542	10,493	V.G	W.C	None	1,049
Marj (El)	55,004	50,004	V.G	W.C	None	5,000
Ouaqf (El) *	---	---	---	---	---	---
Qaraaoun (El)	4,988	---	---	---	---	4,988
Qelia	11,877	---	---	---	---	11,877
Raouda	4,374	3,977	V.G	W.C	None	397
Saghbine	13,111	11,919	V.G	W.C	None	1,192
Sohmor	44,415	---	B	---	---	44,415
Saouiri	49,017	44,561	V.G	W.C	None	4,456
Sltan Yaqoub El Aradi (Sltan Yacoub el Fouqa)	---	---	---	---	---	---

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Sltan Yacoub el Fouqa	6,311	---	---	---	---	6,311
Sltan Yaqoub el Tahta	22,693	20,630	V.G	W.C	None	2,063
Tell Ez Zaazaa	3,055	2,778	V.G	W.C	None	277
Tell Znoub	6,184	3,627	V.G	M.C	None	2,557
Yohmor el Beqaa	18,840	---	---	---	---	18,840
Zellaya	5,095	---	---	---	---	5,095
Total	**635,959**	**409,559**	**---**			**226,400**

6 RACHAIYA CAZA

The water demand projections and the required storage for the different villages and localities of Rachaiya are presented in tabular form in section 6.1 for the study year and the design horizons of 2025 and 2035. The schematics or functional diagrams for the supply systems are presented in section 6.2 with the existing infrastructure in blue, the proposed infrastructure in red, and the infrastructure under construction in green.

Each system is described and its components sized up. All systems are shown on the attached plans showing their geographic extent in the caza.

Section 6.3 summarizes all the facilities and infrastructure components that the systems serving the caza in question will be composed of; namely the:

- Reservoirs,
- Wells,
- Pumping/boosting stations,
- Transmission lines,
- Distribution networks.

The total length of distribution networks required by the design horizon is presented. The length and status of the existing networks is also presented. The total length proposed for construction is then calculated based on the need for extension and replacement.

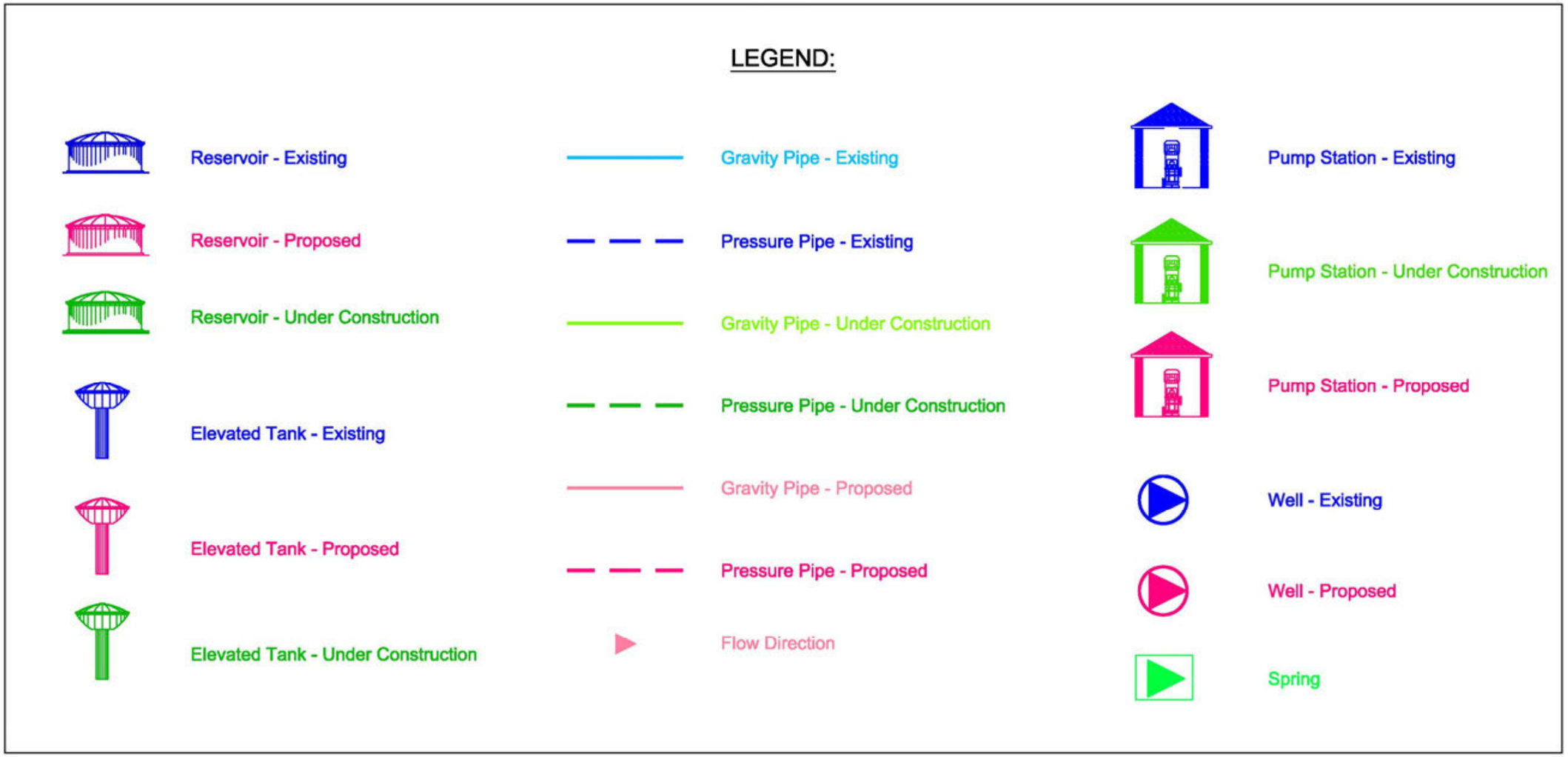
6.1 Water Demand for Rachaiya Caza

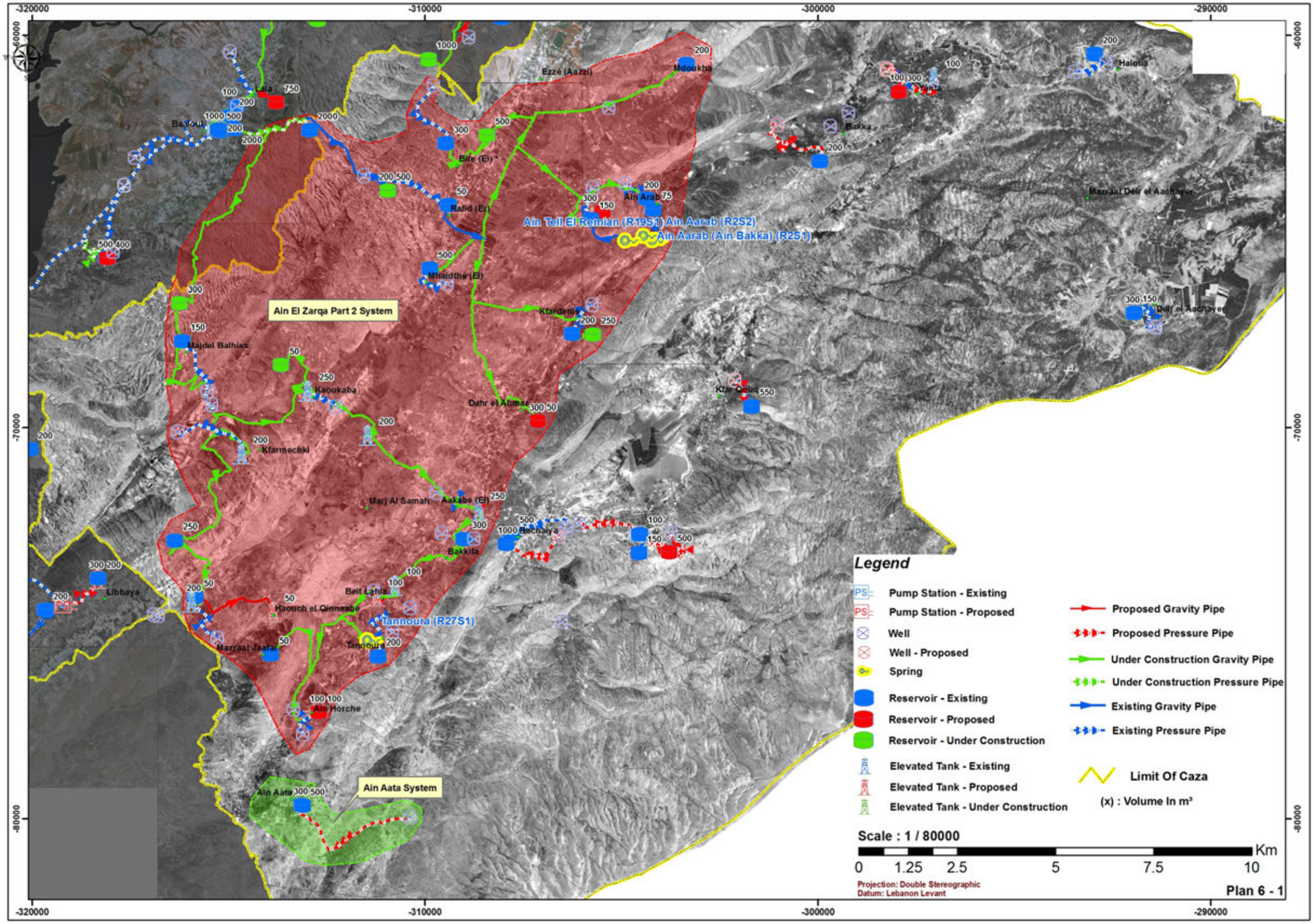
TABLE 6-1: WATER DEMAND AND REQUIRED STORAGE FOR RACHAIYA CAZA

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)
1	Aaiha	3,500	630	338	4,310	810	418	5,127	1,000	501
2	Aain Arab	664	120	114	818	154	129	972	190	144
3	Aakabe (El)	2,227	401	237	2,743	516	288	3,262	636	341
4	Ain Aata	2,308	415	244	2,842	534	296	3,380	659	351
5	Ain Horche	1,007	181	141	1,239	233	164	1,474	287	187
6	Aita El Foukhar	2,420	436	253	2,980	560	308	3,545	691	365
7	Bakka	1,215	219	157	1,497	281	185	1,780	347	214
8	Bakkifa	1,719	309	197	2,116	398	236	2,517	491	277
9	Beit Lahia	996	179	140	1,226	231	162	1,459	284	186
10	Bire (El)	5,600	1,008	505	6,896	1,296	631	8,202	1,599	765
11	Dahr el Ahmar	2,259	407	240	2,782	523	291	3,309	645	345
12	Deir el Aachayer	1,108	199	149	1,365	257	174	1,623	317	200
13	Ezzé (Bire (El))	---	---	---	---	---	---	---	---	---
14	Haloua	150	27	73	185	35	76	220	43	80
15	Haouch El Qinnaabe	1,500	270	180	1,847	347	214	2,197	428	250
16	Kaoukaba	1,215	219	157	1,497	281	185	1,780	347	214
17	Kfar Qouq	3,200	576	314	3,941	741	387	4,687	914	463
18	Kfardenis	1,708	307	196	2,103	395	235	2,502	488	276
19	Kfarmechki	1,173	211	154	1,444	271	180	1,717	335	208
20	Khirbet Rouha	4,267	768	399	5,255	988	496	6,250	1,219	597
21	Majdel Balhiss	1,419	255	173	1,747	328	206	2,078	405	239
22	Mazraat Deir el Aachayer *	---	---	---	---	---	---	---	---	---
23	Mazraat Jaafar (Haouch El Qinnaabe)	---	---	---	---	---	---	---	---	---
24	Mazraat Salsata *	---	---	---	---	---	---	---	---	---
25	Mdoukha	1,306	235	164	1,609	302	194	1,913	373	225
26	Mhaidthé (El)	1,697	305	195	2,090	393	234	2,486	485	274
27	Nabaat *	---	---	---	---	---	---	---	---	---
28	Qennabé (Haouch El Qinnaabe)	---	---	---	---	---	---	---	---	---
29	Rachaiya (Rachaya el Wadi)	---	---	---	---	---	---	---	---	---
30	Rachaya el Faouka (Rachaya el Wadi)	---	---	---	---	---	---	---	---	---
31	Rachaya El Kouasbe (Rachaya el Wadi)	---	---	---	---	---	---	---	---	---

No.	Town Name	Year 2013			Year 2025			Year 2035		
		Estimated Population	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2025)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)	Projected Population (2035)	Average Daily Demand (m^3/d)	Total Volume Required (m^3)
32	Rachaya el Wadi	8,277	1,490	717	10,193	1,916	965	12,124	2,364	1,162
33	Rafid (Er)	4,979	896	455	6,132	1,153	568	7,293	1,422	687
34	Tannoura	1,007	181	141	1,239	233	164	1,474	287	187
35	Yanta	3,421	616	332	4,213	792	409	5,011	977	491
	Rachaiya Total	**60,342**	**10,862**	**6,365**	**74,309**	**13,970**	**7,795**	**88,382**	**17,234**	**9,229**

6.2 Water Systems for Rachaiya Caza





PLAN 6-1: AIN EL ZARQA PART 2 AND AIN AATA WATER SYSTEMS

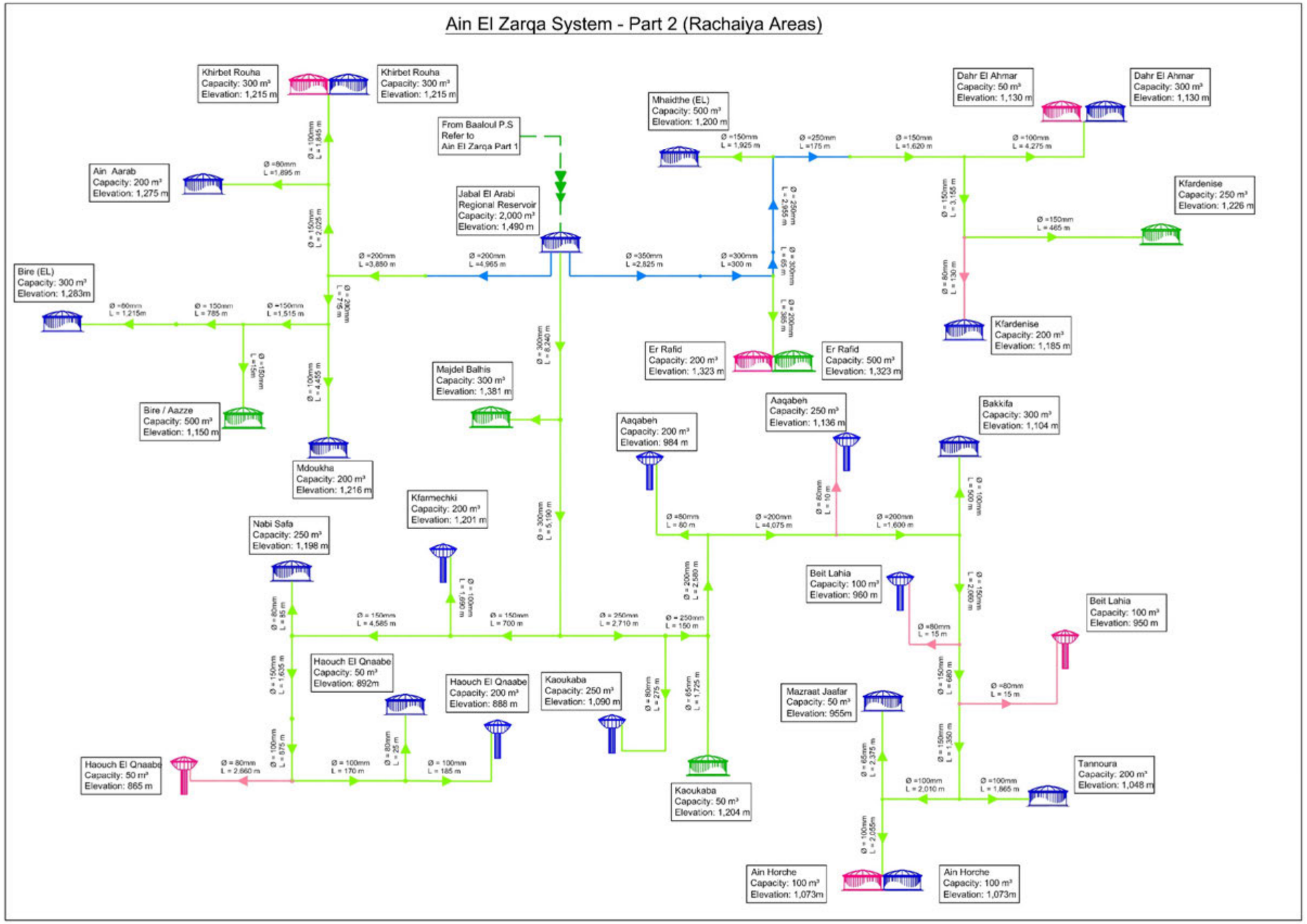


FIGURE 6-1: AIN EL ZARQA PART 2 SYSTEM

➢ *Jabal El Arabi Regional Reservoir (2000 m³)*

Jabal el Arabi regional reservoir is at an altitude of 1490 m and has a capacity of 2,000 m³. It is fed from Ain Ez Zarqa project by a system of 33 l/s pumps each installed in parallel, with a 300 mm pressure pipe, designed for a daily average flow of 140.11 l/s. This reservoir will feed mainly Rachaiya Areas.

There are existing local wells currently operating and will remain as backup systems to supply the local reservoirs in addition to the supply from Jabal El Arabi Regional Reservoir.

Khirbet Rouha, Ain Arab, Bire (El), Aazze, Mdoukha, Nabi Safa, Haouch El Qinnabe, Kaoukaba, Kfarmechki, Majdel Balhis, Aaqabeh, Er Rafid, Bakkifa, Beit Lahia, Mazraat Jaafar, Tannoura, Ain Horche, Kfardenise, Dahr El Ahmar and Mhaidthe (El) will be fed from Jabal El Arabi regional reservoir.

In some villages, the capacities of the reservoirs are increased to meet the population demand in year 2035.

Mdoukhar (200 m³), Bire (El) (300 m³), Haouch El Qennabe (50 m³), Tannoura (200 m³), Bakkifa (300 m³) and Kfardenise (200 m³) existing reservoirs need rehabilitation; Mhaidthe (El) (500 m³), Khirbet Rouha (300 m³), Mdoukha (200 m³), Kfarmechki (200 m³), Kaoukaba (250 m³), Beit Lahia (100 m³) and Aaqabeh (250 m³) existing reservoirs need some minor maintenance; the remaining reservoirs are in good condition.

The total length of water distribution network (including both proposed and existing network that needs replacement or rehabilitation) for this system will be 75,433 m.

TABLE 6-2: SUMMARY OF WATER FACILITIES FOR AIN EL ZARQA PART 2 SYSTEM BY YEAR 2035

Ain El Zarqa (Rachaiya) System							
Facility	**Status**	**Capacity (m³)**	**Number**	**Facility**	**Status**	**Diameter (mm)**	**Number/ Length (m)**
Ground Reservoir	*Existing*	50	2	**Pipe**	*Gravity - Existing*	200	4,965
		100	1			250	3,130
		200	4			300	365
		250	1			350	2,825
		300	4		*Gravity - Under Construction*	65	4,100
		500	1			80	3,495
		2,000	1			100	19,925
	Under Construction	50	1			150	22,515
		250	1			200	13,235
		300	1			250	2,860
		500	2			300	13,430
	Proposed	50	1		*Gravity - Proposed*	80	2,830
		100	1				
		200	1				
		300	1				
Elevated Tank	*Existing*	100	1				
		200	3				
		250	2				
	Proposed	50	1				
		100	1				

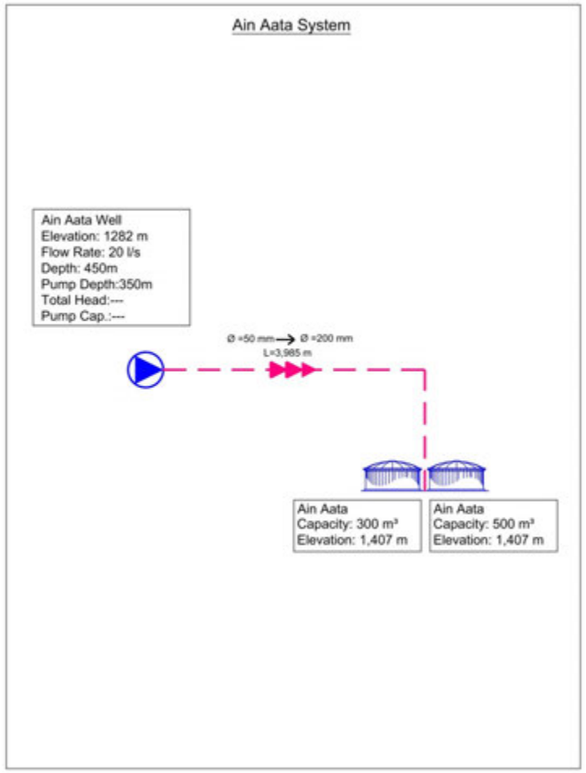


FIGURE 6-2: AIN AATA SYSTEM

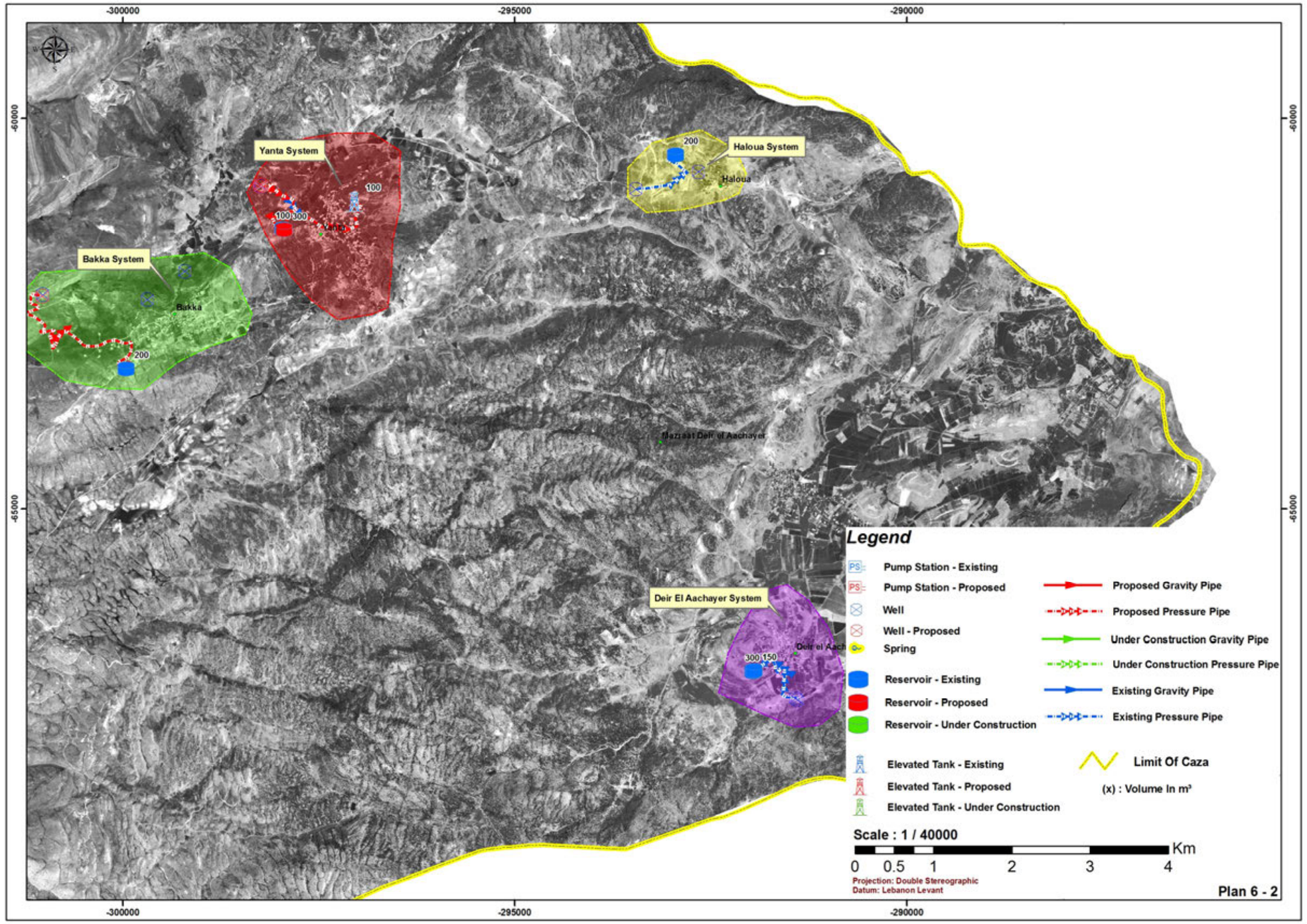
Ain Aata system is a proposed system. Existing water transmission system of Ain Aata well will be replaced by a new one. However, the existing water system of Ain El Maleh spring will be used as backup. The existing length of water distribution network system in Ain Aata is unknown. The total length of the proposed water distribution network will be around 20,610 m.

System description:

Ain Aata existing well will pump water to Ain Aata existing reservoirs (300 m³ & 500 m³) through a 200 mm diameter proposed pipe and these reservoirs will distribute water to Ain Aata village. Existing 50 mm pipe diameter will be replaced by a 200 mm new one to minimize losses. The existing ground reservoirs are in good condition. The existing well condition is unknown.

TABLE 6-3: SUMMARY OF WATER FACILITIES FOR AIN AATA SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter
Description	Existing 300 m³	Existing 500 m³	Existing	Proposed 200 mm
Number/Length	1	1	1	3,985m
Comments	---	---	---	---



PLAN 6-2: HALOUA, YANTA, DEIR EL ACHAYER AND BAKKA WATER SYSTEMS

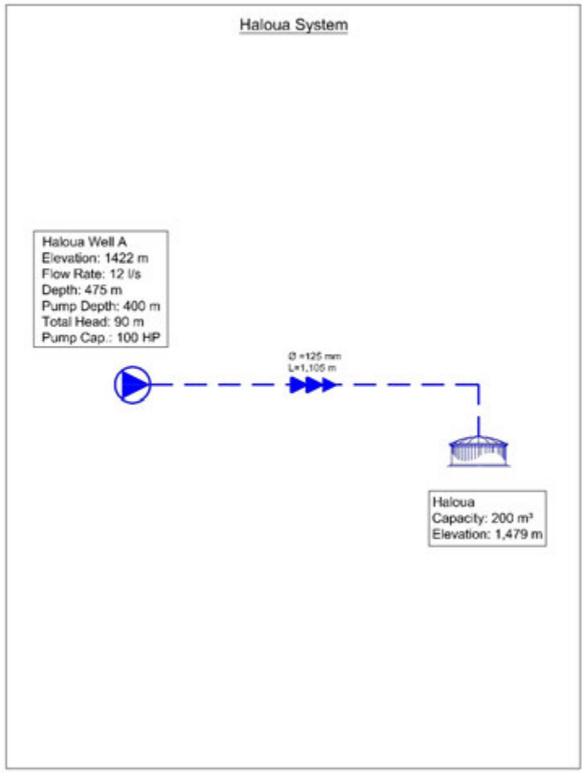


FIGURE 6-3: HALOUA SYSTEM

Haloua system is an existing system. Existing water transmission system of Haloua well will be used. The existing length of water distribution network system in Haloua is unknown. The total length of the proposed water distribution network will be around 2,430 m.

System description:

Haloua existing well will pump water to Haloua existing reservoirs (200 m³) through a 125 mm diameter existing pipe and this reservoir will distribute water to Haloua village. The existing ground reservoir is in good condition. The existing well is in bad condition and it needs minor maintenance.

TABLE 6-4: SUMMARY OF WATER FACILITIES FOR HALOUA SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter
Description	Existing 200 m³	Existing	Existing 125 mm
Number/Length	1	1	1,105m
Comments	---	---	---

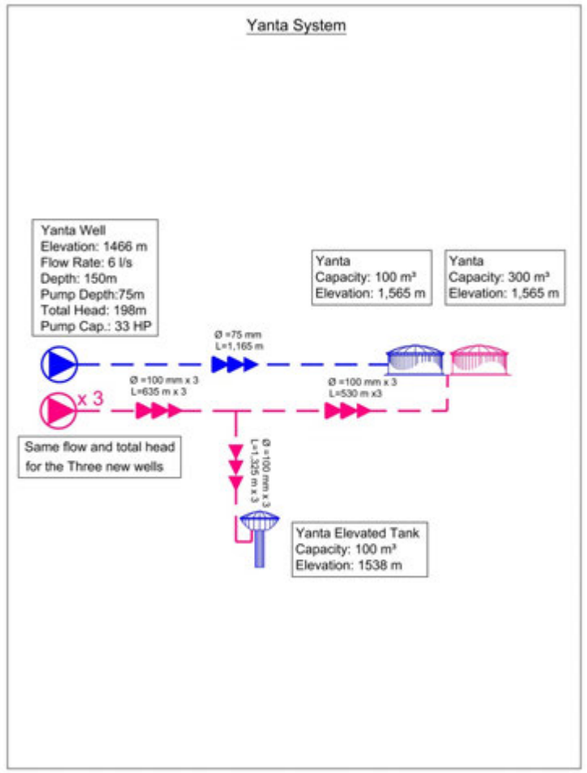


FIGURE 6-4: YANTA SYSTEM

Yanta system is a combined system. The existing water system of Ain Mansia spring will be used as backup. The existing length of water distribution network system in Yanta is unknown. The total length of the proposed water distribution network will be around 16,280 m.

System description:

Yanta existing well will pump water to Yanta existing and proposed ground reservoirs (100 m³, 300 m³) through a 75 mm diameter existing pipe and these reservoirs will distribute water to Yanta village. By the year 2035, three new wells shall be drilled to cover the water demand of the village. These wells will feed individually the three reservoirs through 100 mm diameter proposed pipe. The existing reservoirs are in good condition they need minor maintenance.

TABLE 6-5: SUMMARY OF WATER FACILITIES FOR YANTA SYSTEM BY YEAR 2035

System	Ground Reservoir		Elevated Tank	Well	Pipe Diameter	
Description	Existing 100 m³	Proposed 300 m³	Existing 100 m³	Existing	Existing 75 mm	Proposed 100 mm
Number/Length	1	1	1	1	1,165m	7,470m
Comments	Needs some Minor Maintenance	---	Needs some Minor Maintenance	Drill 3 New Wells	---	---

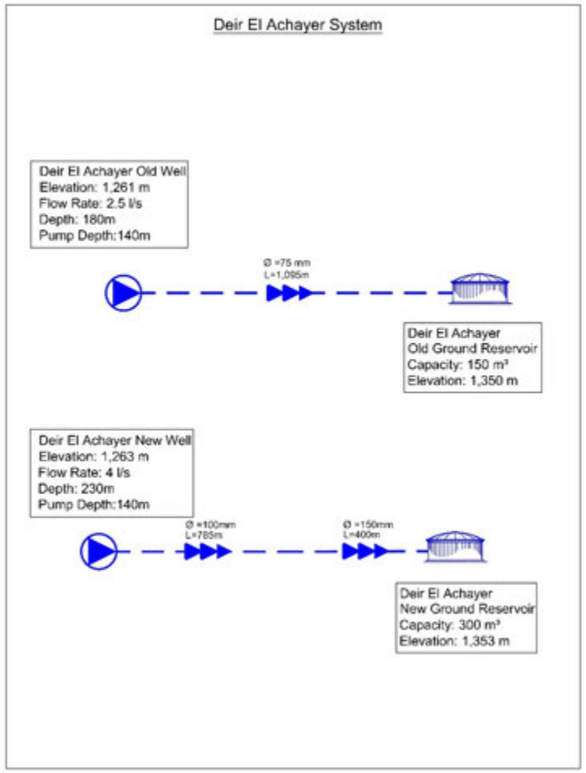


FIGURE 6-5: DEIR EL ACHAYER SYSTEM

Deir el Achayer system is an existing system. Existing water transmission systems of Deir El Achayer new and old wells will be used. The existing length of water distribution network system in Deir El Achayer is 8,673 m but its condition is unknown. The total length of the proposed water distribution network will be around 867 m.

System description:

Deir el Achayer existing new and old wells will pump water to Deir El Achayer existing reservoirs (300 m³ and 150 m³) through 75 mm, 100 mm and 150 mm diameters existing pipes and these reservoirs will distribute water to Deir El Achayer village. No available information regarding the condition of the reservoirs.

TABLE 6-6: SUMMARY OF WATER FACILITIES FOR DEIR EL ACHAYER SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pipe Diameter		
Description	Existing 150 m³	Proposed 300 m³	Existing	Existing 75 mm	Existing 100 mm	Existing 150 mm
Number/Length	1	1	2	1,095m	785m	400m
Comments	Unknown Information	Unknown Information	Redevelopment or New Well Required	---	---	---

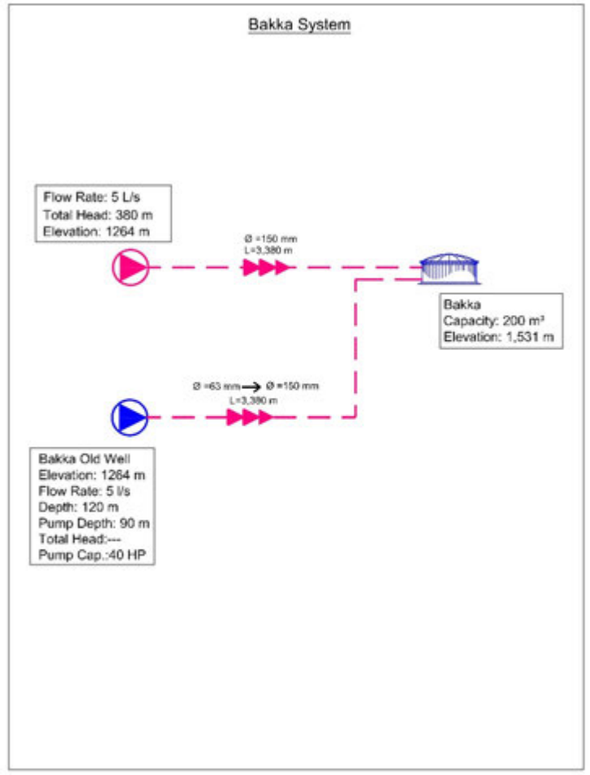


FIGURE 6-6: BAKKA SYSTEM

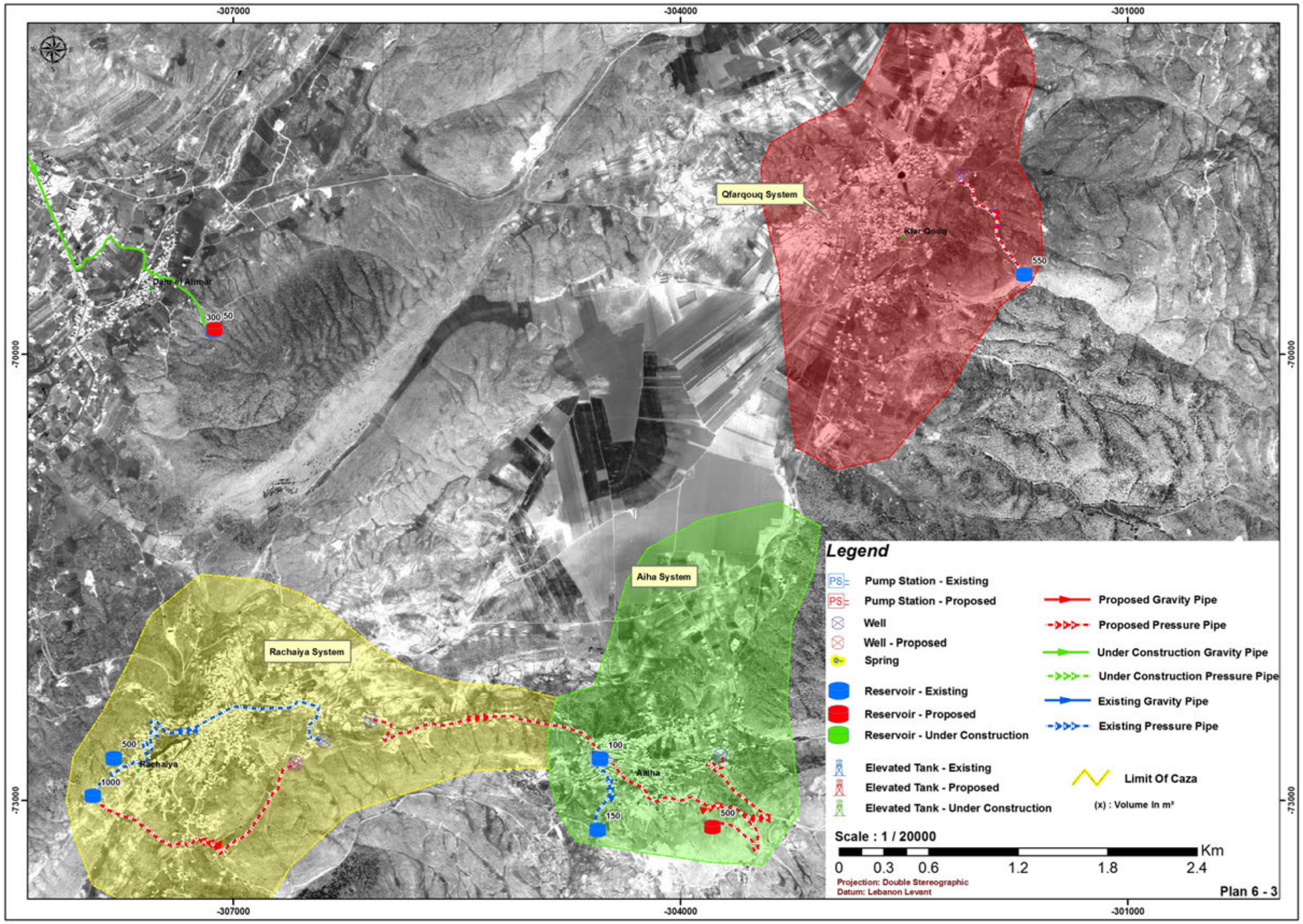
Bakka system is a proposed system. Existing water transmission system of Bakka well will be replaced by a new one. The existing length of water distribution network system in Bakka is 10,600 m and it is in bad condition. The total length of the proposed water distribution network will be around 1,060m.

System description:

Bakka existing and new wells will pump water to Bakka existing reservoir (200 m³) through two 150 mm diameter proposed pipes and this reservoir will distribute water to Bakka village. The existing well is in bad condition. The existing reservoir is in bad condition and it needs rehabilitation.

TABLE 6-7: SUMMARY OF WATER FACILITIES FOR BAKKA SYSTEM BY YEAR 2035

System	Ground Reservoir	Well		Pipe Diameter
Description	Existing 200 m³	Proposed	Existing	Proposed 150 mm
Number/Length	1	1	1	6,760 m
Comments	Needs Rehabilitation	---	---	---



PLAN 6-3: AIHA, QFARQOUQ AND RACHAIYA WATER SYSTEMS

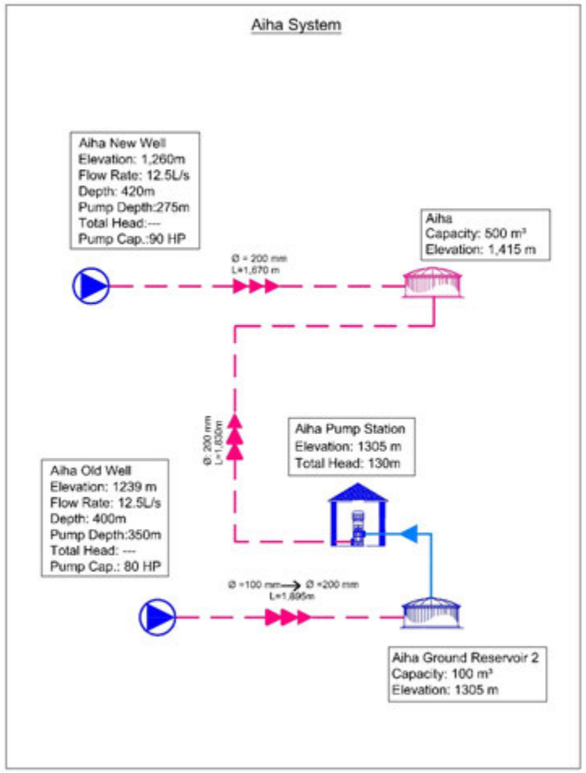


FIGURE 6-7: AIHA SYSTEM

Aiha system is a combined system. The existing length of water distribution network system in Aiha is 17,315 m and it is in bad condition. The total length of the proposed water distribution network will be around 1,731 m.

System description:

Aiha existing new and old wells will pump water to Aiha proposed reservoir (500 m³) through a 200 mm diameter proposed pipe and an existing pump station that pump water from an existing reservoir (100m³). The proposed reservoir will distribute water to Aiha village. The existing wells shall be redeveloped or a new well shall be drilled to increase the yield. The existing new well is in good condition but the old well needs rehabilitation.

TABLE 6-8: SUMMARY OF WATER FACILITIES FOR AIHA SYSTEM BY YEAR 2035

System	Ground Reservoir		Well	Pump Station	Pipe Diameter
Description	Proposed 500m³	Existing 100m³	Proposed	Existing	Proposed 200 mm
Number/Length	1	1	2	1	5,395
Comments	---	Needs Rehabilitation	---	Needs Rehabilitation	---

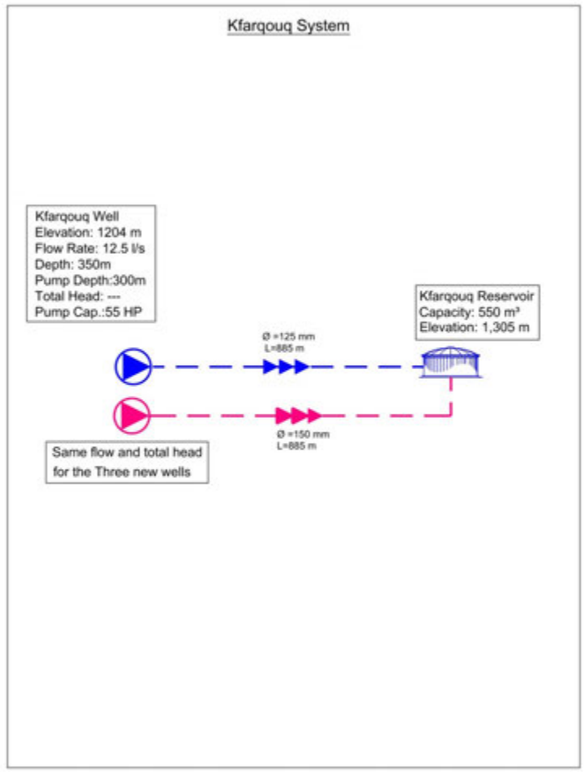


FIGURE 6-8: KFARQOUQ SYSTEM

Kfarqouq system is a combined system. Existing water transmission system of Kfarqouq well will be adopted. The existing length of water distribution network system is unknown. The total length of the proposed water distribution network will be around 36,324 m.

System description:

Kfarqouq existing well will pump water to Kfarqouq existing reservoir (550 m³) through a 125 mm diameter existing pipe and this reservoir will distribute water to Kfarqouq village. By the year 2035, a new well with same capacity of the existing one is needed to cover the water demand of the village. This well will feed individually the existing reservoir through 150 mm diameter proposed pipe. The existing reservoir is old but it is in acceptable condition. It needs some minor maintenance.

TABLE 6-9: SUMMARY OF WATER FACILITIES FOR KFARQOUQ SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter	
Description	Existing 550 m³	Existing	Existing 125 mm	Proposed 150 mm
Number/Length	1	1	885m	885m
Comments	Needs Rehabilitation	Drill a New Well	---	---

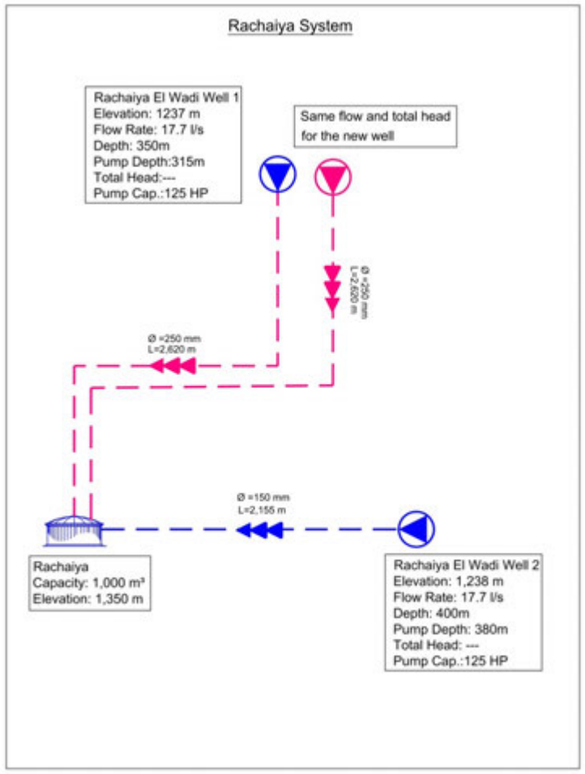


FIGURE 6-9: RACHAIYA SYSTEM

Rachaiya system is a combined system. Existing water transmission system of Rachaiya wells will be used. The existing length of water distribution network system is 32,385 m but it is in bad condition. The total length of the proposed water distribution network will be around 3,238 m.

System description:

Rachaiya existing wells will pump water to Rachaiya existing reservoir (1,000 m³) through 150 mm and 250 mm existing and proposed pipe diameters and this reservoir will distribute water to Rachaiya area. Existing 150 mm diameter pipe will be replaced by a 250 mm new one to minimize losses. By the year 2035, a new well with same capacity of the existing ones is needed to cover the water demand of the village.This well will feed individually the existing reservoir through 250 mm diameter proposed pipe. The existing reservoir and well are in acceptable condition.

TABLE 6-10: SUMMARY OF WATER FACILITIES FOR RACHAIYA SYSTEM BY YEAR 2035

System	Ground Reservoir	Well	Pipe Diameter	
Description	Existing 1000 m³	Existing	Proposed 250 mm	Existing 150 mm
Number/Length	1	2	5,240m	2,155m
Comments	---	Drill a New well	---	---

6.3 Summary of Water Facilities for Systems of Rachaiya Caza by Year 2035

TABLE 6-11: NUMBER OF RESERVOIRS IN CAZA OF RACHAIYA

Reservoir Facility	Volume (m^3)										Total	Total Storage (m^3)
	50	100	150	200	250	300	500	550	1000	2000		
Reservoir - Existing	2	3	1	6	1	5	2	1	1	1	23	8,050
Reservoir - Under Construction	1	-	-	-	1	1	2	-	-	-	5	1600
Reservoir - Proposed	1	1	-	1	-	3	1	-	-	-	7	1,750
Elevated Tank - Existing	-	2	-	3	2	-	-	-	-	-	7	1300
Elevated Tank - Proposed	1	1	-	-	-	-	-	-	-	-	2	150
Total	**5**	**7**	**1**	**10**	**4**	**9**	**5**	**1**	**1**	**1**	**44**	**12,850**

TABLE 6-12: NUMBER OF WELLS USED IN CAZA OF RACHAIYA

Village Name	Existing well	Proposed well
Ain Aata	1	---
Haloua	1	---
Yanta	1	3
Deir El Achayer	2	---
Bakka	1	1
Kfarqouq	1	1
Rachaiya	2	1
Aiha	2	---
Total	**11**	**6**

TABLE 6-13: LENGTHS OF PROPOSED TRANSMISSION PIPE SYSTEMS IN CAZA OF RACHAIYA

Type	Diameter (mm)	Total length (m)
Ductile Iron	80	2,830
	100	7,470
	150	7,645
	200	9,380
	250	5,240

TABLE 6-14: LENGTHS OF EXISTING AND PROPOSED WATER DISTRIBUTION NETWORK FOR RACHAIYA CAZA

Village Name	Total Length Needed for Water Network (m)	Length of Existing Water Network (m)	Existing Water Network Condition	Existing Water Network Coverage	Existing Water Network Requirements	Length of Proposed Water Network (m)
Aaiha	19,046	17,315	V.G	W.C	None	1,731
Aain Arab	5,853	5,321	V.G	W.C	None	532
Aakabe (El)	24,728	---	---	---	---	24,728
Ain Aata	20,607	---	---	---	---	20,607
Ain Horche	5,417	4,925	V.G	W.C	None	492
Aita El Foukhar	10,536	---	---	---	---	10,536
Bakka	11,658	10,598	V.G	W.C	None	1,060
Bakkifa	2,486	2,260	G	W.C	None	226
Beit Lahia	1,634	1,485	V.G	W.C	---	149
Bire (El)	14,315	13,014	V.G	W.C	None	1,301
Dahr el Ahmar	28,649	26,044	V.G	W.C	None	2,605
Deir el Aachayer	9,540	8,673	V.G	W.C	None	867
Ezzé	17,279	11,519	V.G	M.C	None	5,760
Haloua	2,430	---	---	---	---	2,430
Haouch El Qinnaabe	3,870	---	B	---	Replacement	3,870
Kaoukaba	15,674	14,249	V.G	W.C	None	1,425
Kfar Qouq	36,324	---	---	---	Rehabilitation	36,324
Kfardenis	17,552	15,956	V.G	W.C	None	1,596
Kfarmechki	21,795	---	---	---	Rehabilitation	21,795
Khirbet Rouha	41,758	37,962	V.G	W.C	None	3,796
Majdel Balhiss	12,824	11,658	V.G	W.C	None	1,166
Mazraat Deir el Aachayer *	---	---	---	---	Rehabilitation	---
Mazraat Jaafar (Haouch El Qinnaabe)	---	---	---	---	Rehabilitation	---
Mazraat Salsata *	---	---	---	---	---	---
Mdoukha	11,147	10,134	V.G	W.C	None	1,013
Mhaidthé (El)	17,217	15,652	V.G	W.C	None	1,565
Nabaat *	---	---	---	---	---	---
Qennabé (Haouch El Qinnaabe)	---	---	---	---	---	---
Rachaiya	35,621	32,383	V.G	W.C	None	3,238
Rachaya el Faouka (Rachaya el Wadi)	---	---	---	---	---	---
Rachaya El Kouasbe (Rachaya el Wadi)	---	---	---	---	---	---
Rachaya el Wadi (Rachaya)	---	---	---	---	---	---
Rafid (Er)	27,469	24,972	V.G	W.C	None	2,497
Tannoura	10,090	9,173	V.G	W.C	None	917
Yanta	16,277	---	---	---	---	16,277
Total	**441,796**	**273,293**				**168,503**

7 COST ESTIMATION AND PRIORITY ACTION PLAN FOR CAPITAL INVESTMENTS

Chapters 2 to 6 presented in details the water supply and distribution systems proposed for 2035. These include (i) existing infrastructures that are to be maintained or rehabilitated, (ii) infrastructures that are under construction and (iii) infrastructures that the master plan proposes to construct. The functional details and quantities of these infrastructures were also presented. A detailed cost estimation based on a breakdown of quantities and unit prices from a large database containing current and historical prices was carried out for all proposed works. The results are summarized in this chapter.

. It is estimated that the BWE would need a total capital investment of $429 million USD by 2035 in addition to about $113 million USD which the CDR has committed on projects under construction and tendering to serve the 1.5 million projected population within its geographic service area. Most of these projects have been shown as under construction and their cost was not included in the estimation. However one overlap remains in projects under tendering for the Zahle and West Bekaa valued at about $26 million USD. Upon completion these would be deducted from the required capital investment plan of the BWE.

$344 million USD would need to be invested during the first ten years until 2025 at a yearly average of $35 million, then $40 million the next five years, and another $45 million during the last five years. Figure 7-1 presents the capital investment priority plan by priority level. The investments committed by the CDR are shown in a separate quadrant in dark green. Figure 7-2 presents the estimated capital investment costs per caza and level of priority. Figures 7-3 to 7-8 present a breakdown of the of the capital investment costs per type of works per caza and for the whole Bekaa.

Tables 7-2 to 7-14 in the last section of this chapter present the aggregated estimated costs of the proposed infrastructure works broken down by system and by functional components: pump stations, transmission lines, reservoirs, distribution networks, and house connections and subscribers meters. These estimated costs are divided in short term level 1, medium term level 2, and long term level 3 priorities presented under the current year of 2013 (or 2015) and the design horizon years of 2025 and 2035. The capital investments of the newly proposed schemes are assigned to the short term priority given the lead time required for their study and construction and the expected dates of their entry into service. For budgeting purposes the short term priorities could be budgeted over the period extending from 2015 to 2025, the medium term priorities over the period from 2025 to 2030, and the long term priorities over the period from 2030 to 2035.

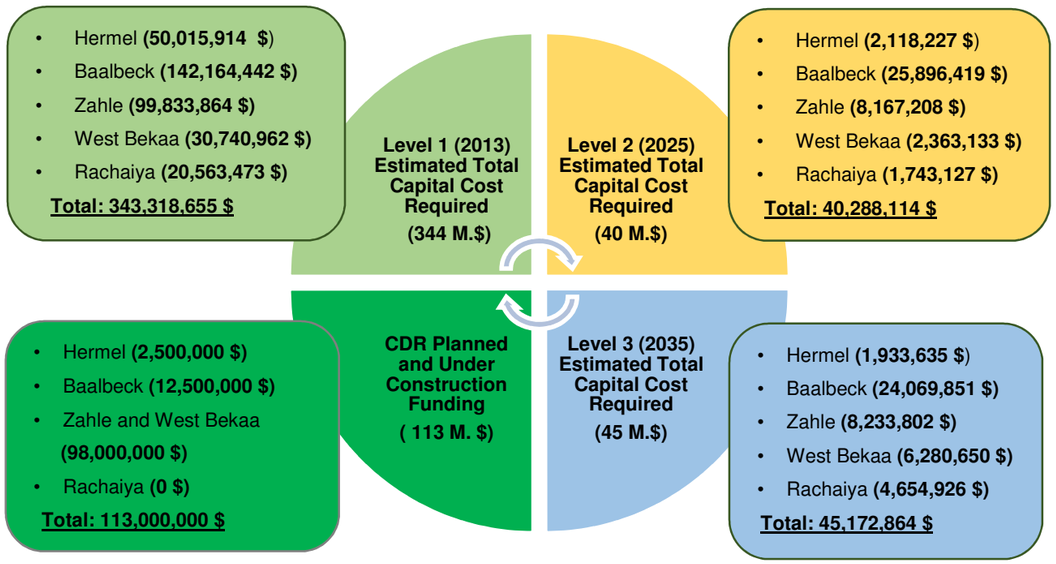


FIGURE 7-1: CAPITAL INVESTMENT PRIORITY ACTION PLAN FOR THE BEKAA

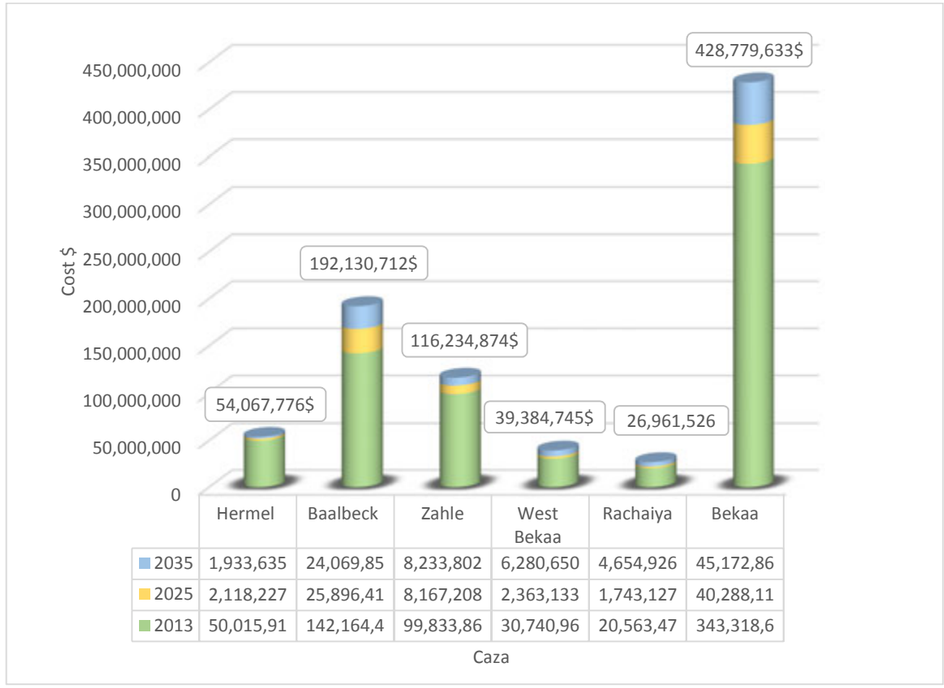


FIGURE 7-2: ESTIMATED CAPITAL INVESTMENT COST WITH PRIORITY LEVELS IN BEKAA

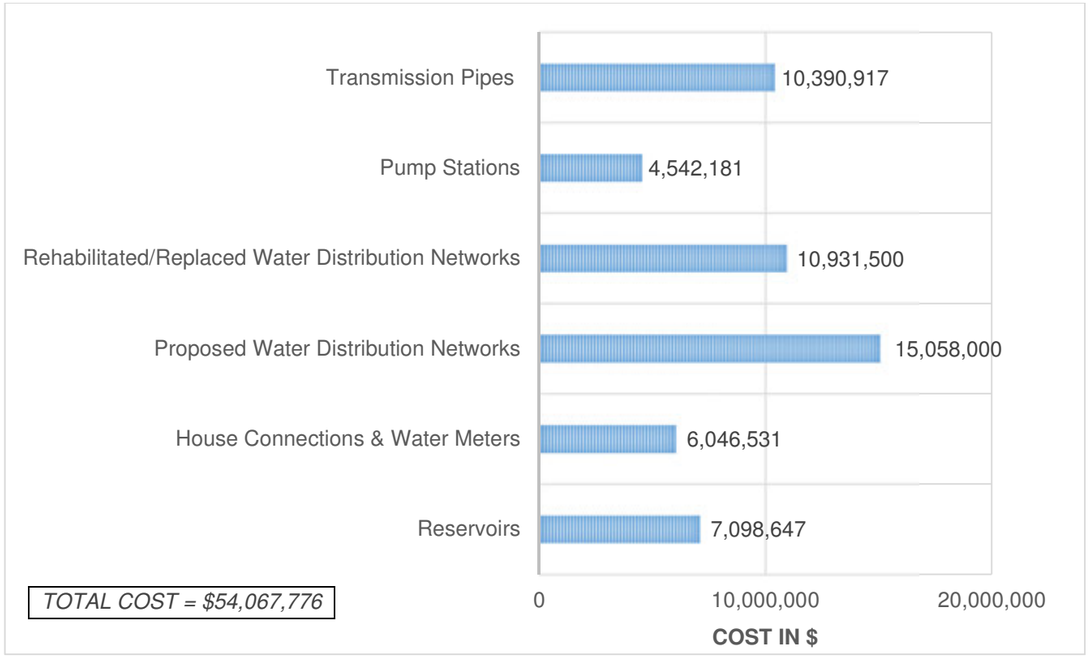


FIGURE 7-3: THE DISTRIBUTION OF COSTS FOR WATER FACILITIES AND NETWORKS IN THE CAZA OF HERMEL

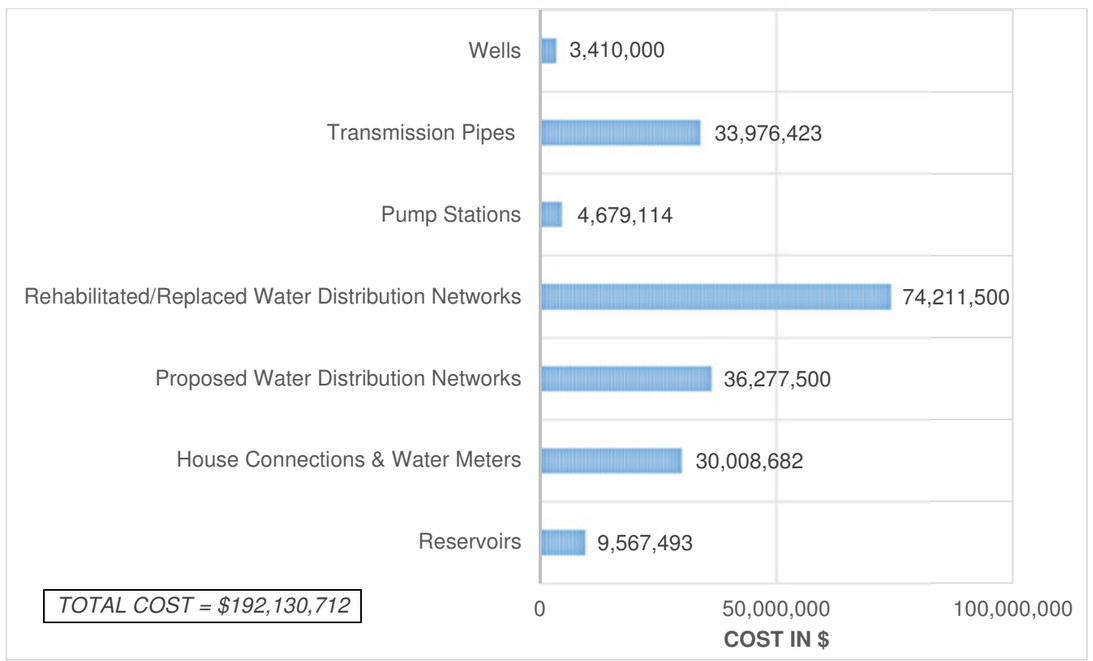


FIGURE 7-4: THE DISTRIBUTION OF COSTS FOR WATER FACILITIES AND NETWORKS IN THE CAZA OF BAALBECK

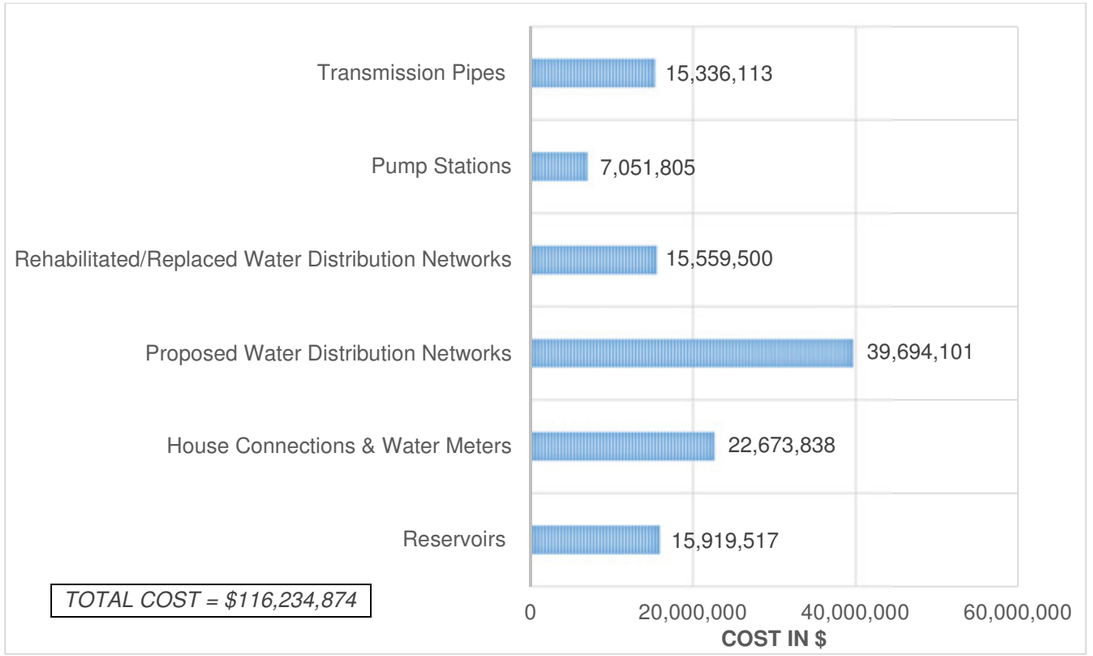


FIGURE 7-5: THE DISTRIBUTION OF COSTS FOR WATER FACILITIES AND NETWORKS IN THE CAZA OF ZAHLE

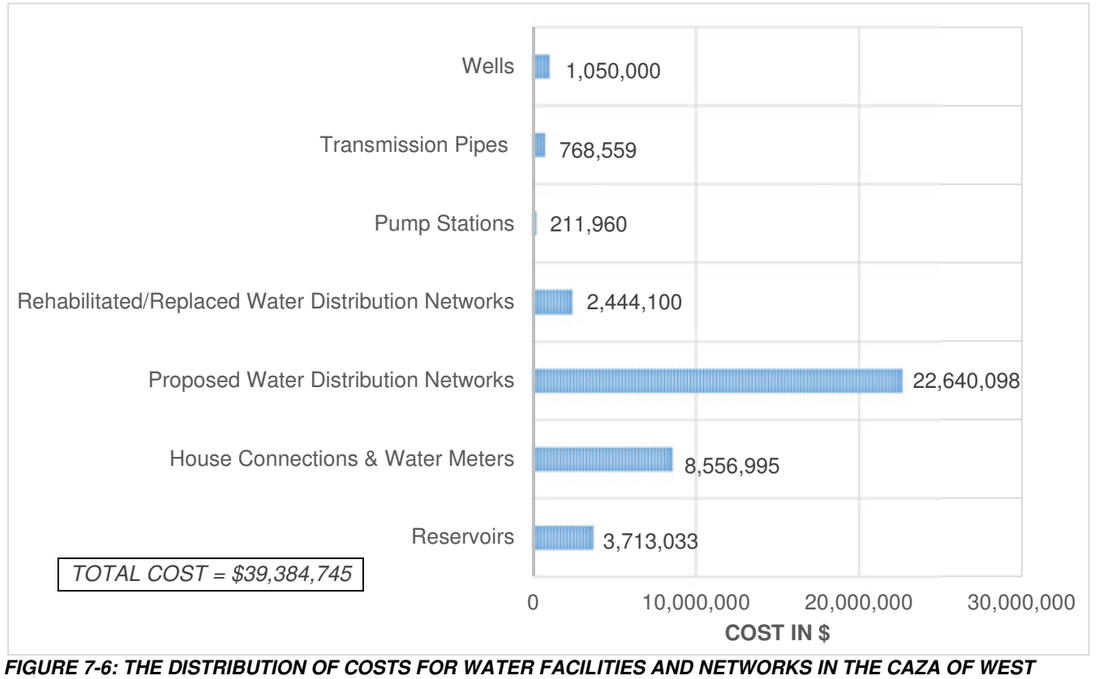


FIGURE 7-6: THE DISTRIBUTION OF COSTS FOR WATER FACILITIES AND NETWORKS IN THE CAZA OF WEST BEKAA

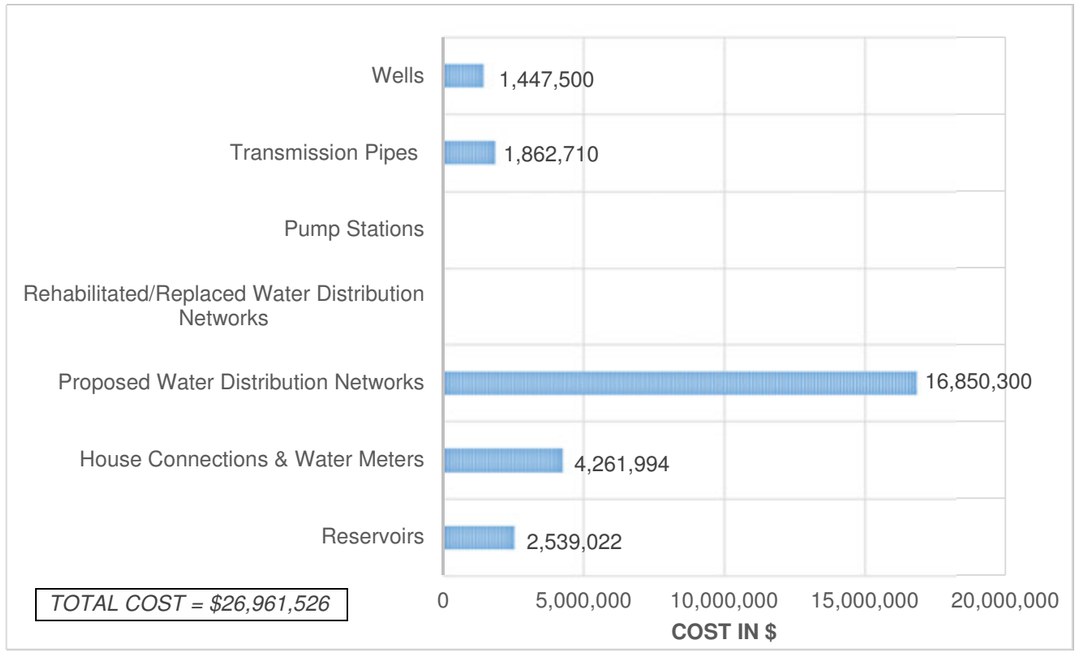


FIGURE 7-7: THE DISTRIBUTION OF COSTS FOR WATER FACILITIES AND NETWORKS IN THE CAZA OF RACHAIYA

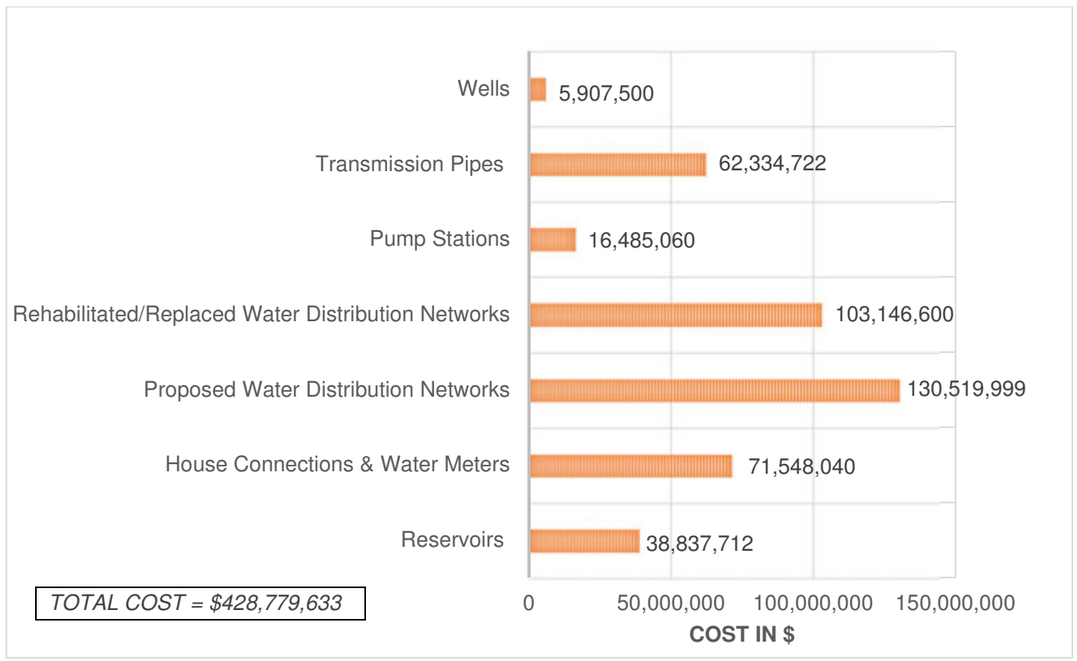


FIGURE 7-8: THE DISTRIBUTION OF TOTAL COSTS FOR WATER FACILITIES AND NETWORKS IN THE BEKAA

The BWE faces multiple challenges in the operation and management of its water supply and distribution systems. The main challenges can be summarized as follows:

- Old networks and infrastructure in need of rehabilitation or replacement
- Incomplete information on the engineering and operational characteristics of the systems it operates
- Service coverage does not reach all of the Bekaa population and localities
- Service interruptions and water shortages in many systems due to insufficient water supply or electrical power interruptions
- Non-revenue water represents a large fraction of the production
- Low to very low collection rates
- Severe shortage in human resources and the need for quality staff
- Dependence on central government financial support and international aid due to insufficient income and large systematic budget deficit

The current study has proposed a capital investment and priority action plan for the supply of water to the projected population of the Bekaa with 2035 as the planning horizon. The capital investment plan water supply strategy has concentrated on combining systems where possible and on shifting as much of the supply sources from wells to springs in line with the NWSS and in order to reduce pumping and electrical power dependence to a minimum. Many of the existing wells would be kept as back up supply sources to be used only in emergencies or severe drought periods. The details of each proposed system and the transition from current supply sources to proposed ones are to be developed through specific detailed feasibility studies and their construction contingent on the availability of funds.

Independent of the implementation of the proposed capital investments the issue of water metering is critical as it addresses the fundamentals of water utility management and it needs to be addressed separately and immediately. Metering is twofold: supply side and customer side. On the supply side it is necessary to meter production, main transmission, reservoirs in/out flow, service nodes, and district nodes in order to measure production, control supply, and identify losses. On the customer side it is necessary to meter subscribers' consumption for tariff setting and fair distribution of costs among consumers.

7.1 Capital Investment for Deployment of System Wide Metering

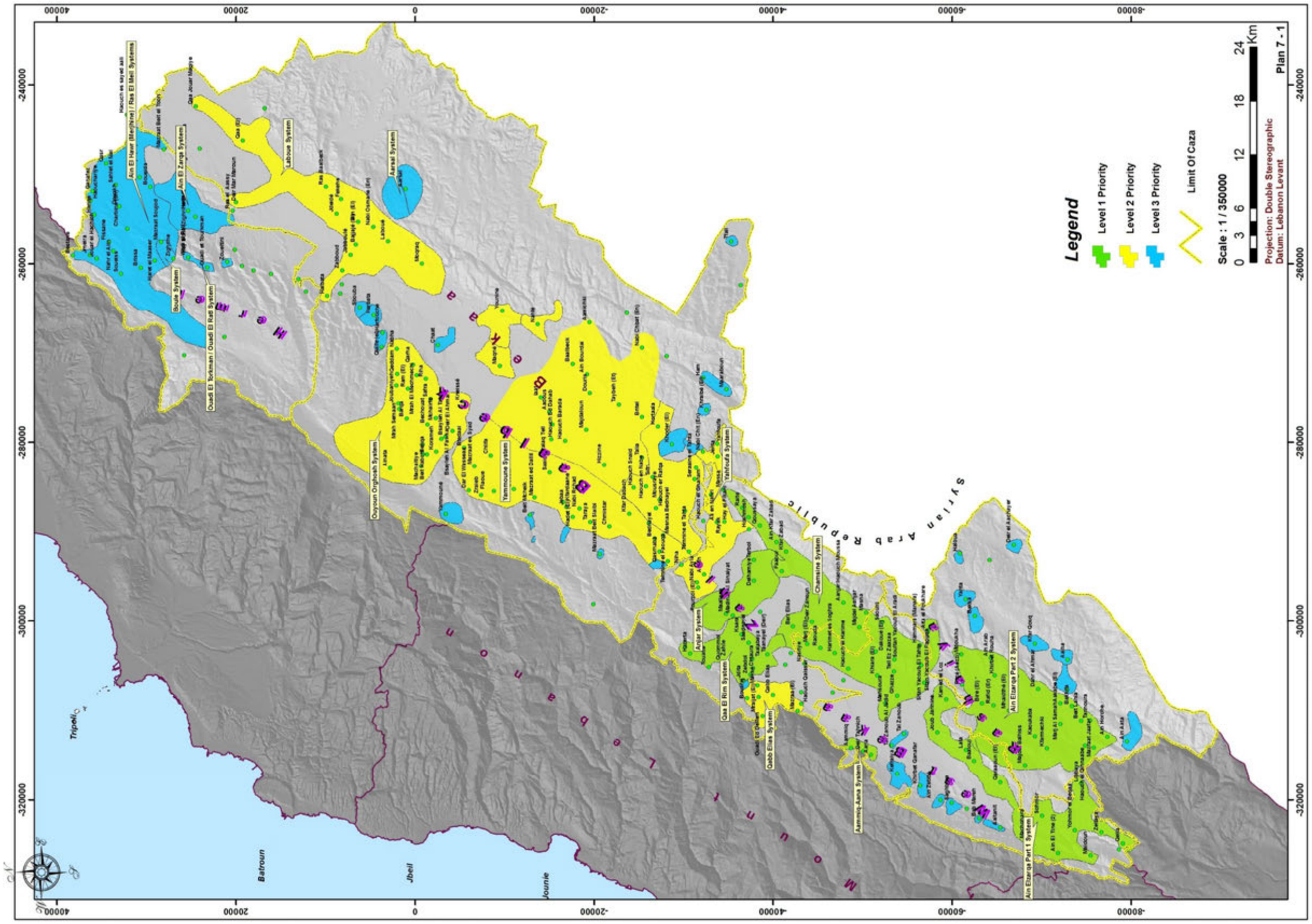
In order to get a good measure of control over its production the BWE would need to deploy supply side metering to measure production and flow at critical nodes. Based on the survey of current assets presented earlier in a separate report the number of system meters required was estimated and is presented in Table 7-1 presents an estimate of those requirements putting the number at 730 meters for the short term and an additional 490 by 2035. Assuming an average $5,000 per installed meter, the BWE would need to invest about $3.65 million USD to deploy a full metering control solution. In fact, the

combination of SCADA and metering is worth studying and albeit the costs may reach double the estimate it would probably pay for itself as the BWE moves all of its subscribers' base to metered connections especially with every new network being finalized. Production and system metering are a high priority and should be considered for execution in the immediate term. As for the deployment of meters to the subscribers it should be carried out concurrently with the construction of new networks. Deployment of meters to existing networks should be considered carefully in light of the ability of the BWE to control non-revenue water and to enforce collection.

Successful customer side metering and subsequent tariff adjustment are contingent on the two essential conditions: (i) the availability of water supply or the ability of the BWE to supply sufficient and controlled amounts of water, and (ii) the possibility of collecting subscriptions or enforcing the collection of subscription and water bills by the BWE. The average collection rate of the BWE falls below 50% in most of its service regions with very large disparities in collection among regions and villages. In some of the poorest communities the collection rates drop as low as 12%. Following the general recommendation of the MEW it is proposed to install customer meters starting from those areas that have had their networks rehabilitated or rebuilt anew and where it is possible for the BWE to supply water in sufficient quantities with minimal losses. The promise of quality service combined with new networks would create the required incentive for subscribers to pay, and for unconnected or illegally connected households and businesses to subscribe and pay. Plan 7-1 proposes a phasing plan in three levels of priority. All recently completed projects, projects under construction, such as in West Bekaa or Rachaiya, and projects slated for construction during the next year, such as Zahle, are priority level 1 to be provided with meters as completed networks come into operation. Priority levels 2 and 3 correspond to the priorities of capital investments in rehabilitation and extension of systems and are tied into them. As newly rehabilitated or constructed networks come into service they should be provided with customer side metering to go along. The cost estimate of consumer metering is included in the capital cost of each proposed project.

TABLE 7-1: SYSTEM WATER METERING REQUIRMENTS

System Meters													
Caza		Hermel		Baalbeck		Zahle		West Bekaa		Rachaiya		Total	
Type	Facility	Water Meters Needed in 2013	Additional Water Meters Needed in the Design Horizon	Water Meters Needed in 2013	Additional Water Meters Needed in the Design Horizon	Water Meters Needed in 2013	Additional Water Meters Needed in the Design Horizon	Water Meters Needed in 2013	Additional Water Meters Needed in the Design Horizon	Water Meters Needed in 2013	Additional Water Meters Needed in the Design Horizon	Water Meters Needed in 2013	Additional Water Meters Needed in The Design Horizon
Production Facilities	Wells	12	0	99	16	44	0	39	4	41	6	232	29
	Springs	3	0	5	0	6	0	4	0	0	0	18	0
	Pump Stations	2	4	6	11	5	10	7	1	7	0	26	28
Storage Facilities	Reservoir	13	30	127	50	51	36	34	12	35	9	255	142
Water Distribution Systems	Transmission	0	10	0	31	0	8	0	2	0	3	0	54
	Network	0	26	100	111	32	57	39	26	28	17	199	237
Sub - Total		**30**	**70**	**337**	**219**	**138**	**111**	**123**	**45**	**111**	**35**	**730**	**490**
Total		**100**		**556**		**249**		**168**		**146**		**1220**	



PLAN 7-1: WATER SYSTEMS CUSTOMERS METERING PRIORITES IN THE BEKAA

7.2 Cost Estimation of Large Systems

TABLE 7-2: AIN EL HAWR (MARJHINE)-RAS EL MEIL COST ESTIMATION

Total Cost Estimation - Ain El Hawr (Merjhine) - Ras El Meil System (Hermel Caza)														
Town Name / Regional Reservoir / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water distribution Network for year 2013 ($)	Total Cost of Required Water distribution Network for year 2025 ($)	Total Cost of Required Water distribution Network for year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Villages														
Bestane	206,061	---	---	56,066	12,996	13,095	780,600	---	---	---	---	---		1,068,818
Boueida	262,309	---	---	89,676	20,714	20,913	549,700	---	---	---	---	---		943,312
Brissa	122,368	---	---	33,660	7,768	7,867	802,800	---	---	---	---	---		974,463
Charbiné (Sh)	262,199	---	---	246,870	57,112	57,610	395,200	---	---	---	---	---		1,018,991
Fissane	126,977	---	---	59,751	13,842	13,942	919,900	---	---	---	---	---		1,134,412
Haouch es sayed aali	180,065	---	---	33,660	7,768	7,866	143,700	---	---	---	---	---		373,060
Hariqa	92,407	---	---	16,830	3,884	3,934	137,200	---	---	---	---	---		254,255
Jmeira	147,941	---	---	11,203	2,589	2,639	361,700	---	---	---	---	---		526,072
Jouar el Hachich	229,237	---	---	149,377	34,556	34,855	109,500	---	---	---	---	---		557,525
Mazraat Beit el Toch	163,909	---	---	22,456	5,178	5,228	500,000	---	---	---	---	---		696,771
Merjhine	174,409	---	---	94,107	21,759	21,958	1,041,800	---	---	---	---	---		1,354,033
Mrah el Aiin	102,041	---	---	33,660	7,768	7,867	173,200	---	---	---	---	---		324,536
Nasriye (en)	127,942	---	---	11,203	2,589	2,639	1,041,400	---	---	---	---	---		1,185,772
Qanafez / Haouchariye / Mrah El Zakbe	156,721	---	---	59,751	13,842	13,942	725,000	---	---	---	---	---		969,256
Qasr / Sahlet El Mai	460,680	219,256	---	995,846	230,489	232,331	4,389,900	---	---	---	---	---		6,528,502
Qouakh	110,310	---	---	43,220	9,958	10,108	409,300	---	---	---	---	---		582,896
Soueiss	114,955	---	---	25,294	5,826	5,875	255,400	---	---	---	---	---		407,350
Zighrine / Mazraat Soujod	129,541	204,737	---	170,638	39,485	39,784	1,659,300	---	---	---	---	---		2,243,485
Regional Reservoir & Pump Stations														
Regional Reservoir	3,092,700	---	---	---	---	---	---	---	---	---	---	---		3,092,700
Merjhine Pump Station	---	---	---	---	---	---	---	---	---	983,096	269,703	269,703		1,522,502
Hermel Pump Station	---	---	---	---	---	---	---	---	---	1,461,638	336,032	420,040		2,217,710
Total Cosf for Year 2013	**6,262,772**	**---**	**---**	**2,153,268**	**---**	**---**	**14,395,600**	**---**	**---**	**2,444,734**	**---**	**---**	**8,972,807**	**34,229,181**
Total Cosf for Year 2025	**---**	**423,993**	**---**	**---**	**498,122**	**---**	**---**	**---**	**---**	**---**	**605,735**	**---**	**---**	**1,527,850**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**502,454**	**---**	**---**	**---**	**---**	**---**	**689,743**	**---**	**1,192,197**
Total Estimated Cost	**6,262,772**	**423,993**	**---**	**2,153,268**	**498,122**	**502,454**	**14,395,600**	**---**	**---**	**2,444,734**	**605,735**	**689,743**	**8,972,807**	**36,949,228**

TABLE 7-3: AIN EL ZARQA (HERMEL) - COST ESTIMATION

Total Cost Estimation - Ain El Zarqa (Hermel) System (Hermel Caza)														
Town Name / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water distribution Network for year 2013 ($)	Total Cost of Required Water distribution Network for year 2025 ($)	Total Cost of Required Water distribution Network for year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Villages														
Hermel (Including Chouaghir el Faouqa and Hay Bidta)	20,000	---	---	1,910,332	442,156	445,691	10,485,500	---	---	---	---	---		13,303,679
Pump Stations														
Ain El Zarqa (Hermel) Pump Station	---	---	---	---	---	---	---	---	---	536,181	132,894	132,894		801,969
Total Cosf for Year 2013	**20,000**	**---**	**---**	**1,910,332**	**---**	**---**	**10,485,500**	**---**	**---**	**536,181**	**---**	**---**	**1,331,000**	**14,283,013**
Total Cosf for Year 2025	**---**	**---**	**---**	**---**	**442,156**	**---**	**---**	**---**	**---**	**---**	**132,894**	**---**	**---**	**575,050**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**445,691**	**---**	**---**	**---**	**---**	**---**	**132,894**	**---**	**578,585**
Total Estimated Cost	**20,000**	**---**	**---**	**1,910,332**	**442,156**	**445,691**	**10,485,500**	**---**	**---**	**536,181**	**132,894**	**132,894**	**1,331,000**	**15,436,648**

TABLE 7-4: LABOUE SYSTEM – COST ESTIMATION

Total Cost Estimation - Laboue System (Baalbeck Caza)														
Town Name / Pump Station	**Reservoir**			**House Connection & Water Meter**			**Water Distribution Network**			**Pump Station**			**Total Cost of Proposed Transmission Pipes ($)**	**Total Cost ($)**
	Total Cost of Reservoirs for Year 2013 ($)	**Total Cost of Reservoirs for Year 2025 ($)**	**Total Cost of Reservoirs for Year 2035 ($)**	**Total Cost of House Connections and Water Meters for Year 2013 ($)**	**Total Cost of House Connections and Water Meters for Year 2025 ($)**	**Total Cost of House Connections and Water Meters for Year 2035 ($)**	**Total Cost of Required Water distribution Network for year 2013 ($)**	**Total Cost of Required Water distribution Network for year 2025 ($)**	**Total Cost of Required Water distribution Network for year 2035 ($)**	**Total Cost of Proposed Pump Station for Year 2013 ($)**	**Total Cost of Proposed Pump Station for Year 2025 ($)**	**Total Cost of Proposed Pump Station for Year 2035 ($)**		
Villages														
Ain (El)	157,500	---	---	460,634	106,602	107,488	---	---	460,800	---	---	---		1,293,023
Bajjajé (El) / Jabboule	138,981	---	---	42,715	9,839	9,979	---	---	594,600	---	---	---		796,115
Deir Mar Maroun	102,041	---	---	4,477	1,073	1,026	198,000	---	---	---	---	---		306,616
Fekehe / Jdeide	209,800	---	---	547,790	126,747	127,819	---	---	1,331,700	---	---	---		2,343,856
Rasm El Hadat (Part of Chaat)	20,000	---	---	149,806	196,998	65,705	1,240,600	---	---	---	---	---		1,673,110
Halbata	20,000	---	---	23,736	5,456	5,549	513,300	---	---	---	---	---		568,041
Laboué	60,000	---	---	575,490	133,182	134,255	6,469,000	---	---	---	---	---		7,371,926
Moqraq (Taoufiqié)	20,000	---	---	81,140	18,793	18,933	3,446,000	---	---	---	---	---		3,584,866
Nabi Osmane (En)	20,000	---	---	191,006	44,207	44,534	---	---	234,500	---	---	---		534,247
Qaa (El)	20,000	---	136,721	409,945	94,897	95,643	3,670,800	---	---	---	---	---		4,428,006
Qaa Jouar Maqiye	304,918	---	---	132,576	30,684	30,917	320,000	---	---	---	---	---		819,095
Qaa Ouadi El Khanzer	147,941	---	---	20,472	4,756	4,756	530,000	---	---	---	---	---		707,926
Ras Baalbeck	20,000	---	---	326,426	75,544	76,151	2,234,200	---	---	---	---	---		2,732,321
Zabboud	40,000	---	---	55,912	12,964	13,057	812,800	---	---	---	---	---		934,733
Pump Stations														
Laboue pump	---	---	---	---	---	---	---	---	---	925,965	44,298	130,018		1,100,281
Ain (EL) pump	---	---	---	---	---	---	---	---	---	246,744	44,298	44,298		335,340
Moqraq pump	---	---	---	---	---	---	---	---	---	178,346	26,304	26,304		230,954
Fekehe pump	---	---	---	---	---	---	---	---	---	200,106	44,298	44,298		288,702
Qaa pump	---	---	---	---	---	---	---	---	---	197,767	0	44,298		242,065
Total Cosf for Year 2013	**1,281,181**	**---**	**---**	**3,022,126**	**---**	**---**	**19,434,700**	**---**	**---**	**1,748,928**	**---**	**---**	**6,224,605**	**31,711,540**
Total Cosf for Year 2025	**---**	**0**	**---**	**---**	**861,742**	**---**	**---**	**0**	**---**	**---**	**159,198**	**---**	**---**	**1,020,940**
Total Cosf for Year 2035	**---**	**---**	**136,721**	**---**	**---**	**735,812**	**---**	**---**	**2,621,600**	**---**	**---**	**289,216**	**---**	**3,783,349**
Total Estimated Cost	**1,281,181**	**0**	**136,721**	**3,022,126**	**861,742**	**735,812**	**19,434,700**	**0**	**2,621,600**	**1,748,928**	**159,198**	**289,216**	**6,224,605**	**36,515,829**

TABLE 7-5: OUYOUN ORGHOSH – COST ESTIMATION

Total Cost Estimation - Ouyoun Orghosh System (Baalbeck Caza)														
Town Name	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Ainata	91,700	---	---	93,265	21,591	21,731	1,567,600	---	---	---	---	---		1,795,887
Barqa/ Mrah El Aouja/Mrah Semaan	80,000	---	---	52,415	12,171	12,218	1,842,700	---	---	---	---	---		1,999,503
Bechouat / Mchairfe / Beit Habchi	70,980	82,041	---	83,938	19,445	19,585	---	2,202,500	---	---	---	---		2,478,489
Beliqa	104,593	---	---	2,798	653	653	123,300	---	---	---	---	---		231,997
Deir el Ahmar / Korrameh / Bsayleh El Faouqa / Mrah Maroun / Mrah El Batal	120,700	---	---	296,861	68,689	69,249	---	4,424,400	---	---	---	---		4,979,899
Kneissé	20,000	---	---	79,882	18,513	18,607	747,500	---	---	---	---	---		884,502
Machaitiye	20,000	---	---	5,596	1,306	1,306	678,200	---	---	---	---	---		706,408
Nabha	20,000	---	---	238,431	55,167	55,632	---	4,498,100	---	---	---	---		4,867,330
Qarha / Mrah El Mechemchi	40,000	63,893	46,222	22,989	5,316	5,316	---	649,800	---	---	---	---		833,536
Qeddam	20,000	---	---	33,576	7,787	7,787	579,700	---	---	---	---	---		648,850
Ram (El) / Joubaniyeh	40,000	94,955	---	93,265	21,591	21,731	---	---	519,200	---	---	---		790,742
Riha	20,000	---	---	36,933	8,580	8,627	422,300	---	---	---	---	---		496,440
Safra	138,981	---	---	83,938	19,445	19,585	387,200	---	---	---	---	---		649,149
Zrazir	20,000	82,041	---	93,265	21,591	21,732	568,000	---	---	---	---	---		806,629
Total Cosf for Year 2013	**806,954**	**---**	**---**	**1,217,152**	**---**	**---**	**6,916,500**	**---**	**---**	**---**	**---**	**---**	**---**	**8,940,606**
Total Cosf for Year 2025	**---**	**322,930**	**---**	**---**	**281,845**	**---**	**---**	**11,774,800**	**---**	**---**	**---**	**---**	**---**	**12,379,575**
Total Cosf for Year 2035	**---**	**---**	**46,222**	**---**	**---**	**283,759**	**---**	**---**	**519,200**	**---**	**---**	**---**	**---**	**849,181**
Total Estimated Cost	**806,954**	**322,930**	**46,222**	**1,217,152**	**281,845**	**283,759**	**6,916,500**	**11,774,800**	**519,200**	**---**	**---**	**---**	**---**	**22,169,362**

TABLE 7-6: YOUNINE - MAQNE AND NAHLE SYSTEM – COST ESTIMATION

Total Cost Estimation – Younine-Maqne-Nahle System (Baalbeck Caza)														
Town Name	Reservoir			Well			House Connection & Water Meter			Water Distribution Network			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of Proposed Wells for Year 2013 ($)	Total Cost of Proposed Wells for Year 2025 ($)	Total Cost of Proposed Wells for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water distribution Network for year 2013 ($)	Total Cost of Required Water distribution Network for year 2025 ($)	Total Cost of Required Water distribution Network for year 2035 ($)		
Maqne	20,000	---	---	---	---	---	147,545	34,182	34,415	2,049,600	---	---		2,285,742
Younine	114,161	---	---	---	150,000	---	543,776	125,852	126,856	4,216,700	---	---		5,277,345
Nahle	20,000	---	---	---	---	---	279,794	64,755	65,273	---	---	171,200		601,022
Total Cosf for Year 2013	**154,161**	**---**	**---**	**---**	**---**	**---**	**971,115**	**---**	**---**	**6,266,300**	**---**	**---**	**1,438,295**	**8,829,871**
Total Cosf for Year 2025	**---**	**---**	**---**	**---**	**150,000**	**---**	**---**	**224,789**	**---**	**---**	**---**	**---**	**---**	**374,789**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**226,544**	**---**	**---**	**171,200**	**---**	**397,744**
Total Estimated Cost	**154,161**	**---**	**---**	**---**	**150,000**	**---**	**971,115**	**224,789**	**226,544**	**6,266,300**	**---**	**171,200**	**1,438,295**	**9,602,404**

TABLE 7-7: YAMMOUNE SYSTEM - COST ESTIMATION

Total Cost Estimation - Yammoune System (Baalbeck Caza)														
Town Name / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmissi-on Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Villages														
Baalbeck / Aamichki	204,740	---	440,680	4,237,622	980,725	988,606	---	---	2,676,600	---	---	---		9,528,973
Bednayel	51,640	---	---	523,821	121,197	122,224	2,889,400	---	---	---	---	---		3,708,282
Beit Chama	20,000	---	---	201,219	46,585	46,958	1,676,700	---	---	---	---	---		1,991,462
Boudai (Aalaq Tell)/ El Qaaqiyeh/ El Hafir / Mrah bou brahim, mrah el blate , mrah el jeddaoui, mazraat beit slim	80,000	167,857	---	426,173	98,628	99,420	6,442,600	---	---	---	---	---		7,314,678
Britel	20,000	---	---	634,387	146,845	148,011	---	---	1,808,700	---	---	---		2,757,943
Btedaai / mazraat beit ghosayn	89,100	82,041	---	60,669	14,036	14,176	1,324,100	---	---	---	---	---		1,584,122
Chlifa / Mazraat es Syad	40,000	---	---	96,390	22,290	22,477	---	---	1,217,800	---	---	---		1,398,957
Chmistar	60,000	---	---	687,828	159,203	160,462	6,003,400	---	---	---	---	---		7,070,893
Dar el Wasseaa	102,041	---	---	20,704	4,803	4,850	483,000	---	---	---	---	---		615,398
Flaoue	20,000	---	63,893	104,970	24,295	24,482	981,000	---	---	---	---	---		1,218,640
Hadet (El)	20,000	167,857	---	281,613	65,192	65,705	---	1,831,800	---	---	---	---		2,432,167
Haouch Barada	163,909	---	---	22,710	5,270	5,316	---	---	47,400	---	---	---		244,605
Haouch en Nabe	233,461	---	---	68,643	15,902	16,041	927,700	---	---	---	---	---		1,261,747
Haouch er Rafqa (Mousraye)	328,783	---	---	334,074	77,316	77,923	---	1,729,800	---	---	---	---		2,547,896
Haouch Snaid	233,461	---	---	71,673	16,555	16,741	---	---	148,700	---	---	---		487,130
Haouch Tell Safiyé (Aadous)	122,368	---	---	59,176	13,710	13,803	1,390,100	---	---	---	---	---		1,599,157
Hizzine	283,311	---	---	96,390	22,290	22,477	---	---	143,100	---	---	---		567,568
Hortaala	169,381	---	---	177,016	40,943	41,316	4,688,900	---	---	---	---	---		5,117,556
Iaat	222,475	---	---	205,462	47,565	47,938	---	---	324,900	---	---	---		848,340
Jebaa	156,721	---	---	25,974	6,016	6,063	---	622,200	---	---	---	---		816,974
Kfar Dabach	20,000	---	---	46,446	10,726	10,865	796,000	---	---	---	---	---		884,037
Kfardaane (Mazraat ed Dallil)	20,000	---	---	121,105	28,026	28,212	2,950,400	---	---	---	---	---		3,147,743
Khoder (El)	20,000	138,981	---	231,203	53,488	53,954	---	---	52,400	---	---	---		550,026
Majdaloun	206,061	---	---	41,922	9,746	9,746	---	---	42,600	---	---	---		310,075
Nabi Rchad	20,000	---	---	83,938	19,445	19,585	1,888,100	---	---	---	---	---		2,031,068
Qasrnaba	40,000	---	63,893	293,877	67,990	68,549	---	1,799,400	---	---	---	---		2,333,709
Saaidé	20,000	---	---	78,389	18,140	18,279	---	---	152,300	---	---	---		287,108
Seraaine el Tahta / Serraain el Faouka	194,409	---	---	419,690	97,136	97,928	---	---	2,238,700	---	---	---		3,047,863
Talia	194,409	---	---	111,591	25,834	26,021	---	---	190,100	---	---	---		547,955
Taraya	20,000	---	---	266,130	61,601	62,115	---	---	277,300	---	---	---		687,146
Taybeh (Et)	20,000	---	---	90,140	20,845	21,031	2,230,000	---	---	---	---	---		2,382,016
Temnine el Tahta	20,000	---	---	448,650	103,851	104,643	---	---	173,200	---	---	---		850,344

Total Cost Estimation - Yammoune System (Baalbeck Caza)														
Town Name / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmissi-on Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Zraieb	57,500	63,893	---	31,524	7,274	7,368	463,300	---	---	---	---	---		630,859
Pump Stations														
Hadet (El) Pump Station	---	---	---	---	---	---	---	---	---	93,548	26,304	---		119,852
Qsarnaba Pump Station	---	---	---	---	---	---	---	---	---	191,655	42,860	---		234,515
Baalbeck Pump Station	---	---	---	---	---	---	---	---	---	1,339,067	413,916	85,720		1,838,703
Total Cosf for Year 2013	**3,473,770**	**---**	**---**	**10,601,119**	**---**	**---**	**35,134,700**	**---**	**---**	**1,624,270**	**---**	**---**	**21,892,288**	**72,726,148**
Total Cosf for Year 2025	**---**	**620,629**	**---**	**---**	**2,453,468**	**---**	**---**	**5,983,200**	**---**	**---**	**483,080**	**---**	**---**	**9,540,377**
Total Cosf for Year 2035	**---**	**---**	**568,466**	**---**	**---**	**2,473,285**	**---**	**---**	**9,493,800**	**---**	**---**	**85,720**	**---**	**12,621,271**
Total Estimated Cost	**3,473,770**	**620,629**	**568,466**	**10,601,119**	**2,453,468**	**2,473,285**	**35,134,700**	**5,983,200**	**9,493,800**	**1,624,270**	**483,080**	**85,720**	**21,892,288**	**94,887,795**

TABLE 7-8: YAHFOUFA SYSTEM - COST ESTIMATION

Total Cost Estimation - Yahfoufa System (Baalbeck and Zahle Cazas)														
Town Name / Pump Station	**Reservoir**			**House Connection & Water Meter**			**Water Distribution Network**			**Pump Station**			**Total Cost of Proposed Transmission Pipes ($)**	**Total Cost ($)**
	Total Cost of Reservoirs for Year 2013 ($)	**Total Cost of Reservoirs for Year 2025 ($)**	**Total Cost of Reservoirs for Year 2035 ($)**	**Total Cost of House Connections and Water Meters for Year 2013 ($)**	**Total Cost of House Connections and Water Meters for Year 2025 ($)**	**Total Cost of House Connections and Water Meters for Year 2035 ($)**	**Total Cost of Required Water Distribution Network for Year 2013 ($)**	**Total Cost of Required Water Distribution Network for Year 2025 ($)**	**Total Cost of Required Water Distribution Network for Year 2035 ($)**	**Total Cost of Proposed Pump Station for Year 2013 ($)**	**Total Cost of Proposed Pump Station for Year 2025 ($)**	**Total Cost of Proposed Pump Station for Year 2035 ($)**		
Villages														
Jenta	114,955	---	---	21,964	5,083	5,477	150,800	---	---	---	---	---		298,279
Nabi Chit (En)	94,900	---	---	626,646	145,073	156,099	---	---	171,700	---	---	---		1,194,418
Yahfoufa	122,368	---	---	31,943	7,415	7,967	233,000	---	---	---	---	---		402,693
Nasriyet Rizk (Nasireh)	140,900	---	---	72,886	16,881	18,174	1,328,700	---	---	---	---	---		1,577,541
Ali en Nahri	626,742	---	---	587,707	136,027	146,389	1,711,400	---	---	---	---	---		3,208,265
Haouch el Ghanam	138,981	---	---	46,166	10,725	11,502	42,700	---	---	---	---	---		250,074
Hoshmosh	440,680	308,783	---	9,979	2,332	2,490	312,300	---	---	---	---	---		1,076,564
Rayak- Haouch Hala	35,190	---	---	898,792	208,027	223,916	2,423,000	---	---	---	---	---		3,788,925
Nabi Ayla	122,368	---	---	73,912	17,115	18,373	448,600	---	---	---	---	---		680,368
Fourzol (El)	391,415	---	---	486,609	112,617	121,195	2,117,300	---	---	---	---	---		3,229,136
Ablah	466,259	---	---	450,142	104,177	112,132	1,441,700	---	---	---	---	---		2,574,410
Niha	156,721	---	---	93,638	21,637	23,353	1,112,500	---	---	---	---	---		1,407,849
Pump Stations														
Nabi Chit pump	---	---	---	---	---	---	---	---	---	200,106	44,298	44,298		288,702
Total Cosf for Year 2013	**2,851,479**	**---**	**---**	**3,400,384**	**---**	**---**	**11,322,000**	**---**	**---**	**200,106**	**---**	**---**	**5,222,560**	**22,996,529**
Total Cosf for Year 2025	**---**	**308,783**	**---**	**---**	**787,109**	**---**	**---**	**---**	**---**	**---**	**44,298**	**---**	**---**	**1,140,190**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**847,067**	**---**	**---**	**171,700**	**---**	**---**	**44,298**	**---**	**1,063,065**
Total Estimated Cost	**2,851,479**	**308,783**	**---**	**3,400,384**	**787,109**	**847,067**	**11,322,000**	**---**	**171,700**	**200,106**	**44,298**	**44,298**	**5,222,560**	**25,199,784**

TABLE 7-8: QAA EL RIM SYSTEM - COST ESTIMATION

Total Cost Estimation - Qaa El Rim System (Zahle Caza)														
Town Name / Regional Reservoir / Pump Station	**Reservoir**			**House Connection & Water Meter**			**Water Distribution Network**			**Pump Station**			**Total Cost of Proposed Transmiss -ion Pipes ($)**	**Total Cost ($)**
	Total Cost of Reservoirs for Year 2013 ($)	**Total Cost of Reservoir s for Year 2025 ($)**	**Total Cost of Reservoirs for Year 2035 ($)**	**Total Cost of House Connection s and Water Meters for Year 2013 ($)**	**Total Cost of House Connection s and Water Meters for Year 2025 ($)**	**Total Cost of House Connection s and Water Meters for Year 2035 ($)**	**Total Cost of Required Water Distributio n Network for Year 2013 ($)**	**Total Cost of Required Water Distributio n Network for Year 2025 ($)**	**Total Cost of Required Water Distributio n Network for Year 2035 ($)**	**Total Cost of Proposed Pump Station for Year 2013 ($)**	**Total Cost of Proposed Pump Station for Year 2025 ($)**	**Total Cost of Proposed Pump Station for Year 2035 ($)**		
Villages														
Chtaura	229,237	---	---	184,150	42,663	42,956	692,100	---	---	---	---	---		1,191,106
Hazerta	40,000	---	---	225,644	52,232	52,650	1,990,200	---	---	---	---	---		2,360,726
Qaa er Rim	146,920	---	---	139,398	32,217	32,551	1,070,800	---	---	---	---	---		1,421,886
Saadnayel	1,052,168	516,084	---	691,138	159,956	161,210	1,381,500	---	---	---	---	---		3,962,056
Taalabaya - Jalala	---	---	---	1,138,414	263,502	265,549	1,993,300	---	---	---	---	---		3,660,765
Taanayel (Deir)	262,309	---	---	74,295	17,174	17,341	278,100	---	---	---	---	---		649,219
Touaite	---	---	---	34,223	7,939	7,981	476,600	---	---	---	---	---		526,743
Part of Zahlé / El Karme Dhour / Haouch El Oumara/Ksara	719,083	516,084	---	1,558,989	360,800	363,704	11,057,550	---	---	---	---	---		14,576,210
Regional Reservoir & Pump Stations														
Hazerta Regional Reservoir	1,606,861	1,077,908	---	---	---	---	---	---	---	---	---	---		2,684,769
Qaa el Rim pump	---	---	---	---	---	---	---	---	---	102,026	---	---		102,026
Chtaura pump	---	---	---	---	---	---	---	---	---	92,108	---	---		92,108
Qaa el Rim pump	---	---	---	---	---	---	---	---	---	1,685,578	195,754	391,508		2,272,840
Total Cosf for Year 2013	**4,056,578**	**---**	**---**	**4,046,251**	**---**	**---**	**18,940,150**	**---**	**---**	**1,879,712**	**---**	**---**	**3,093,553**	**32,016,244**
Total Cosf for Year 2025	**---**	**2,110,076**	**---**	**---**	**936,483**	**---**	**---**	**---**	**---**	**---**	**195,754**	**---**	**---**	**3,242,313**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**943,942**	**---**	**---**	**---**	**---**	**---**	**391,508**	**---**	**1,335,450**
Total Estimated Cost	**4,056,578**	**2,110,076**	**---**	**4,046,251**	**936,483**	**943,942**	**18,940,150**	**---**	**---**	**1,879,712**	**195,754**	**391,508**	**3,093,553**	**36,594,007**

TABLE 7-9: QABB ELIAS SYSTEM - COST ESTIMATION

Total Cost Estimation - Qabb Elias System (Zahle Caza)														
Town Name / Regional Reservoir / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Villages														
Bouarej	202,475	---	---	125,734	29,083	29,334	814,000	---	---	---	---	---		1,200,626
Haouch es Siyadi / Haouch Qaissar, Tell El Akhdar	102,041	---	---	7,396	1,713	1,712	174,500	---	---	---	---	---		287,362
Maksé	192,575	---	---	140,066	32,384	32,677	---	---	42,400	---	---	---		440,102
Mraijat (El)	187,857	---	---	121,011	28,038	28,247	947,900	---	---	---	---	---		1,313,053
Ouadi Ed Dellem	154,409	---	---	85,912	19,890	20,015	501,000	---	---	---	---	---		781,226
Qabb Elias	592,019	---	---	903,620	209,097	210,810	2,726,000	---	---	---	---	---		4,641,546
Regional Reservoirs / Pump Stations														
Regional Reservoir	346,519	---	---	---	---	---	---	---	---	---	---	---		346,519
Ouadi El Dellem pump	---	---	---	---	---	---	---	---	---	197,767	---	44,298		242,065
Total Cosf for Year 2013	**1,777,895**	**---**	**---**	**1,383,739**	**---**	**---**	**5,163,400**	**---**	**---**	**197,767**	**---**	**---**	**1,115,770**	**9,638,571**
Total Cosf for Year 2025	**---**	**---**	**---**	**---**	**320,205**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**320,205**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**322,795**	**---**	**---**	**42,400**	**---**	**---**	**44,298**	**---**	**409,493**
Total Estimated Cost	**1,777,895**	**---**	**---**	**1,383,739**	**320,205**	**322,795**	**5,163,400**	**---**	**42,400**	**197,767**	**---**	**44,298**	**1,115,770**	**10,368,269**

TABLE 7-9: JDITA-ZEBDOL SYSTEM - COST ESTIMATION

Total Cost Estimation - Jdita Zebdol System (Zahle Caza)															
Town Name / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Village														
Jdita and Zebdoul	444,019	---	---	464,868	107,599	108,476	2,526,700	---	---	---	---	---	59,925	3,711,587
Pump Station														
Jdita pump	---	---	---	---	---	---	---	---	---	146,527	---	42,860	---	189,387
Total Cosf for Year 2013	**444,019**	**---**	**---**	**464,868**	**---**	**---**	**2,526,700**	**---**	**---**	**146,527**	**---**	**---**	**59,925**	**3,642,039**
Total Cosf for Year 2025	**---**	**---**	**---**	**---**	**107,599**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**107,599**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**108,476**	**---**	**---**	**---**	**---**	**---**	**42,860**	**---**	**151,336**
Total Estimated Cost	**444,019**	**---**	**---**	**464,868**	**107,599**	**108,476**	**2,526,700**	**---**	**---**	**146,527**	**---**	**42,860**	**59,925**	**3,900,974**

TABLE 7-10: ANJAR SYSTEM - COST ESTIMATION

Total Cost Estimation - Anjar System (Zahle Caza)														
Town Name / Regional Reservoir / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Villages														
Delhamiye	262,309	---	---	73,376	17,007	17,090	775,400	---	---	---	---	---		1,145,182
Maallaqa/Karak Nouh	386,809	516,084	---	1,495,600	346,114	348,870	1,994,300	---	---	---	---	---		5,087,777
Upper Zahlé	499,920	---	---	1,558,989	360,800	363,705	10,732,550	---	---	---	---	---		13,956,639
Lower Zahlé	440,675	---	---											
Regional Reservoirs / Pump Stations														
Regional Reservoirs	1,098,388	---	---	---	---	---	---	---	---	---	---	---		1,098,388
Anjar pump	---	---	---	---	---	---	---	---	---	2,514,277	585,708	292,854		3,392,839
Zahle pump	---	---	---	---	---	---	---	---	---	581,840	89,350	89,350		760,540
Total Cosf for Year 2013	**2,688,101**	**---**	**---**	**3,127,965**	**---**	**---**	**13,502,250**	**---**	**---**	**3,096,117**	**---**	**---**	**6,850,285**	**29,264,718**
Total Cosf for Year 2025	**---**	**516,084**	**---**	**---**	**723,921**	**---**	**---**	**---**	**---**	**---**	**675,058**	**---**	**---**	**1,915,063**
Total Cosf for Year 2035	**---**	**---**	**---**	**---**	**---**	**729,665**	**---**	**---**	**---**	**---**	**---**	**382,204**	**---**	**1,111,869**
Total Estimated Cost	**2,688,101**	**516,084**	**---**	**3,127,965**	**723,921**	**729,665**	**13,502,250**	**---**	**---**	**3,096,117**	**675,058**	**382,204**	**6,850,285**	**32,291,650**

TABLE 7-11: CHAMSINE SYSTEM - COST ESTIMATION

Total Cost Estimation - Chamsine System (Zahle and West Bekaa Cazas)														
Town Name / Regional Reservoir / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmiss -ion Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distributio n Network for Year 2013 ($)	Total Cost of Required Water Distributio n Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Villages														
Aanjar/Haouch Moussa / Haouch El Harime (Jezire, Harimet El Soughra)/ Bar Elias(Deir Zanoun) / Chebrqieh / Khiara (Tell Ez Zaazaa) / Raouda / El Marj	381,400	---	---	2,015,968	466,572	470,343	---	---	1,986,000	---	---	---		5,320,282
Ain Kfar Zabad	20,000	---	---	135,595	31,339	31,632	---	---	127,600	---	---	---		346,166
Faaour	20,000	---	---	133,714	30,964	31,172	---	---	135,500	---	---	---		351,350
Dakoué (El) (Es Salamiyeh-Er Rachidiyeh)	40,000	---	---	21,273	6,059	6,101	---	---	92,700	---	---	---		166,133
Kfar Zabad	286,053	---	---	258,153	59,754	60,255	---	---	374,900	---	---	---		1,039,115
Majdel Aanjar	157,500	---	209,237	989,281	228,987	230,783	---	---	771,600	---	---	---		2,587,388
Massa	20,000	---	---	88,837	20,516	20,726	---	---	218,600	---	---	---		368,679
Qoussaya / Deir El Ghazal / Raite (Hay el Fikani)	20,000	---	118,981	332,030	76,803	77,472	---	---	640,100	---	---	---		1,265,386
Terbol	400,154	---	---	328,437	76,008	76,594	---	785,600	---	---	---	---		1,666,793
Sltan Yacoub el Fouqa/ El Tahta / Mansoura/ Ghazze	233,615	---	---	595,824	137,894	138,980	---	---	1,262,600	---	---	---		2,368,913
Hammara (Manara)	117,500	---	154,409	192,215	44,502	44,836	---	---	282,700	---	---	---		836,162
Saouiri	383,683	---	---	335,373	77,639	78,223	---	---	445,600	---	---	---		1,320,518
Aita El Foukhar	56,980	---	---	101,122	23,400	23,609	1,053,600	---	---	---	---	---		1,258,711
Regional Reservoirs / Pump Station														
Anjar Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Terbol 1 Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Sultan Yacoub El Faouqa Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Sultan Yaaqoub el Faouqa Pump	---	---	---	---	---	---	---	---	---	93,548	---	26,304		119,852
Total Cosf for Year 2013	**2,196,885**	**---**	**---**	**5,527,822**	**---**	**---**	**1,053,600**	**---**	**---**	**93,548**	**---**	**---**	**333,995**	**9,205,850**
Total Cosf for Year 2025	**---**	**---**	**---**	**---**	**1,280,437**	**---**	**---**	**785,600**	**---**	**---**	**---**	**---**	**---**	**2,066,037**
Total Cosf for Year 2035	**---**	**---**	**482,627**	**---**	**---**	**1,290,726**	**---**	**---**	**6,337,900**	**---**	**---**	**26,304**	**---**	**8,137,555**
Total Estimated Cost	**2,196,885**	**---**	**482,627**	**5,527,822**	**1,280,437**	**1,290,726**	**1,053,600**	**785,600**	**6,337,900**	**93,548**	**---**	**26,304**	**333,995**	**19,409,442**

TABLE 7-12: AANA SYSTEM - COST ESTIMATION

Total Cost Estimation - Aana System						
Town Name	**Cost of Reservoirs, House Connections, Pump Stations and Water Meters for Year 2013 ($)**	**Cost of Reservoirs, House Connections, Pump Stations and Water Meters for Year 2025 ($)**	**Cost of Reservoirs, House Connections, Pump Stations and Water Meters for Year 2035 ($)**	**Cost of Water distribution Network ($)**	**Total Cost of Transmission Pipes ($)**	**Total Cost**
Aana	92,963	21,514	21,691	94,600		230,768
Deir Tahnich	3,320	753	797	26,600		31,470
Aammiq	48,827	11,288	11,421	54,200		125,736
Total Cosf for Year 2013	**145,110**	**---**	**---**	**175,400**	**---**	**320,510**
Total Cosf for Year 2025	**---**	**33,555**	**---**	**---**	**---**	**33,555**
Total Cosf for Year 2035	**---**	**---**	**33,909**	**---**	**---**	**33,909**
Total Estimated Cost	**145,110**	**33,555**	**33,909**	**175,400**	**---**	**387,974**

TABLE 7-13: AIN EL ZARQA PART 1 SYSTEM - COST ESTIMATION

Total Cost Estimation - Ain El Zarqa Part 1 System (West Bekaa Caza)														
Town Name / Regional Reservoir / Pump Station	**Reservoir**			**House Connection & Water Meter**			**Water Distribution Network**			**Pump Station**			**Total Cost of Proposed Transmission Pipes ($)**	**Total Cost ($)**
	Total Cost of Reservoirs for Year 2013 ($)	**Total Cost of Reservoirs for Year 2025 ($)**	**Total Cost of Reservoirs for Year 2035 ($)**	**Total Cost of House Connections and Water Meters for Year 2013 ($)**	**Total Cost of House Connections and Water Meters for Year 2025 ($)**	**Total Cost of House Connections and Water Meters for Year 2035 ($)**	**Total Cost of Required Water Distribution Network for Year 2013 ($)**	**Total Cost of Required Water Distribution Network for Year 2025 ($)**	**Total Cost of Required Water Distribution Network for Year 2035 ($)**	**Total Cost of Proposed Pump Station for Year 2013 ($)**	**Total Cost of Proposed Pump Station for Year 2025 ($)**	**Total Cost of Proposed Pump Station for Year 2035 ($)**		
Villages														
Ain El Tine (2)	185,389	---	---	146,217	33,821	34,131	941,100	---	---	---	---	---		1,340,658
Baaloul	59,500	---	---	127,757	29,571	29,792	1,659,000	---	---	---	---	---		1,905,620
Joubb Jannine	137,500	---	---	443,388	102,613	103,454	---	---	459,500	---	---	---		1,246,455
Kamed el Loz	137,500	---	---	442,680	102,436	103,277	---	---	348,800	---	---	---		1,134,693
Lala	334,434	---	---	309,876	71,714	72,290	1,248,900	---	---	---	---	---		2,037,214
Libbaya	105,880	262,309	---	210,450	48,695	49,093	1,771,600	---	---	---	---	---		2,448,027
Machghara	20,000	---	---	693,015	160,383	161,666	2,624,100	---	---	---	---	---		3,659,164
Maidoun	30,980	---	---	42,409	9,827	9,872	876,900	---	---	---	---	---		969,988
Qaraaoun (El)	39,500	182,475	---	287,742	66,579	67,154	498,800	---	---	---	---	---		1,142,250
Qelia	182,541	---	---	78,222	18,106	18,238	1,187,700	---	---	---	---	---		1,484,807
Sohmor	94,900	209,237	---	349,805	80,966	81,586	4,441,500	---	---	---	---	---		5,257,994
Yohmor el Beqaa	40,000	---	---	186,545	43,162	43,515	1,884,000	---	---	---	---	---		2,197,222
Zellaya	39,500	---	---	24,657	5,711	5,755	509,500	---	---	---	---	---		585,123
Regional Reservoirs / Pump Station														
Libbaya Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Ain El Tine Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Jabal El Arabi Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Baaloul Regional	20,000	---	---	---	---	---	---	---	---	---	---	---		20,000
Libbaya Pump station	---	---	---	---	---	---	---	---	---	65,804	26,304	---		92,108

Total Cost Estimation - Ain El Zarqa Part 1 System (West Bekaa Caza)														
Town Name / Regional Reservoir / Pump Station	Reservoir			House Connection & Water Meter			Water Distribution Network			Pump Station			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Total Cost of Proposed Pump Station for Year 2013 ($)	Total Cost of Proposed Pump Station for Year 2025 ($)	Total Cost of Proposed Pump Station for Year 2035 ($)		
Total Cosf for Year 2013	1,333,215	---	---	3,342,763	---	---	17,643,100	---	---	65,804	---	---	446,445	22,832,146
Total Cosf for Year 2025	---	654,021	---	---	773,584	---	---	---	---	---	26,304	---	---	1,453,909
Total Cosf for Year 2035	---	---	---	---	---	779,823	---	---	808,300	---	---	---	---	1,588,123
Total Estimated Cost	1,333,215	654,021	---	3,342,763	773,584	779,823	17,643,100	---	808,300	65,804	26,304	---	446,445	25,874,178

TABLE 7-14: AIN EL ZARQA PART 2 SYSTEM - COST ESTIMATION

Total Cost Estimation - Ain El Zarqa Part 2 System (Rachaiya Caza)											
Town Name	Reservoir			House Connection & Water Meter			Water Distribution Network			Total Cost of Proposed Transmission Pipes ($)	Total Cost ($)
	Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)		
Aain Arab	74,900	---	---	33,062	7,668	7,668	---	---	53,200		176,498
Aakabe (El)	60,334	---	---	110,888	25,693	25,842	2,472,800	---	---		2,695,557
Ain Horche	20,000	82,041	---	50,141	11,552	11,702	---	---	49,200		224,636
Bakkifa	91,700	---	---	85,593	19,767	19,967	---	---	22,600		239,627
Beit Lahia	32,090	147,941	---	49,593	11,452	11,602	---	---	14,900		267,578
Bire (El) / Ezze(Aazzi)	111,700	---	---	278,837	64,530	65,029	---	---	706,100		1,226,196
Dahr el Ahmar	20,000	---	63,893	112,481	26,042	26,241	---	---	260,500		509,157
Haouch El Qinnaabe	69,100	---	104,708	74,689	17,278	17,427	387,000	---	---		670,202
Kaoukaba	60,334	---	---	60,498	14,042	14,092	---	---	142,500		291,466
Kfardenis	94,900	---	---	85,045	19,668	19,867	---	---	159,600		379,080
Kfarmechki/ Nabi Safa	57,688	---	---	58,406	13,494	13,593	2,179,500	---	---		2,322,681
Khirbet Rouha	188,749	---	---	212,464	49,195	49,543	---	---	379,600		879,551
Majdel Balhiss	20,000	---	---	70,655	16,332	16,482	---	---	116,600		240,069
Mdoukha	30,980	---	---	65,029	15,087	15,137	---	---	101,300		227,533
Mhaidthé (El)	39,500	---	---	84,498	19,568	19,717	---	---	156,500		319,783
Rafid (Er)	20,000	---	118,981	247,916	57,411	57,809	---	---	249,700		751,817
Tannoura	74,900	---	---	50,141	11,552	11,702	---	---	91,700		239,995
Total Cosf for Year 2013	**1,066,875**	**---**	**---**	**1,729,936**	**---**	**---**	**5,039,300**	**---**	**---**	**87,730**	**7,923,841**
Total Cosf for Year 2025	**---**	**229,982**	**---**	**---**	**400,331**	**---**	**---**	**---**	**---**	**---**	**630,313**
Total Cosf for Year 2035	**---**	**---**	**287,582**	**---**	**---**	**403,420**	**---**	**---**	**2,504,000**	**---**	**3,195,002**
Total Estimated Cost	**1,066,875**	**229,982**	**287,582**	**1,729,936**	**400,331**	**403,420**	**5,039,300**	**---**	**2,504,000**	**87,730**	**11,749,156**

7.3 Cost Estimation of Individual Systems

TABLE 7-15: INDIVIDUAL SYSTEMS - COST ESTIMATION

Total Cost Estimation - Individual Systems																		
Caza	Town Name / Regional Reservoir / Pump Station	Reservoir			Well			House Connection & Water Meter			Water Distribution Network			Transmission Pipe			Total Cost ($)
		Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of Proposed or Rehabilitated Well for Year 2013 ($)	Total Cost of Proposed or Rehabilitated Well for Year 2025 ($)	Total Cost of Proposed or Rehabilitated Well for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Cost of Proposed Transmission Pipes 2013 ($)	Cost of Proposed Transmission Pipes 2025 ($)	Cost of Proposed Transmission Pipes 2035 ($)	
	Village																	
Hermel	Boule	102,041	---	---	---	---	---	13,942	3,712	3,344	355,000	---	---	64,480	---	---	542,519
	Ouadi El Tourkman /Wadi El Ratl	40,000	---	147,800	---	---	---	35,850	8,297	8,364	523,400	---	---	---	---	---	763,711
	Zoueitini	102,041	---	---	---	---	---	14,336	3,318	3,344	230,000	---	---	22,630	---	---	375,669
Baalbeck	Aarsal	137,500	---	---	1,150,000	460,000	460,000	1,262,071	292,093	294,428	---	---	979,000	1,426,415	373,000	436,000	7,270,506
	Ain Bourdai	151,468	---	---	---	---	---	42,715	9,839	9,979	151,600	---	---	---	---	---	365,602
	Drouris	328,783	---	---	---	---	---	505,577	117,010	117,946	---	---	1,725,300	344,400	---	---	3,139,016
	Harbata and Sbouba	170,500	---	122,368	150,000	150,000	150,000	232,462	53,814	54,187	---	---	491,700	223,295	134,710	134,710	2,067,746
	Harfouch and Qlaile	40,000	---	---	---	---	---	5,596	1,306	1,306	415,000	---	---	---	---	---	463,207
	Chaat	157,500	---	138,981	---	150,000	---	299,613	69,342	69,902	1,240,600	---	---	34,100	---	---	2,160,038
	Yammoune	20,000	---	---	150,000	---	---	112,850	26,114	26,347	76,000	---	---	20,500	---	---	431,812
	Temnine Al Faouka	20,000	---	102,368	150,000	---	---	212,970	49,290	49,663	---	---	168,800	25,420	---	---	778,512
	Ham and Maaraboun	142,368	---	---	---	---	---	94,384	21,824	22,010	1,306,600	---	---	---	---	---	1,587,187
	Khraibe	20,000	---	---	---	---	---	57,404	13,290	13,430	813,400	---	---	---	---	---	917,525
	Khoder	20,000	---	---	---	---	---	231,203	53,487	53,954	---	---	52,300	---	---	---	410,944
	Tfail	20,000	---	---	---	---	---	23,456	5,456	5,456	658,700	---	---	---	---	---	713,068
	Masnaa El Zohra (Part of Hadet El)	20,000	---	---	---	---	---	---	---	---	1,831,700	---	---	---	---	---	1,851,700
	Mazraat Beit Sleibi	20,000	---	---	---	---	---	37,306	8,627	8,720	1,023,700	---	---	---	---	---	1,098,353
	Beit Mcheik (Ramassa & Qeld El Sabeh)	60,000	---	---	115,000	---	---	111,918	25,881	26,114	511,500	---	---	---	---	---	850,413
	Nabi Chit	132,400	---	---	---	175,000	---	626,646	145,073	146,192	---	---	171,600	---	43,710	---	1,440,621
West Bekaa	Tall Znoub	49,100	---	---	---	---	---	36,742	8,499	8,588	---	---	255,700	---	---	---	358,630
	Kefraiya	158,981	---	---	150,000	---	---	108,058	25,011	25,188	---	---	208,800	47,120	---	---	723,159
	Khirbet Qanafar	20,000	---	---	---	---	---	199,206	46,083	46,481	2,028,400	---	---	47,500	---	---	2,387,670
	Ain Zebde	128,188	---	---	75,000	---	---	47,632	11,023	11,111	---	---	95,800	---	---	---	368,755
	Saghbine	40,000	---	---	300,000	300,000	---	169,458	39,221	39,531	---	---	119,200	49,580	30,080	---	1,087,070
	Aaitanit	102,041	---	---	75,000	---	---	50,952	11,775	11,908	---	---	265,400	93,154	---	---	610,231
	Bab Mareh (Deir Ain ej Jaouzé)	102,041	---	---	150,000	---	---	21,824	5,047	5,091	501,100	---	---	---	---	---	785,103
Rachaiya	Ain Aata	20,000	---	---	112,500	---	---	107,417	24,853	25,039	2,060,700	---	---	247,070	---	---	2,597,579
	Haloua	20,000	---	---	100,000	---	---	6,981	1,629	1,629	---	---	243,000	---	---	---	373,239
	Yanta	322,809	---	---	300,000	---	150,000	159,217	36,860	37,140	1,627,700	---	----	204,180	---	102,090	2,939,996
	Deir El Achayer	40,000	---	---	75,000	---	---	51,580	11,938	12,033	---	---	86,700	---	---	---	277,251
	Bakka	74,900	---	---	150,000	---	---	56,547	13,125	13,171	---	---	106,000	338,000	---	---	751,743
	Kfarqouq	113,157	---	---	---	175,000	---	148,931	34,487	34,720	3,632,400	---	---	---	44,250	---	4,182,945
	Rachaiya	20,000	---	---	---	175,000	---	385,220	89,173	89,871	---	---	323,800	---	445,400	---	1,528,463

Total Cost Estimation - Individual Systems																	
Caza	Town Name / Regional Reservoir / Pump Station	Reservoir			Well			House Connection & Water Meter			Water Distribution Network			Transmission Pipe			Total Cost ($)
		Total Cost of Reservoirs for Year 2013 ($)	Total Cost of Reservoirs for Year 2025 ($)	Total Cost of Reservoirs for Year 2035 ($)	Total Cost of Proposed or Rehabilitated Well for Year 2013 ($)	Total Cost of Proposed or Rehabilitated Well for Year 2025 ($)	Total Cost of Proposed or Rehabilitated Well for Year 2035 ($)	Total Cost of House Connections and Water Meters for Year 2013 ($)	Total Cost of House Connections and Water Meters for Year 2025 ($)	Total Cost of House Connections and Water Meters for Year 2035 ($)	Total Cost of Required Water Distribution Network for Year 2013 ($)	Total Cost of Required Water Distribution Network for Year 2025 ($)	Total Cost of Required Water Distribution Network for Year 2035 ($)	Cost of Proposed Transmission Pipes 2013 ($)	Cost of Proposed Transmission Pipes 2025 ($)	Cost of Proposed Transmission Pipes 2035 ($)	
	Village																
	Aiha	286,737	---	---	210,000	---	---	162,894	37,698	38,024	---	---	173,100	334,490	---	---	1,242,943
	Total Cosf for Year 2013	**3,202,556**	**---**	**---**	**3,412,500**	**---**	**---**	**5,632,959**	**---**	**---**	**18,987,500**	**---**	**---**	**3,522,334**	**---**	**---**	**34,757,849**
	Total Cosf for Year 2025	**---**	**---**	**---**	**---**	**1,585,000**	**---**	**---**	**1,304,196**	**---**	**---**	**---**	**---**	**---**	**---**	**1,071,150**	**---**	**3,960,346**
	Total Cosf for Year 2035	**---**	**---**	**511,518**	**---**	**---**	**760,000**	**---**	**---**	**1,314,213**	**---**	**---**	**5,466,200**	**---**	**---**	**672,800**	**8,724,731**
	Total Estimated Cost	**3,202,556**	**---**	**511,518**	**3,412,500**	**1,585,000**	**760,000**	**5,632,959**	**1,304,196**	**1,314,213**	**18,987,500**	**---**	**5,466,200**	**3,522,334**	**1,071,150**	**672,800**	**47,442,926**