Annex 7

Global Costs for Water Resources Development

Annex 7 Global Unit Costs of Water Supply and Wastewater Projects

1. Water Supply related Global Unit Costs

(1) Table 1. SIU Global Cost Estimates

Item	Unit	Average Global Cost (USD)	Spread (USD)	Notes
Land	% of capital cost	10%	9.20% 16.30% 9.20% 6.60%	Central North South Bekaa
Resources	US$/m^3/day	126		Based on boreholes
Transmission	US$/capita	63		
Storage	US$/m^3	200	450 200 175 168	100 m^3 reservoir 500 m^3 reservoir 1000 m^3 reservoir 1500 m^3 reservoir
Distribution pipe work	US$/capita	66	57 174 245	Dense development Medium development Low density village
House connections	US$/capita	18		Based on US$ 250 per connection with one connection supplying 3 families of size 4.7

Source: CDR, MHER, MoE, Commission of the European Communities
SIU-1-Water & Wastewater Sector, Outline Sector Plans Water, Wastewater and Irrigation Discussion Document, Nov. 1996

(2) Table 2. Global Unit Costs Estimated by JICA from Table 1

Item	Unit	Average Global Cost (USD)	Notes
Transmission	US$/m^3/day	210	Assuming 300 l/c/d for the average per capita consumption including leakage and non-domestic use
Storage	US$/m^3/day	67	Assuming 300 l/c/d for the average per capita consumption including leakage and non-domestic use and 8 hours-volume of daily water demand for storage
Distribution pipe work	US$/m^3/day	220	Assuming 300 l/c/d for the average per capita consumption including leakage and non-domestic use
House* connections	US$/capita	53	Based on US$ 250 per connection with one connection supplying 1 families of size 4.7

(3) Table 3. Flow meter (1997 price)

Item	Unit	Average Global Cost (USD)	Notes
Flow meter	US$/capita	21	Based on US$ 100 per connection with one connection supplying 1 families of size 4.7

GIBB-KA-KCIC JV, CDR, Awari Conveyor Project For Beirut Water Supply, Financial and Cost Analysis Study, Draft Report, April 1997

(4) Treatment Unit Costs

Table 4 Water Treatment Costs by Treatment Level

Capacity m3/day	Treatment Costs US$			Per capacity unit costs US$/m3/day		
	A	B	C	A	B	C
500	57817	337201	420634	116	674	841
1000	85238	555432	747756	85	555	748
1500	106966	743732	1046925	71	496	698
2000	125664	914897	1329274	63	457	665
2500	142390	1974354	1599742	57	790	640
3000	157696	1225062	1861103	53	408	620
4000	185262	1507002	2363032	46	377	591
5000	209921	1769657	2843838	42	354	569
6000	232487	2017900	3308455	39	336	551
7000	253448	2254765	3760028	36	322	537
8000	273126	2482307	4200727	34	310	525
9000	291749	2702000	4632133	32	300	515
10000	309480	2914947	5055449	31	291	506
11000	326447	3122004	5471617	30	284	497
12000	342748	3323848	5881393	29	277	490
15000	388369	3903160	7078081	26	260	472
20000	456258	4801449	8986998	23	240	449
			Average	48	396	583

Note: A) Groundwater treatment With Simple Chlorination including Borehole
B) Ditto with Filtration, Chlorination and Contact Tank
C) Surface Water treatment - Filtration, Chlorination and Contact Tank
Source: CDR, MHER, MoE, Commission of the European Communities
SIU-1-Water & Wastewater Sector, Construction Cost Database April 1995

Table 5 Costs of Water Supply Project for Awari Conveyor

Quadaniye Treatment plant (Phase 1)	
Capacity	260,000m^3/day
Water production	82MCM/year
Estimated per capita consumption	
Cost estimate	59.5M US$
Land acquisition	0.8M US$
Total costs	60.3M US$
Per capacity costs	232US$/m3/day

GIBB-KA-KCIC JV, CDR, Awari Conveyor Project For Beirut Water Supply, Financial and Cost Analysis Study, Draft Report, April 1997

In this study, the average costs derived from Construction Cost Database (1995) above are used.

(5) O & M of Water Supply System

Beirut Water Authority
Actual total O & M expenditure in 2001: 34,781,241,399 LL/year
Estimated average daily water supply: 270,000 m3/day
Subscribers: 210,067
Unit O & M costs: 0.24 US$/m3

Chamsine Water Authority
Actual total O & M expenditure in 2001: 988,410,467 LL/year
Estimated average daily water supply: 25,448 m3/day
Unit O & M costs: 0.07 US$/m3

Barouk Water Authority
Actual total O & M expenditure in 2001: 4,936,007,832 LL/year
Estimated average daily summer water resource: 26,300 m3/day
Unit O & M costs: 0.34 US$/m3

Sour Water Authority
Actual total O & M expenditure in 2001: 1,202,756,175 LL/year
Estimated average daily summer water resource: 28,328 m3/day
Unit O & M costs: 0.08 US$/m3

Jabal Amel Water Authority
Actual total O & M expenditure in 2001: 960,600,086 LL/year
Estimated average daily summer water resource: 20,276 m3/day
Unit O & M costs: 0.09 US$/m3

Kesrwan Water Authority
Actual total O & M expenditure in 2001: 11,617,482,883 LL/year
Estimated average daily summer water resource: 47100 m3/day
Unit O & M costs: 0.45 US$/m3

Bcharre Region Water Supply Project, Water Supply Master Plan, Final Report, Jan.1999
Estimated O & M expenditure: 993,000 LL/year
Estimated average daily water demand: 17,067 m3/day
Estimated unit O & M costs: 0.15 US$/m3

The estimated unit O & M costs vary depending on water authorities from 0.07 to 0.45 US$/m3. This variation may be caused by difference in pumping costs and scale of water supply system, etc. It should be also noted that the current O & M expenditures of some of water authorities are not enough for appropriate O & M activities. The current 21 authorities will soon be consolidated to four regional authorities. The future expenditure level will be close to large water authorities such as Beirut. In this study, the unit O & M costs is assumed at 0.3 US$/m3

considering current expenditure level of Beirut Water Authority. .

(6) Leakage Control Costs

The relationship between the leakage activities and their effectiveness cannot not clearly defined and thus it is very difficult to estimate between their costs and leakage reduction. This study assumes the following leakage control costs and the reduction considering the leakage control costs and leakage ratio in Tokyo; 5 % of the total expenditure is used for leakage control and current leakage ratio is about 9 %.

Leakage target	Costs
35 %	additional 1.5 % of O&M costs
25 %	additional 3.0 % of O&M costs
10 %	additional 5.0 % of O&M

(7) Water Conservation Costs

Many water conservation measures take minimal operation costs. Also it is very difficult to estimate the relationship between the costs of conservation measures and their effectiveness. This study assumes the following operating costs for radical and moderate water conservation measures.

Intensity of conservation measures	Costs
No measures	0 % of O & M costs
Moderate measures	additional 1 % of O&M costs
Radical measures	additional 2 % of O&M costs

(8) Meter readings

Total no. of subscribers	210,067 persons (Beirut Water Authority in 2001)
Daily meter readings	30 subscriber/person/day
Salary	500 US$/month
Reading fee per time	166,500 US$/time
6 time per year readings	999,000 US$/6times/year
Daily average water supply	170,000 m3/day
Equivalent unit costs	0.01 US$/m3 (6 times per year readings)

2. Sewerage System Costs

The followings are summaries of sewerage project costs. Considering these project costs, this study assumes the following global unit cost.

Investment

WWTP + sludge treatment	700 US$/$m^3$/day (Conventional Activated Sludge Process)
WWTP + sludge treatment	200 US$/$m^3$/day (Upflow Anaerobic Sludge Blanket)
Wastewater network	550 US$/$m^3$/day

O&M cost

CASP	0.150 US$/$m^3$
UASB	0.050 US$/$m^3$

(1) Tripoli Sewerage System Project

Table 6 Costs of Tripoli Sewerage System Project

Estimated capacity	140,000-190,000 m3/day	
Investment cost unit flow		
Wastewater treatment plant	484-679 US$/m3/day	CASP + digester dewatering, and gas utilization facility
Wastewater network of new facility only	272-383 US$/m3/day	184 km of network
Sea outfall	38-77 US$/m3/day	
Total excl. sea outfall	774-1038 US$/m3/day	including 130 km of existing network
Wastewater network including existing network cost	465-650 US$/m3/day	
Total excl. sea outfall and including existing network	980-1293 US$/m3/day	
O&M cost per m3 for sewerage system	0.13-0.16 US$/m3	

Source: CDR, MHER CES, BTD (1998) Project No 1342 Contract No 6261 Feasibility Study for Tripoli Sewerage Final Report, Vol. 1: Report. Sept 1998.

(2) Beirut Sewerage System Project

Table 7 Costs of Gadir Wastewater Treatment Plant

Estimated capacity	251,000 m3/day	Remarks
Investment cost		
WWTP(1), main collector and sea outfall	756 US$/m3/day	CASP+digester, dewatering, gas utilization facility
WWTP(2), main collector and sea outfall	276 US$/m3/day	UASB+digester, dewatering, and gas utilization facility
WWTP(3), main collector and sea outfall	552 US$/m3/day	UASB+CASP+digester, dewatering, and gas utilization facility
WWT(1) only	678 US$/m3/day	
WWT(2) only	198 US$/m3/day	
WWT(3) only	475 US$/m3/day	
O&M cost		
WWTP(1), main collector and sea outfall	0.110 US$/m3	
WWTP(2), main collector and sea outfall	0.033 US$/m3	
WWTP(3), main collector and sea outfall	0.055 US$/m3	

CDR, MHER, CES, BTD, Festivity Study on Ghadir Wastewater Treatment Plant, Facility Study, Final Version, July 2000, Project No. 1035, Contract No. 6510

(3) Bekaa (Aanjar, Majdel Aanjar, Saouiri, Barr Elias, El Marj and El Raouda)

Table 8 Costs of Wastewater Treatment Plant for Bekaa

Estimated capacity	15,000 m3/day	
Investment cost unit flow		
Wastewater treatment plant	822 m3/day	CASP+digester, dewatering, and gas utilization facility
O&M cost		
Wastewater treatment plant	0.14 m3/day	CASP+digester, dewatering, and gas utilization facility

CDR, BTD. Wastewater Treatment Plant for Aanjar, Majdel Aanjar, Saouiri, Barr Elias, El Marj and El Raouda, Preliminary Design Report, June 1999, Contract No 6517 Addendum No 1-6517/2

3. Treated Wastewater Reuse

The unit costs for tertiary treatment facilities are derived from the cases in USA. Table 9 and Table 10 are explained these costs and treatment processes. In this study, the costs of tertiary treatment of No 6, which is the least cost alternative, are adopted. The capital and O & M costs for tertiary treatment additional to secondary treatment are 70 US$/m3/day and 0.04 US$/m3, respectively.

(1) Tertiary Treatment Costs for Urban Uses

Table 9 Cost of Wastewater Treatment Plant by Capacity and Type of Treatment in USA

No.	Capital cost (US$/m3/day)			O&M cost ($/m3)		
	3,785 m3/d	18,925 m3/d	37,850 m3/d	3,785 m3/d	18,925 m3/d	37,850 m3/d
1	779	280	199	0.109	0.077	0.069
2	1,612	761	658	0.195	0.135	0.125
3	1,717	803	690	0.217	0.153	0.144
4	1,506	697	659	0.217	0.149	0.141
5	2,219	972	933	0.376	0.284	0.276
6	1,873	830	793	0.253	0.174	0.166
7	1,863	880	816	0.246	0.174	0.165
8	1,876	956	911	0.478	0.395	0.387
9	2,008	1,099	1,009	0.203	0.151	0.153
10	2,391	1,350	1,304	0.594	0.492	0.484
11	3,554	2,314	2,223	0.898	0.718	0.695
12	3,197	1,873	1,729	0.767	0.612	0.586

Note: Modified from the data from "Takashi Asano. (1998). *Wastewater Reclamation and Reuse*. Water Quality Management library Vol. 10. Technomic. Lancaster."

Note: No.2 is the costs for conventional secondary treatment plant. No. 5 – 12 is the costs of tertiary treatment.

Table 10 Treatment Process and Recommended use of effluent (A supplement table for Table 9)

No	Treatment process	Recommended usage of effluent
1	Primary treatment (Preliminary treatment and primary clarifier)	Fodder, fiber, and seed crops, orchards and vineyards
2	Conventional activated sludge	Landscape impoundment, Pasture for milking animal, Livestock and wildlife watering, Golf course, freeway and green belt irrigation
3	Combined trckling filter and activated sludge	Landscape impoundment, Livestock and wildlife watering, Golf course, freeway and green belt
4	Extended aeration (oxidation ditch)	
5	Secondary treatment plus full title 22 facility	Agricultural food crop, Recreational impoundment, Parks, Playground and schoolyard irrigation
6	Secondary treatment plus direct filtration	Agricultural food crop, Recreational impoundment, Parks, Playground and schoolyard irrigation
7	Secondary treatment plus contact filtration	Agricultural food crop, Recreational impoundment, Parks, Playground and schoolyard irrigation
8	Secondary treatment-contact filtration-phosphorus removal	Fishery habitat
9	EIMCO bardenpho process	Fishery habitat
10	Secondary treatment-contact filtration-carbon adsorption	Groundwater recharge
11	Secondary treatment-contact filtration-phosphorus removal-reverse osmosis	Industrial
12	Secondary treatment-lime treatment-reverse osmosis	Industrial

Source: Takashi Asano. (1998). *Wastewater Reclamation and Reuse*. Water Quality Management library Vol. 10. Technomic. Lancaster."

Table 11 Additional costs of tertiary treatment to secondary treatment (CASP)

No.	Capital Costs	O&M costs
	Treatment capacity 18,925 m3/d	
6	69	0.039
7	119	0.039
8	195	0.26
9	338	0.016
10	589	0.357
11	1,553	0.583
12	1,112	0.477

Note: Derived from the Table 9 and Table 10.

(2) Cost for Irrigation Uses

Table 11 Costs of Treated Wastewater Reuse for Irrigation Use

Target irrigation zone	Calculated investment cost	Calculated pumping energy cost	Length of pipeline
	US$/ha	US$/m3	m
Beirut golf court	8,000	0.019	3,000
Damour/Jiye	10,353	0.028	19,750
Beirut International Airport	2,059	0.008	1,500
Basic investment cost used in Lebanon	5,000	0.050	-

Note: * Investment costs include pumping facility and lift pipeline.

For the pumping energy cost per cubic meter, a basic rate is taken as 0.05 USD/m3. This is a typical figure in Lebanon that corresponds to pumping groundwater for irrigation.

For the investment cost per hectare, a basic cost rate is taken as adopted by the MHER.

Source: CDR, MHER, CES, BTD, Festivity Study on Ghadir Wastewater Treatment Plant, Facility Study, Final Version, July 2000, Project No. 1035, Contract No. 6510

Annex 8

MEW's Comments on Interim Report

Remarks & Observations
on the Interim Report on Water Resource Management Master Plan
in the Republic of Lebanon

CHAPTER	IDENTIFICATION	REMARKS
Chapter 1 - Introduction	1.1 Background By Mr. Zuheir el Hasan By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** The phrase "relatively rich water resources" should be replaced with "adequate water resources". The phrase " ...as compared to other neighboring middle eastern countries where extreme chronic shortage of water prevails" must be removed. In the second last line of page 1-1 the word "incomplete" can be replaced with "lacking", and the word "accelerated" should be replaced with "exacerbated the". **By Eng. Adib Geadah:** - Add an executive summary in English and Arabic - The figures of 823 mm of mean annual precipitation and 8600 mcm/y for Lebanon are in contradiction with chapters 2 and 4
	1.2 Objectives of the Study	
	1.2 Study Area By Eng. Adib Geadah	**By Eng. Adib Geadah:** The criteria and methodology to be set by the Japanese Team in the restricted areas (i.e border areas of South Lebanon) for actual data collection by LRA, are still to be provided to LRA.
	1.4 Scope of the Study	

	1.5 Overall Working Schedule of the Study By Mr. Zuheir el Hasan By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** The last sentence of the paragraph under the heading "Stage 2: First Field Survey in Lebanon" it is stated that "Initial environmental examination will also be done during this stage". There is no evidence of this in the introduction, which by definition should "introduce" readers to some the salient points of the study. **By Eng. Adib Geadah:** Stage 2: All the data documents, information,....collected during the phase 1 of the study should be stored in one copy in the MEW according to an extensive inventory to be established in order to act as a database/ data bank for the future.
	1.6 Personnel Engaged in the Study	

Generally, speaking the introduction does not "introduce" the reader to much in terms of some of the findings of the study. Further, it is very difficult to read. (By Zuheir el Hasan)

Remarks & Observations
on the Interim Report on Water Resource Management Master Plan
in the Republic of Lebanon

CHAPTER	IDENTIFICATION	REMARKS
Chapter 2 – General Description of the Area 2.1 Socio-economy	2.1.1 Administrative units By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** On page 2.1 there is a reference to the three branches of Government: legislative, administrative and judicial. I think the word administrative should be replaced with "executive", which is a more recognizable term.
	2.1.2 Population By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** Referring to page 2.3, the report uses a growth rate of 1.79% for 1999, 1.78% for 2000 and 1.7% for 2001. We believe that this growth rate is simply too low, particularly if one was to include the refugee camps. A figure closer to 2% would be realistic in our view. In any case there is insufficient support for their use of the growth rates they quoted. Another point worth noting is that in the study of the population, there seems to be no accounting of permanent and temporary residents, or primary and secondary residents. It is a fact in Lebanon, that in addition to the growth in population in summer due to tourism, and Lebanese returning for vacations, significant numbers of people leave the cities, particularly Beirut, and spend 3 to 4 months in the rural areas of Lebanon. This particularly evident for Mount Lebanon and the south of Lebanon. No demand analysis could be complete without taking this into account.
	2.1.3 Economic Profile By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** This section needs to be studied thoroughly by an economist. The agricultural and industrial sectors need to be analysed further since they impact on demand so much. However, in the last sentence of page 2.6, they state that real GDP grew moderately, although in Table2.1-8 it is quoted at 8%, which would not be regarded as anything other than strong. It must be noted-and this applies to all the data and tables throughout-that all the referencing is poor and it is difficult to corroborate that data they quote.
	2.1.4 Government Finance	

Remarks & Observations
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CHAPTER	IDENTIFICATION	REMARKS
Chapter 2 – General Description of the Area 2.2 Topography & Geology	2.2 Topography & Geology By Mr. Zuheir el Hasan By Dr. Sélim Catafago	**By Mr. Zuheir el Hasan:** This section is very difficult to read. I found it very ambiguous, e.g. "Side slopes are gradual, slow and ruined". Further, the height of Mount Harmon that they quote is wrong.. It is approximately 2,400 meters above sea level. The phrase" The plain can only be found near Tell Bin of the north" is blatantly wrong. Generally speaking, there appears to be too many errors of fact in this section. I think this section, like that relating to socio-economic analysis, needs extensive review and perhaps drastic re-writing. **By Dr. Sélim Catafago:** Page 2-11 Mount- Harmon reaches its peak at 2, 000 m and not at 1,600 m
2.3 Meteorology & Hydrology	2.3.1 Observation Stations By Dr. Sélim Catafago By Eng. Adib Geadah	**By Dr. Sélim Catafago:** Page 2-18 Table 2-3.3 is a list of rehabilitated hydrometric stations not hydrologic. Table 2-3-4 (1) and (2) same remark. **By Eng. Adib Geadah:** LRA was managing 81 gauging stations in total. Add: out of which 70 were equipped with limnigraphs. LRA conducts direct measurements of Stream flow… Add: - At present and since 1977 only the low discharges that is less or equal 8-9 m3/s are practically measured by velocity flow meters. - Fig 2.3.1 :station 496 to be in red - Table 2.3.4(2): station 496 is already rehabilitated since Nov 2002
	2.3.2 Meteorology By Dr. Wajdi Najem By Dr. Sélim Catafago By Eng. Adib Geadah	**By Dr. Wajdi Najem:** - The series of annual rainfall for various stations in fig. 2.3.2. are not correct, because data of different locations have been grouped in one series. - The average annual rainfall estimated at 823 mm for Lebanon is not precise. What is the source of this estimation? - As mentioned in the annex 3.2, for the SSM simulation study, in page 3.2-9, the basic three stations used as the principal input for the model are: - Beirut international airport: In fact the values given for this station, correspond to four stations: **Ras beirut : from 1 September 1933 to 1 September 1939** **Bir Hassan from 1940 to 1953** **Aerogare from 1954 to 1963**

		Aeroport from 1964 until now, but with one change of location in 1982 And each of these stations has different mean. - Tripoli: this station has been moved three times since its installation in 1939. the values used from 1962 until now are not very accurate, and the station is not very reliable. - **Cedars: Jica presents the data for this station from 1947 to 2002, and uses data from 1962 to 2001.** **But we have many objections for the use of this station for the following reasons:** **- There are many missing years: 1972, 1976, 1977, 1984 to 1995, and many missing months from 1997 to 2001.** **- Due to heavy winds, rainfall measured at high altitudes with snow , misses completely accuracy and indicates wrong values of rain.** - **Remarks concerning the use of rainfall as input in the model will be developed in the next sections.** **Anyway, we did not find in the interim report and the annex, any control of the meteorological data and its homogeneity, nor any study concerning its structure for Lebanon, before its spatialisation and use in the model.** **By Dr. Sélim Catafago:** Page 2-21 The rainfall average value proposed by JICA 823 mm is not justified. The average rainfall is undoubtly different Page 2-22 The annual rains presented in the figure 2-3-2 do not belong to the same category and cannot be presented as measured in the same station under the same conditions. **By Eng. Adib Geadah:** - Average annual rainfall is estimated about 823 mm: to be justified and checked according to the most recent sources of data.
	2.3.3 Hydrology By Mr. Zuheir el Hasan By Dr. Wajdi Najem By Dr. Sélim Catafago By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** On page 2.23 they quote the catchment area as 8,210 km^2, while in Table 2.3-5 they reach the figure 8,055 km^2. The runoff data they quote in Table 2/3-6 can be disputed. The runoff for Hasbani is quoted at 85 mcm/a, when it is now internationally agreed that is approximately 150 mcm/a. They have taken the data for the last ten years, when we know that this period has been very dry. They should consider a much longer time series to generate their data.. Their total runoff is 3,069 mcm/a while the State of the Environment Report quoted 3,900 mcm/a. **By Dr. Wajdi Najem:** - Table 2.3-5 is not accurate, because the area of El Kebir catchment (434 km2) is in fact the area of the catchment for the hydrometric station of Arida on the kebir. - **Table 2.3-6 that gives annual runoff of major rivers of Lebanon, and that is essential for the calibration of the models, contains many important errors and lacks coherence and consistency:** **- no temporal homogeneity: instead of the average of the station, runoff has been considered for some stations only for the last ten years, while the measurements for this period is not very accurate: example: El Bared, El Kelb, Nahr Beirut,** **- The use of specific yield for extrapolation of the runoff from gauged to ungauged area of a watershed is**

		completely inconsistent in the case of alimentation from a spring: example of El assi river, where it has been found that the total runoff is 656 MCM, instead of 410 MCM. **- Misinterpretation of measurements where runoff has been counted two times: example: Awali river: the runoff of 371 MCM is due to the diversion of litani to the awali power station, and it is not the natural runoff.** **- Values of runoff especially for international river are not adequate: case of El Assi and especially Hasbani.** - **The use of this table for calibration issues is very dangerous.** - **Anyway, we did not find in the report any analysis and control of the hydrometric data, especially the chronology of the station, its change of place, the water use in front of it, the validity of the curves used,...** **By Dr. Sélim Catafago:** Page 2-23 Conclusions given at the end of the page concerning the areas of side basins of El Kabir, Arka, Ibrahim and Hasbani are not justified. Page 2-24 Table 2-3-5 error in the estimation of El Kabir area. These areas proposed for the other water shaeds are acceptable but should be better estimated. For the Hasbani the area mentioned corresponds to the one of the hydrometric station of downstream Wazzani. Page 2-25 Table 2-3-6 the annual volumes are incorrect. Page 2-27 The extrapolations in figure 2-3-4 are inaccurate, without any justification, and are not even proposed by generation. Page 2-28 & 2-29 The calculation of the average volumes were not realized in good conditions noting that during decades measurements were lacking. **By Eng. Adib Geadah:** (1) Major rivers: Mention that catchments areas were measured by the study on GIS system at scale 1:200000 and that the scale 1:50000 should be used. Table 2.3-5: catchments areas should be measured at scale 1:50000 Table 2.3-6 : -runoff of litany :689 MCM/y is underestimated. The figure is =780MCM/y - Runoff El Hasbani: 85 MCM/y is under estimated. The figure is = 145 MCM/y - Run off of El Hasbani: 85 MCM/y is completely wrong. The figure is around 145 MCM/y Fig 2.3-3: Marj Marjayoun is a separate sub basin from El Hasbani.

	2.3.4 Surface Water Quality By Miss Randa Nemr By Eng. Adib Geadah	**By Miss Randa Nemr:** As surface water quality is influenced by industrial discharges, agricultural activities and domestic wastewater, it would be necessary to conduct an assessment of the extent of pollution and the suitability of surface water for different usages. Therefore, the concentrations of pollutants (other than BOD and Nitrate should be identified). High concentrations of fecal and total coliforms are reported but the values are not given. Nevertheless the concentrations of coliforms are related to the discharge of municipal wastewater what about the concentrations of pesticides and pollutants from industrial activities. The section on the evaluation of water quality in Qaroon refers to high concentrations, diluted concentrations and low concentrations. Actual figures should be provided to give a better understanding of the extent of pollution. With respect to Coastal Water, it is stated that high concentrations of heavy metals are identified next to industrial areas. Do the industrial areas discharge directly into the sea? If not then any water course along the discharge to the sea would be polluted and its quality should be assessed. Table 2.3.11 shows high concentrations of fecal coliformd from the discharge of raw sewage, however in some locations wastewater treatment plants are being or will be constructed what will be impact of these plants and where other plants should be constructed. **By Eng. Adib Geadah:** Table 2.3-9 show the date of validity
2.4 Hydrogeology	2.4.1 Hydro-geological Setting of Lebanon By Mr. Zuheir el Hasan By Dr. Sélim Catafago	**By Mr. Zuheir el Hasan:** The 1st paragraph of page 2-34 is conjecture; it is not scientific. The last sentence of the 2nd paragraph of page 2-34 is very problematic:" Thus, the foundation of the country has huge groundwater storage capacity with almost enough precipitation but volume of available water resources, **they said**, in chronic shortage". The phrase "they said" is very strange in deed. **By Dr. Sélim Catafago:** Page 2-34 The hydro-geological analysis is copied from previous studies without visiting the site or giving personal comments.
	2.4.2 Hydro-geological Unit By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** In the 2nd paragraph of page 2-36, the following phrase appears: " ...the Litani River,.....collects the major part of the water in the plain and courses out to the coastal basin at the south plain **miraculously**" This is a very strange description of the Litani River.

	2.4.3 Springs By Mr. Zuheir el Hasan By Dr. Sélim Catafago By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** Page 2-36, it is quoted that Beirut River runoff is 101 mcm/a. In general, all the runoff data they use is erroneous. **By Dr. Sélim Catafago:** Page 2-41 Figure 2-4-5 it is not indicated whether these are average measurement volumes and there are no remarks and conclusions relative to these volumes. **By Eng. Adib Geadah:** Page2-39 para. (2) spring: The various sectorial studies on ground water and aquifers during the period 1970-2002 should be assessed and evaluated in order to update the old study of ground water of UNDP,1970 Page 2-42, Para. (3) submarine springs: The recent aerial infra red survey of the Lebanese coast undertaken by the LNCRS and the Syrian counterpart should be shown.
	2.4.4 Groundwater Well By Dr. Sélim Catafago By Eng. Adib Geadah	**By Dr. Sélim Catafago:** Page 2-45 reproduction of the PNUD study without any comments. **By Eng. Adib Geadah:** Page 2-45 para (3) well yield / ground water yield: table 2.4.2 is to be updated.
	2.4.5 Spring & Groundwater Quality By Miss Randa Nemr	**By Miss Randa Nemr:** Similarly to surface water quality, other water quality parameters and pollutants should be measured to assess the extent of pollution, the required treatment measures and the suitability of the water resources for drinking purposes especially that ground water is the major source of water supply for drinking purposes. It is that general situation of groundwater and spring water qualities from a hydrogeology point of view is explained in Section 2.4.6, however the referred section does not cover water quality and the data required for SSM does not take water quality into consideration.
	2.4.6 Data Collection on Hydro-geological Aspect	

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Chapter 2 – General Description of the Area 2.5 Water Supply and Wastewater	2.5.1 Water Supply By Mr. Zuheir el Hasan By Miss Randa Nemr By Dr. Sélim Catafago	**By Mr. Zuheir el Hasan:** In the 2nd paragraph of page 2-52, it is stated that several studies that have dealt with resources are summarized in the Annex. They quoted Bechtel, Howard Humprey and Haggar, none of which are summarized in the Annex. They quote the yield at 777,000 m^3/day in summer and Howard Humphrey 823,000 m^3/day. I believe, that these are the yields for winter, and in the summer they decrease by between 30 to 40%. In some areas, yields of springs decreases by 70%. The picture they paint is overly optimistic. On page 2-55 the state that the water supply coverage is highest in Hasbaya (95%) and that Jezzine, Marjayoun and Bint Jbeil rely on public water network. This is very misleading because it could imply that these regions have enough water, which is far from the truth. In fact according to the Mapping of Living Conditions in Lebanon report conducted by the Ministry of Social Affairs and United Nations, these areas are amongst the most poorly served in terms of water supply. In fact, network coverage is poor; supply is very intermittent. Supply is not provided for more than one or two days a week, and only for a few hours when it does come. Table 2.5-2 needs to be revised because the connection rates are misleading, and the per capita supply is based on the number of people connected. It does not account for the number of people not connected. In addition, as was argued above, there is no account of seasonal variations, permanent and temporary residents. (By Zuheir el Hasan) **By Miss Randa Nemr:** (12) Water supply facility – (a) Water treatment plant. It is mentioned that the existing treatment plants can treat 47% of the water resources. Are these the resources for drinking water purposes? Is all drinking water treated? What about the other 53% of the water resources? How can the raw water become drinkable by applying chlorination only when water analyses presented in previous sections refer to high concentrations of sodium, chloride and nitrates in some water bodies. Would chlorination alone make the drinking water quality meet WHO standards and the standards set by the Lebanese Government? Furthermore it was mentioned that water resources are affected by industrial discharges and agricultural. Do we have assurances that the water resources that are being used for drinking water do not contain pesticides or heavy metals? What is the raw water quality that is being used for drinking purposes? ((12) Water supply facility – (a) Water treatment plant. It is mentioned that the existing treatment plants can treat 47% of the water resources. Are these the resources for drinking

		water purposes? Is all drinking water treated? What about the other 53% of the water resources? How can the raw water become drinkable by applying chlorination only when water analyses presented in previous sections refer to high concentrations of sodium, chloride and nitrates in some water bodies. Would chlorination alone make the drinking water quality meet WHO standards and the standards set by the Lebanese Government? Furthermore it was mentioned that water resources are affected by industrial discharges and agricultural. Do we have assurances that the water resources that are being used for drinking water do not contain pesticides or heavy metals? What is the raw water quality that is being used for drinking purposes? (by Miss Randa Nemr) **By Dr. Sélim Catafago:** Page 2-56 Table 2-5-2 the results concerning allocations per inhabitant per day are debatable. Page 2-58 table 2-5-4 the estimation of leakage ratio is to be verified.
	2.5.2 Domestic and Industrial Wastewater By Miss Randa Nemr By Eng. Adib Geadah	**By Miss Randa Nemr:** With respect to the wastewater treatment plants it would be necessary to identify the type and degree of treatment (primary, secondary or tertiary) and where the treated effluent will be discharged (sea, water course, etc..) whether it would possible to re-use the treated effluent and for what purposes. The above information will also enable identifying whether the treatment plant will have a positive impact mainly with respect to reducing pollution in specific water bodies. **By Eng. Adib Geadah**: Page 2-61, Para (3) Industrial waste water discharge: what about some existing recycling capabilities?

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Chapter 2 – General Description of the Area 2.6 Land Use and Irrigation	2.6.1 Land use By Eng. Saïd Bitar By Eng. Adib Geadah	**By Eng. Saïd Bitar:** Page 2-64 Table 2.6.1 shows the present land use in Lebanon. The source of this table is from Lebanon Agricultural Research institute / FAO (1995) and the data shown in this table were updated by the Team. 1. The data seems to be inaccurate based on the official reports that state that the agricultural land in Lebanon has a total area of 250,000 ha and not 340,765 ha as indicated in the table updated by the Study Team. 2. We would like to know what was the criteria and basis used by the Team in updating the data. The Lebanese Government intends to develop agricultural lands through private sectors and the Green Plan. The total area for agricultural land is to increase to 300,000 ha in the next 30 years. This is a realistic target. The land will be irrigated through the public sector and private irrigation networks. **By Eng. Adib Geadah**: Table 2.6-1 Present land use: Forest 2,631.06 Km^2 ?? Over estimated. This figure should be around 6-8 % of the total area of Lebanon, i.e 627-836 km^2 only.
	2.6.2 Present Irrigation By Eng. Saïd Bitar By Eng. Adib Geadah	**By Eng. Saïd Bitar:** **Page 2-65 Institutions in Irrigation Sector:** The information concerning the irrigation sector is not very accurate. In 2000, Law 221 was published on the Water Sector. This Law divided Lebanon into 4 autonomous water authorities. They were given a large range of activities that begin from the planning to the exploitation of water in all its sectors (potable water, irrigation and wastewater). So they are to take the full control of the irrigation sector. What was described is this section was inaccurate since you have relied (taken) on the present interim situation of the water authorities that will be functioning for a period of maximum 2 years. **Page 2-66 Existing Irrigation Schemes**: - Table 2.6.1 and 2.6.2 are contradictory because in table 2.6.1 you state that the agricultural land (Horti-culture, field crops and orchards) is 340,800 ha whereas in table 2.6.2 you state that the cultivated area in 1999 was only 261,000 ha. This figure is closer to reality than that of table 2.6.1. - You state that the cultivated area in 1993 was 189,200 ha. In 1999 it reached 261,000 ha. We conclude that the difference during the 6 years was: 261,000 ha – 189,200 ha = 71,800 ha The average of increasing cultivated area each year will be: 71,800 ha / 6 = 11,967 ha or 6%

		If we use the same ratio we can reach in 2030: 261,000 x 4.3 = 1, 100,000 ha Therefore, the target set by the Government to reach within the next 30 years 300,000 ha is very reasonable. **By Eng. Adib Geadah:** - Page 2-66 para. (2) existing irrigation schemes: ...and 90,000 ha approximately could be the base for estimation of current consumption of irrigation : this figure should be split up into : - Annual irrigation (2 seasons): 70,000 ha - Spring irrigation (1 season): 20,000 ha - Table 2.6-3 and 2.6-5: the ratios to net irrigated are of surface water and ground water should be different from a scheme to another and from a caza to another (0.48 and 0.52 ratios should be relaxated).
	2.6.3 proposed/Ongoing Irrigation Scheme By Eng. Saïd Bitar By Eng. Adib Geadah	**By Eng. Saïd Bitar:** Page 2-73 and 2-74 The JICA Study Team has concluded that only 4 schemes would involve an expansion of irrigation area without specifying the surface of the extended area. These 4 schemes are: 1- Bared 2- South Bekaa Phase II 3- Left Bank Scheme 4- South Bekaa Right Bank and North Zone This conclusion is considered inaccurate because by the year 2030 at least 70% of the cultivated land will be irrigated. Considering that our target of irrigated land by 2030 will reach 300,000 ha then at least 210,000 ha must be irrigated by that date. If we consider that presently we are to irrigate 90,000 ha, then we will need to provide irrigation water for 120,000 ha for the next 30 years, which are only rain fed today. **By Eng. Adib Geadah:** - Table 2.6-7 : correct Middle south (Khardalé dam) as follows: Khardalé Dam and middle cretaceous aquifer: 13,000 ha and 86 MCM/y - Page 2-73: correct the total net irrigated area from 63,025 ha to 67,025 ha - Table 2.6-8: correct code P12 as follows : Khardalé + Middle cretaceous aquifer: 13,000 ha – 86 MCM/y - Ratio of surface water :0.7 Ratio of ground water 0.3

The above section needs in depth analysis because it impacts greatly on their calculations of demand. I think it needs strengthening and needs to account more significantly with the other variables that impact. (By Zuheir el Hasan)

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Chapter 2 – General Description of the Area 2.7 Hydro-power Generation	2.7.1 Power Supply in Lebanon	
	2.7.2 Hydro-Power By Eng. Adib Geadah	**By Eng. Adib Geadah:** Page 2-83 : - Correct : and conveyed through tunnel to the Joun plant correct.: ..... consuming approximately 120 million m3/y from the Qaraoun dam, added to 20 MCM/y of allocation for domestic supply in the Conveyor 800 .
Chapter 2 – General Description of the Area 2.8 Institutions in the Water Sector	2.8.1 Administrative structure of Lebanon By Mr. Zuheir el Hasan By Dr. Hyam Mallat By Eng.Bassam Jaber	**By Mr. Zuheir el Hasan:** The 3rd paragraph of page 2-86, the report speaks of the confessional or sectarian nature of Lebanon's parliament. I don't believe a study dealing with water resources management needs to deal with Lebanon's political system. To also deal with the effect of confessionalism on bureaucratic appointments is uncalled for and I believe totally unnecessary. Page 2-94, it is stated that the average household income is approximately 12,000 USD. 40% have average household incomes less than 6,000 USD. **By Dr. Hyam Mallat:** Page 2-86 Paragraph 2 points out to the policy of recruitment. We think that this paragraph should be rephrased with much more precautions according to the recruitment made normally by the Civil Service Office, the rights included in the civil servants law (D.L. 112/59), the policy of salary and the stability of the public function. Page 2-86 Paragraph 3. The word sectarian is really not appropriate in the case of Lebanon and the analysis of this situation is too superficial. **By Eng. Bassam Jaber** Page 2-86, para 1- line 4 :

		CDR is not the only institution that studies and executes the projects of infrastructure in Lebanon only those financed by foreign countries and institutions. Page 2-86, para 1- line 8: : "Office of Minister of State for Administrative Development OMSAD" Page 2-86, para 1- Line 10-11: "Enhancement..." is not correct. Page 2-86, para 2- Line 6: "unless..." : is not correct
	2.8.2 Stakeholders in the Water Resources Sector By Dr. Hyam Mallat By Eng. Bassam Jaber By Eng. Adib Geadah	**By Dr. Hyam Mallat:** Page 2-87 Paragraph 2- line 3. Replace law No. 337 with law No. 377. Page 2-87 Paragraph 4. We think that it should be more appropriate to replace the denomination of Directorate General of Operations with General Directorate of Exploitation. Page 2-91 Paragraph 5. Replace law No. 337 with law No. 377. Page 2-92 Paragraph 1. The Ministry of Agriculture is in charge of water irrigation according to article 1 of law decree 31 dated 18 January 1955. We think that this paragraph should reflect the real situation in this matter. Page 2-92 Paragraph 2. The Ministry of Public Health is in charge of delivering permits to bottle drinking water. This mission is not reflected in this paragraph. Page 2-93 In the paragraph related to the Ministry of Environment, it should be noted that the Code for the Protection of the Environment was issued by law 444 dated 29 July 2002 - and that some amendments should be adopted in this matter. **By Eng. Bassam Jaber:** Page 2.86- Paragraph 1: "2.Water Authority..." : Overseeing "3.Litani River...." : Overseeing Should add the followings: - Council for displayed Persons - Council for the South Page 2-87, Paragraph 3- Line 6: " Geology Department...": It Should be Expropriation Dpt. Line 8-9-10:" Under DGO....": DGO is only overseeing and reviewing for approval or refusing decision of the Board. Page 2.88- Figure 2.8-2:Organigrame 1."Exploitation and Water Rights Department": Should be changed to Expropriation and Water... 2. "Implementation Department" : Should include one more section called : " Central Section".

		3. "Environment Department" : Should be changed to :" Environment Protection Department" 4. Why under DGO it is called Secretary Department and under DGHER it is called Administration Department. 5. In DGHER, under Administration Dept. the staff , office equipments , Archive are not sections. 6. In DGO , under Secretary/ Administration Dept. , we should add : Accounting section & Legal section Page 2.89 – Paragraph 2: RWA does not carry out research Page 2.91 – under Paragraph Litani River Authority:" The technical ... 130 stations...": should be max 70 stations Page 2.91- under Paragraph Ministry of Interior : Line 3 : Law # 337 should be changed to Law # 377 page 2.92- under Paragraph Ministry of Agriculture : It should be noted that Cooperatives NEVER undertake studies and designs of Wastewater and drainage systems. Page 2.92- Under Paragraph Ministry of Public Health: It should be noted that this Ministry is responsible for water quality monitoring and not water quality Page 2.97 – Table 2.-87 1. Ministry of Environment does not undertake implementation of wastewater projects and solid waste project 2. It is not sure to what extent the Ministry of Environment is involved in Planning of wastewater and Solid waste projects 3. Ministry of Agriculture should have the planning responsibility mover to the sector of irrigation water and NOT the sector of wastewater. **By Eng. Adib Geadah:** - Page 2-90: Litani River authority correct:..... for the development of Litani River catchments water and soil resources via multi purpose projects Correct: ..... and power generation of Litani / Awali basins Delete: in this context, its functions include those of 4 water authorities - Page 2-91: correct:..... to maintain 130 rivers gauging stations, out of which 70 were equipped with analog limnigraphs
	2.8.3 Reform of the Water Resources Sector By Dr. Hyam Mallat	**By Dr. Hyam Mallat:** Page 2-97 In the table 2.8.7 some amendments should be made as for the Ministry of Agriculture who is in charge for water irrigation.

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Chapter 2 – General Description of the Area 2.9 Environmental Consideration	2.9.1 Law and Legislation By Miss Randa Nemr By Dr. Hyam Mallat	**By Miss Randa Nemr:** With respect to environmental management related to monitoring of water pollution, it is true that the Ministry of Environment lacks resources however it should be noted that the MOE has an enforcement role while several other ministries are responsible for water quality monitoring. What would be needed is not only additional resources but the development of an integrated water quality monitoring program in which the activities of each organization are clearly identified. Then the MOE will be able to fulfill its enforcement role. **By Dr. Hyam Mallat:** Page 2-101 Under item (3) Environmental Administration, it should be noted that law 216 was already amended and that the missions of the Ministry of Environment go beyond the enumeration. Page 2-102 Under paragraph (4) Law and Legislation, we think that there is a large misunderstanding of the legislation. Legally, we should consider water laws in one part and environmental laws on the other. The legislation issued by "Arrêtés" (at that time, Arrêté meant law) concern specifically public domain, water rights, concessions… The approach is too superficial and we think that the analysis should be split into two parts: the water laws on one hand and the environmental legislation on the other. Page 2-102 Paragraph 5. The law enforced by Decree 8735 (and not the decree) dated 23 August 1974 (and not October) concerns namely public hygiene and not the protection against pollution which is only part of it. Page 2-102 Last paragraph. An amendment should be made to the Code of Environment which way issued by law 444 on 29 July 2002 and not by decree 121018. Page 2-103 Some corrections should be made in the table 2.9.2.: - "Arrêté" (Law) (and not order) 144 dated 10/6/1925 (and not 1923). This law concerns the public domain and not the protection of surface and ground water resources. - Arrêté law 320 concerns the protection and the utilization of public water. - Decree 14438 dated 2/5/1970 concerns the prospect and the utilization of the underground waters (and not the restriction on the depth of unlicensed boreholes). - Law decree 8735 does not only concern the solid and liquid wastes. - Law decree (and not order) 69 dated 9/9/1983 is the Code of Urbanism and not the urban development.

		- Decree 5616 dated 6/9/1994 on Quarry Expropriation was abolished by decree 8801 dated 4/10/2002. Page 2-106 Paragraph 6. A correction should be made and the term decree 5211 replaced with the word decision.
	2.9.2 Current Situation on Environment	
Chapter 2 – General Description of the Area 2.10 Field Survey by Sub-contract	2.10.1 Field Survey General By Miss Randa Nemr	**By Miss Randa Nemr:** What are the criteria for the selection of the rivers and springs to be tested? How is the sampling conducted? As stated earlier, it would be necessary to include in the water quality analyses other pollutants such as trace metals and pesticides. What is required to see whether chlorination alone will make the water suitable for drinking or whether any other treatment processes are required.
	2.10.2 B/Q and Technical Specification By Eng. Adib Geadah	**By Eng. Adib Geadah:** - Pages 2-114 and 2-115 ⊗1) B/Q of the works: The measurements of the river and spring flows during January 2003 should have been done three times rather than one. Additional measurements should be conducted during April –May 2003.
	2.10.3 Progress of the Survey	
	2.10.4 Current Evaluation of Survey Results (summertime Measurements) By Dr. Wajdi Najem By Dr. Sélim Catafago By Eng. Adib Geadah	**By Dr. Wajdi Najem:** **- The conclusions concerning table 2.10-2 for comparison of survey results are not evident for two reasons:** **1- There should have been a meeting with LRA responsible to find interpretation for this difference.** **2- Especially in summer, there has been no investigation for water use on the river, especially where there is irrigation schemes and power generation. This could explain the difference for Nahr Ibrahim and Nahr AWALI.** **By Sélim Catafago:** Page 2-117 Table 2-10-1 the measurements taken during summer are not consistent due to the missing information on the intakes for potable water and for irrigation. Table 2-10-2 the comparison has no sense. Page 2-118 & 119 The measurements are insignificant as well as the resulting conclusion. **By Eng. Adib Geadah:** Table 2.10-2: The comparison has non sense and is not valid at all in view of the very limited (only one) measurements conducted by the consultant

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Chapter 3 – Tools for Decision Making in Water Resources 3.1 GIS Database	3.1.1 Overview of GIS Database By Eng. Mazen Makke	**Remarks by Eng. Mazen Makke**: - The GIS database was mostly developed based on data collected from various reports and references. The quality of the database is questionable. The collected and adopted figures have been repeatedly used and mentioned in many reports and references and even inherited without paying any attention to their accuracy, reliability and original sources. - Unreliable and outdated data and information certainly lead to confusing and erroneous conclusions. It is recommended that the collected input data be checked with care and confirmed accurately.
	3.1.2 Structure of Data By Eng. Mazen Makke	**Remarks by Eng. Mazen Makke**: The database was clearly structured and designed. However, many data in various GIS data tables are still missing and need to be completed.

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Chapter 3 – Tools for Decision Making in Water Resources 3.2 Hydrological Circulation Model	3.2.1 Concept of hydrological Circulation Model By Mr. Zuheir el Hasan By Dr. Wajdi Najem By Eng. Mazen Makke By Dr. Sélim Catafago	**By Mr. Zuheir el Hasan:** The concepts are not clear. Lacking in terms of mathematical formulation and modeling. (By Zuheir el Hasan) **By Dr. Wajdi Najem:** **- There is no clear explanation of the model structure, and no references to which similar locations to Lebanon, where the model has been applied.** **- Concerning the input, and as explained before, the three meteorological stations used are not reliable, and this should affect the quality of the output of the model.** **- The rainfall correlation coefficients calculated in annex 3.2, table 5.1 pages 3.2-14, and application of basic rainfall data (table 5.6) are not very adequate for the spatial representation of rainfall over Lebanon, especially when using as basic stations, three non reliable stations. (By Dr. Wajdi Najem)** **Remarks by Eng. Mazen Makke**: - The Synthetic Simulation Model, SSM, is a water balance model based on the concept of the "Tank Model". It superficially treats the general components of the natural hydrogeologic circulations such as the precipitation, evapotranspiration, retention and percolation water, inflows and outflows, recharge, and underground storage. - SSM is a lumped model and not a distributed one, that is, it is spatially averaged within the individual basins and/or sub-basins through both its plane and vertical sub-models. - A distributed model is recommended in this work since it takes advantage of the spatial distribution and variations of parameters for the purpose of more accurate modeling; the case of grid-based modeling. **By Dr. Sélim Catafago:** Page 3-6 The structure of the model is not very clear. Page 3-7 The concept of underground behavior is not similar to what happens in the karstic formations.

	3.2.2 Model Structures By Mr. Zuheir el Hasan By Eng. Mazen Makke By Dr. Sélim Catafago By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** On page 3-9, the state quite clearly that the Litani River basin provides water to the Hasbani basin. This is conjecture, scientifically, and unacceptable as they are not to deal with international waters according to the agreement between JICA and the Lebanese Government. Page 3-11, there is talk of trial and error, which is a little hard to accept. **Remarks by Eng. Mazen Makke**: - The above model does not satisfactorily explain the external and internal hydrogeologic processes as functions of time and space. In general, a hydrologic or hydrogeologic model is an attempt to describe these complexe natural processes, which transpose precipitation in all its forms (rain, snow, dew, hail) into surface runoff and underground inflows and outflows. - SSM is apparently like a black box. No information is available about its structure and nothing is mentioned about the equations that link the inputs to outputs. The model is not supported by any universally applied and conventional and international equations in hydrology and hydrogeology. **By Dr. Sélim Catafago:** Page 3-9 The exchanges between underground basins are not justified specially at the borders. **In fact, this part is not included in the Scope of work given to JICA.** **By Eng. Adib Geadah:** - Figure 2.3.4 Sub-basin Model: - The exchanges with Syria and Israel should be deleted completely because they contradict with the scope of work of the agreement. - The transfers between sub basins require to be validated by physical checks. - The transfer from Litani middle to Hasbani is very debatable and not validated by any thorough hydrological studies. - All the quantitative figures of the model are inaccurate and debatable.
	3.2.3 calibration of the Model By Dr. Wajdi Najem By Eng. Mazen Makke By Dr. Sélim Catafago	**By Dr. Wajdi Najem:** **- referring to what has been explained before for the runoff table and remarks about their values, the process of calibration should be reviewed.** **As for the validation, the passive validation is not very convincing.** **For all the reasons above, great caution should be observed to, as the model results and their interpretation, before a good calibration and validation of the model in Lebanon.** **Remarks by Eng. Mazen Makke**: - The above model should be calibrated and tested against actual reliable, updated and representative data. Still is the same problem of data quality. - Surface water simulation was calibrated based on "pattern matching" of surface and river runoffs and trial and error

		approaches. These cannot be considered as professional and advanced methods of calibration. There are much more advanced and mathematics-based methods that can be applied for hydrogeologic model validation. - As far as the ground water simulation is concerned, the lack of data was a limiting factor. However, calibration should not be restricted to three locations in Lebanon that are self-representative. A passive verification approach was adopted for calibration of ground water and it is unclear. **By Dr. Sélim Catafago:** Page 3-11 The calibration problem is not convincing. The annual scale of the superficial flow lacks consistency and was estimated by trial and error. The calibration of the ground water is not adequate and does not reflect reality.
	3.2.4 Water balance simulation By Eng. Mazen Makke By Dr. Sélim Catafago By Eng. Adib Geadah	**By Eng. Mazen Makke:** - Boundary conditions and constraints of the application of the model are not well and clearly defined for the different areas in Lebanon neglecting the specificities of the different regions. - Both the model and the input data are questionable and need to be justified and clarified. This fact may lead to erroneous conclusions. **By Dr. Sélim Catafago:** Page 3 -12 Simulation of the model is not clear. The sequence happens at a scale much more refined then the one used for the calibration. Page 3-13 The points presented should be clearer. **By Eng. Adib Geadah:** Water balance between Lebanon, Syria and Israel should be deleted as it contradicts the Agreement.
3.3 Digital Balancing Model (DBM)	3.3.1 Overview of DBM By Eng. Mazen Makke By dr. Sélim Catafago	**By Eng. Mazen Makke:** - It is a part of GIS database system and acts as a tool to make predictive calculation of water demand and possible water supply in the future. It also determines the status of the water balance in the future. DBM is a customized interface of GIS developed specifically to meet the requirements and purposes of the model. - GIS is a useful technique for coping with vast amounts of data and incorporating the spatial relationships between data from different sources. It plays the role of a RDBMS, relational database management system. - Another advantage of GIS is the capability to overlay information provided by thematic maps of the concerned study area. **By Dr. Sélim Catafago:** Page 3 -16 The digital balance model is not, according to the succinct explications, adequate for the elaboration of the Master Plan. Its general structure seems static and inadequate to evolutions and they lack dynamic character.

	3.3.2 Framework of DBM By Mr. Zuheir el Hasan By Eng. Mazen Makke By Dr. Sélim Catafago	**By Mr. Zuheir el Hasan:** Although the method they use to calculate demand seems reasonable, it assumes too low a growth rate in population and it totally ignores the issue of permanent and secondary population. This section needs in depth analysis. **By Eng. Mazen Makke:** The DBM interface was customized based on a programming language or scripts about which nothing is mentioned and clarified. The program should be accessible to the Lebanese counterpart for solving any unexpected modification or in case of system failure. **By Dr. Sélim Catafago:** Page 3 -17 & 3-23 The results and information that the model can generate are not evident. The performances do not seem convincing.
	3.3.3 Procedure of Predictive Calculation of Water Demand By Eng. Mazen Makke	**By Eng. Mazen Makke:** - The input parameters of the DBM were specified and its determining equations and formulas were based on most of the cases on criteria solely proposed by JICA study team without the intervention and participation of the Lebanese policy makers that know better about their country. - There should be some kind of participatory approach and coordination with the different stakeholders that are involved in the water sector, to discuss, comment and refine the findings of the working team. For the findings is a national issue of high importance for future planning.
	3.3.4 Procedure for Predictive Calculation of Possible Water Demand By Eng. Mazen Makke	**By Eng. Mazen Makke:** - The input parameters of the DBM were specified and its determining equations and formulas were based on most of the cases on criteria solely proposed by JICA study team without the intervention and participation of the Lebanese policy makers that know better about their country. - There should be some kind of participatory approach and coordination with the different stakeholders that are involved in the water sector, to discuss, comment and refine the findings of the working team. For the findings is a national issue of high importance for future planning.
	3.3.5 Output By Eng. Mazen Makke By Eng. Adib Geadah	**By Eng. Mazen Makke:** The output of any GIS or RDBMS analyses depends on the quality of the GIS database. Regardless of the technique used to develop the database, there is a great need to confirm the quality of the database and to verify the used criteria. Otherwise, erroneous conclusions will be obtained. **By Eng. Adib Geadah:** It should be checked and validated by physical confirmation and multiple cross-checking.

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Chapter 4 – Water Resources 4.1 Water Resources Potential	4.1.1 Results of SSM Simulation By Dr. Sélim Catafago By Eng. Adib Geadah	**By Dr. Sélim Catafago:** Page 4 -3 If it were true that transfers exist between water sheds, then conclusions relative to Abou Ali, Damour and Awali are incorrect. The conclusions are not based on a strong base and are rather hastily made. **Concerning the border watersheds, these are not part of the JICA mission assigned in the Scope of Work.** Page 4-4 The ground water balance is based on the measurements of the last 10 years. The results can be considered with much more suspicion because on the one hand the data was not checked and on the other hand the model used was not very clear. Thus, it does not permit to validate the results in the absence of the model effective validation. Page 4-6 The equations of the proposed water balance are neither clear nor valid and should be reviewed. **By Eng. Adib Geadah**: - Table 4.1.1: Current Surface water balance : Results should be validated and checked. They diverge from the most reliable figures already appearing in a multitude of bibliographies. In particular, Litani and Hasbani figures are debatable (Hasbani figures related to the past 10 years where no data nor records were available) Fig 4.1.1 and table 4.1.2: data for Litani and Hasbani is not accurate Fig 4.1.2 Trans border flows and flows between Litani and Hasbani are rejected
	4.1.2 Water Resources Potential By Mr. Zuheir el Hasan By Dr. Sélim Catafago By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** They quote a figure of 2,700 mcm for water lost through evapo- transpiration. This is half what Lebanese experts quote usually. Unfortunately they do not provide any justification for this figure. This is also a general fault of the entire study: they do not justify sufficiently enough any of their assumptions. **By Dr. Sélim Catafago:** Page 4 -7 The aspect of the underground resources potential was not proved and must be considered with much more precaution. **By Eng. Adib Geadah**: Table 4.1.3: Natural surface water balance : Data for litany and Hasbani is rejected - Table 4.1.4 : Natural ground water Balance: Data for litany and Hasbani is rejected

4.2 Surface Water development Potential	4.2.1 Development Strategy By Eng. André Attallah By Eng. Adib Geadah	**By Eng. André Attallah:** Due to unevenly distributed precipitation throughout the year in Lebanon, most rainfall occur within a limited period of 70 to 90 days during the wet season, and due to the topographical and geological characteristics of our country water flows down into the sea immediately, in addition to intensive exploitation of groundwater during the last drought years .The best solution for maximum utilization of Surface Water Resources under these conditions was constructing Dams. MEW has taken the initiative depending on previous studies done in the past and on visits conducted to different sites all over Lebanon to identify best possible location for these dams. The proposed dams were scheduled in the 10-year plan of our General Directorate. **By Eng. Adib Geadah**: (1) Drought year : Give the recurrence interval for 2 and 3 consecutive dry years and propose remedial measures, particularly the safety buffer storage in the storage dams.
	4.2.2 Development Potential by Direct Intake By Dr. Sélim Catafago By Eng. André Attallah By Eng. Adib Geadah	**By Dr. Sélim Catafago:** Page 4-11 The notion of potential development by direct intake is a particular approach that needs to be better clarified whether in its form or in its terms concerning the definition of terms. The hypothesis on the classified discharges is debatable. Page 4-13 The 10 year return period draft can be adopted and derived from series that allow reaching this estimation. However, the series used to reach these values should be reviewed. The notion of the reserved discharge is confusing. The potential estimation based on daily discharges creates problems as to the operation of filling the lack of measurements. Taking into consideration the intakes in the relation of potentialities as it was presented, appeals to certain reservation from our part. The volumes of international rivers that are presented should be reviewed. Page 4-14 Table 4-2-1 The numbers mentioned in the table of the surface water development potential by direct intake are not credible. Page 4-15 The hypothesis and conclusions relative to the different water flows are not properly based. **By Eng. André Attallah:** They concentrated also on the direct intake facility, which is widely mentioned in their study ignoring that we have deficit in surface water in dry seasons .The Hydrological study contain wrong data and the water demand is under estimation. **By Eng. Adib Geadah**: - Table 4.2-1: Surface water development by direct intake: Figures for Litani and Hasbani are rejected. El Hasbani station no 496 doesn't include the Wazzani spring. Therefore, the statement that 35 MCM can be used in Lebanon is largely under estimated

	4.2.3 Development Potential by Storage Facility By Mr. Zuheir el Hasan By Dr. Sélim Catafago By Eng. André Attallah By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** Page 4.25 they refer to Hasbani Dam, which again is something they should refrain from dealing with, as this involves an international water course. In addition, nobody in Lebanon refers to it as the Hasbani Dam. It is referred to as the Ibl al Saqi Dam. **By Dr. Sélim Catafago:** Page 4-19 to 22 The remarks relative to the possibilities of storage in the projected catchments areas are not acceptable. The estimation of volumes based on the catchments applying the proportionality between the area of the side water shed relative to the axe of the catchment with the one of the gauging station is unacceptable, specially knowing that a big part of surface flow results from springs of karstic environment. Page 4-23 Table 4-2-3 Results obtained from the simulation of catchments are doubtful. Page 4-25 The results concerning the dams of Noura Tahta, Assi and Hasbani are subjective and derived from interpretation that cannot be scientifically proved. Page 4-26 Table 4-2-5 and 4-2-6 the conclusions concerning the catchment storage capacity of required volumes and of planned volumes are not acceptable because they are based on subjective hypothesis and interpretations. It unjustly cancels the necessity to resort to consistent surface storage. **By Eng. André Attallah:** The evaluation of JICA team in their study for dams proposed by our General Directorate in the 10 year plan was only associated with hydrological factors without taking into consideration the most important aspects such as: topographical, geological, economical, environmental, water demand and civil work aspects. Consequently, the evaluation and results reached by the JICA Team, about Surface Water development by dams, did not take into consideration the feasibility and necessity of dams development. In addition to that, the hydrological study conducted by JICA Team was not accurate since the data considered contained wrong figures. Among the factors listed above, MEW considered the geological, topographical, and hydrological ones as major criteria in identifying the best sites for the dams. In many sites where high potential surface development was not available, the strategy of transfer of water from basin to basin was adopted to maximize the storage capacity of these dams. This system was approved by most Lebanese water experts from different universities as well as foreign water experts who came to Lebanon during the two periods of 1960-1975 and 1992-1998 in different domains such as hydrology ,hydrogeology and geology .The JICA team didn't discuss with us their results and they ignored the adopted 10 year work plan 2002 developed by our directorate, for example the Chabrouh Dam, which is under construction, the figures in their study show that this dam will not recover the designed storage volume. This is also applicable to other dams, because the JICA Team didn't ask us about the strategy or the information on how these dams were supposed to undertake their Development Potential of Water.

		Following are some other examples about these dams and their additional storage resource: • Qarqaf : from Arqa river basin • Younine : from Wadi Nahle basin ,storage volume was reduced to 7MCM due to Geological aspects more than hydrological aspects • Chabrouh: from Allaban spring • Boquata :from springs ,the hydro-geological basin is more important than hydrological basin Dar bechtaar : from Abou Ali river basin **By Eng. Adib Geadah:** - Table 4.2-2: Massa dam of 8 MCM : this storage should be deducted from the storage potential of Qaraoun Dam? - Table 4.2-4: Summary of Dam simulation (Bekaa and South): The figure of 32.62 MCM of storage capacity for el Hasbani is underestimated and not validated by a long series of data. Table 4.2-6 Massa Dam reduces the available storage for Qaraoun Dam
	4.2.4 Overall Surface Water Development Potential By Dr. Sélim Catafago By Eng. André Attallah By Eng. Adib Geadah	**By Dr. Sélim Catafago:** Page 4-28 The notion of direct intake from surface water remains vague. **By Eng. André Attallah:** Since the study of JICA Team as we mentioned before rely on wrong Data and is not on line with the 10 year work plan Strategy of MEW the results reached are not logical . Finally, it is important to note that MEW is aware of future water demand in Lebanon and know the reasons why these dams are proposed, in addition to its future scope about the General Director Plan of water demand supplied by these dams. **By Eng. Adib Geadah:** - Table 4.2-7: Surface Water development Potential: Figures for Litani-South and El Hasbani are not accurate

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CHAPTER	IDENTIFICATION	REMARKS
Chapter 4 – Water Resources 4.3 Groundwater Resources Development Potential	4.3.1 Resources Potential and Resources Development potential	
	4.3.2 Groundwater Resources Development Potential By Dr. Sélim Catafago By Eng. Adib Geadah	**By Dr. Sélim Catafago:** Page 4-29 The concept of ground water potential should be reviewed. Page 4-30 Table 4-3-1 the ground water resources development potential that results from the model and that distinguishes between interior and coastal zones show numbers that cannot be taken into consideration without control and verification through different calculation methods. Page 4-31 The coastal ground water resources development potential should be reviewed for the same reasons mentioned previously. Page 4-32 The ground water resources development potential in the sea Table 4-3-2 is not realistic. The proposed numbers are unrealistic. There is also a risk that the same volumes are counted several times. Page 4-33 The conclusion on the numbers as a whole can be refuted. **By Eng. Adib Geadah:** - Table 4-3-1: Ground water resources Potential: El Hasbani: Fig of 6.584 MCM of existing withdrawal is overestimated. Fig of 57.389 MCM of net development potential is underestimated. - Page 4.31, Para (2) GW resources dev. Potential is in a coastal sub basin: Asses the possibility of desalination of any brakish resources (i.e 3000-6000 ppm) by means of reverse osmosis particularly in the densely urban surfaces of Greater Beirut.

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CHAPTER	IDENTIFICATION	REMARKS
Chapter 5 – Water Demand 5.1 Domestic and Industrial Water Demand	5.1.1 Current Situation By Mr. Zuheir el Hasan By Mr. Ali el Khatib & André Attallah	**By Mr. Zuheir el Hasan:** Table 5.1-11quotes and annual growth rate in population for Nth Lebanon, Sth Lebanon, Nabatiyah and Bekaa of 1.57%, 1.52, 1.31, 1.47. This is too low. Again their numbers, data and assumptions should be better referenced and justified. On page 5-16, they once gain quote that connection rate in Hasbaya is 95%. This is incorrect. **By Mr. Ali el Khatib & André Attallah:** The JICA Team started their study about the present Water Demand with wrong figures regarding residential, non residential water consumption, industrial consumption and population; these figures are totally different from our current figures and under estimated, because according to MEW the present water demand (in 2002) is around 56% more than JICA's figures. MEW has its own experience, strategy and data for present and future water demand in Lebanon and ready to discuss all these figures and records.
	5.1.2 Criteria Settings By Mr. Ali el Khatib & André Attallah	**By Mr. Ali el Khatib & André Attallah:** Since the JICA team started their study about the present Water Demand with wrong data it's logically to see that the projected future demand wouldn't be reliable. According to MEW the projected Water Demand (in 2020) is around 97% more than JICA's estimated figures. To reach good Criteria thorough investigation and statistics a complete survey on ground must be done.
	5.1.3 Current and Projected Water Demand By Mr. Ali el Khatib & André Attallah	**By Mr. Ali el Khatib & André Attallah:** Since all parameters and related figures in the above sections were not accurate and reliable, the database used in their Digital Balancing Model for Assessment of the current and projected Water Demand will not lead to accurate results, and it proved that it's not in line with the ten years work plan 2002 for our General Directorate. In addition the Model used by JICA team is different from the model used in Lebanon and it might be invalid in Lebanon.

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CHAPTER	IDENTIFICATION	REMARKS
Chapter 5 – Water Demand 5.2 Irrigation Water Demand	5.2.1 Introduction By Eng. Adib Geadah	**By Eng. Adib Geadah:** - Fig 5.2-1: procedure of estimation of irrigation water demand: data to be validated by comparison with the results of old and recent experimental stations particularly for crop coefficients
	5.2.2 Parameters for Estimation of Irrigation Water Demand By Eng. Adib Geadah	**By Eng. Adib Geadah:** -Page 5-23: Correct:..... accounting for 63,025 ha including 38,530 ha To: ..... accounting for 67025 ha including 42330 ha - Table 5.2-2 correct as follows : No 12 Khardalé and Middle Cretaceous Aquifer: 13,000 ha –13,000 ha – year 2020 - Correct the starting years as follows: No 5 (2010) – No 6 (2010) - No 7 (2015) – No 8 (2010) No 11(2015) - NO 12(2020) - Correct the total as follows : 67025 ha and 42330 ha
	5.2.3 Current and Projected Water Demand By Eng. Adib Geadah	**By Eng. Adib Geadah:** Fig 5.2-7 : to be rectified according to new table 5.2-2 above - Table 5.2-11: correct as follows: p.12 Khardalé + Middle cretaceous aquifer: 13,000 ha – 13,000 ha Tables 5.2-12 and 5.2-13: to be rectified according to new Table 5.2-2 above
5.3 Overall Water Demand	5.3 Overall Water Demand By Eng. Adib Geadah	**By Eng. Adib Geadah:** - Figure 5.3-1, Table 5.3-1 and 5.3-2 (1) and 5.3.2 (2) to be rectified according to new table 5.2-2 above

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CHAPTER	IDENTIFICATION	REMARKS
Chapter 6 – Provisional strategy & Scenarios of Water Resources Management 6.1 National Policy & Strategy for Water Resources Management	6.1 National Policy & Strategy for Water Resources Management	
6.2 Water Budget	6.2 Water Budget By Eng. Adib Geadah	**By Eng. Adib Geadah:** Table 6.2-1 to be adjusted for its irrigation component according to the basic new Table 5.2-2 above
6.3 Issues Concerning Water Resources Management	6.3.1 General Description By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** Water Quality: The description of the water quality situation is very general and similar to several other countries. What is needed is to provide specific information about the situation in Lebanon. For instance what is excessive fertilizer? How much fertilizer is consumed in the country? What is the application rate? How many of the water resources have nitrate levels above the standards? Similarly to pesticides, apart for the testing in Litani do we know whether we have pesticides residues in the water resources? If so in which resources and at what levels? Since 1994, all reports have stated the same causes of pollution however and until now there is no data on the concentration of various pollutants in the water resources. It might be necessary to conduct the necessary analyses so that the description of the water quality would be quantitative and not qualitative.

	6.3.2 Problems Related to Water Resources Management By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** Water quality should be incorporated in the water resources management. In this respect, the laboratory capacities of the country should be assessed to identify whether the country has the capacities to conduct the required testing. On the other hand an integrated water quality monitoring program is lacking and should be developed.
	6.3.3 Operation and Institutional Support By Mr. Zuheir el Hasan By Eng. Adib Geadah	**By Mr. Zuheir el Hasan:** Data on water quality, wastewater should be also considered as part of the data base. **By Eng. Adib Geadah:** - Page 6-20: Water Resources Management center: It should be concerted with the day to day and real time management needs and contingencies of LRA.
	6.3.4 Consideration on Reuse of Wastewater from the Viewpoint of Water Quality By Mr. Zuheir el Hasan	**By Mr. Zuheir el Hasan:** The information on Ghadir is right since it is a preliminary treatment plant. However it should be noted that other plants are being designed for re-use. For instance the treatment plant of Baalbeck which is almost complete is a secondary treatment with an allocation for the installation of filters in case the treated effluent contains nematodes. This treatment plant has been designed for re-use. What about the other treatment plants that are under construction?
	6.3.5 Scoping for Initial Environmental Examination	

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CHAPTER	IDENTIFICATION	REMARKS
Chapter 7 – Technology Transfer	By Eng. Adib Geadah	**By Eng. Adib Geadah:** Provide a sub-Module of training for LRA Engineers to be tailored according to the specific needs of LRA (real-time management of water resources) - Coordinate with LRA for their on going following activities: - The OMSAR,LRA/GIS/DMS projects - The GIS component of Conveyor 800 project
Chapter 8 – Further Work Schedule	By Miss Randa Nemr By Eng. Adib Geadah	**By Miss Randa Nemr:** An integrated water quality monitoring program should be among the priority projects. **By Eng. Adib Geadah:** - Page 8.1: - Second Field Survey in Lebanon (May and June 2003) Additional measurements of rivers and spring discharges should be taken in May and June. - The physical constitution of the data base bank at MEW by collecting copies of all documents (including a systematic inventory) should be performed. - Add at the end of report: a systemic bibliography and list of documents collected.

By Dr. Hyam Mallat:
In conclusion, it appears that:

- The report is not very thorough in its analysis of the legal and administrative framework. Some legal texts are not taken into consideration. Some offers are not cited correctly and many corrections should be made.

- Water legislation is absolutely not present in the report.

- The environment legal situation is a melting pot of many texts without a clear and methodological analysis.

General Comments on JICA Interim Report
By Eng. Saïd Bitar - Head of Irrigation Department
The JICA Study Team states in the Preface of the Interim Report (Main Report) that results of phase I were obtained by field survey works that were made from the beginning of July 2002 to 17 February 2003.
This information is not accurate as more than 99% of the data given in the report was collected from different Lebanese and International entities. In addition, the JICA made use of the data without giving any critical study.
Furthermore, only one flow measurement of some springs and rivers was done in September 2002 by a Lebanese consultant. It is wrong and completely inaccurate to consider this one measurement in the Master Plan especially after a gap of 25 years.
Moreover, the JICA Study Team states in the Preface of the Report that all figures may be reviewed and modified when additional data and information will be available during Phase II of the study. The problem here does not lie in obtaining new data or changing figures but rather in the whole structure, policies, bases and criteria of phase I study that must be reviewed and refined. For this reason it would be advisable to first change Phase I before of Phase II of the study begins.

By Eng. Bassam Jaber:
The Report as presented cannot be acceptable. Consequently, Phase II of the study should not begin before Phase I is corrected and approved by the Ministry.

By Dr. Sélim Catafago
Tendencies cannot be detected from short series. Thus we can only conclude that the volumes of available water in the rivers are diminishing.

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CHAPTER	IDENTIFICATION	REMARKS
Pluviometric Data	By Dr. Sélim Catafago	**Page 2.3.1 – to Page 2.3.4** The long series of rainfall data of Beirut Airport, Tripoli and the Cedars are characterized by the fact that these measurements often contain errors. Moreover, taking each series individually, we conclude that they do not belong to the same statistical family. This is due to the fact that stations have changed their location or that the material has been replaced during this long period. We notice a difference between Airport and Golf stations although they are very close. These remarks can also be applied to the other group of stations. In the absence of analysis and control, these measurements should be considered with much more precaution. The spatio-temporal homogeneity and the aleatory character of these series were not verified. It is absolutely necessary before using these measurements to proceed to these verifications. The historic of these stations should also analyzed.
Hydrometric Data	By Dr. Sélim Catafago	**Pages 2.3.3 and 2-3-8** As for the pluviometric series, these series reproduce raw data supplied by the hydrometric service of Litani River Authority, knowing that these series before the 80's could not be the same as those proposed in the 90's. In fact the location could have been transferred and the measurement equipment could have been changed. New stations have been equipped on Damour and Beirut rivers. The exchange from one water shed to another also modifies the volumes measured. This was the case at the mouth of Awali river were the volumes seem to have increased astonishingly since the year 1963 by the beginning of the functioning of the hydro-electric central of Awali (Paul Arcache) that receives important volumes of water from the Litani In brief these series have neither been verified nor analyzed to shift the anomalies. Moreover, there is no history for this station. Thus, no characteristic has been put in evidence. In addition, the control of spatiotemporal homogeneity and the risky characteristic of these series do not appear. Taking into consideration these summary and general observations, these data cannot be used as presented, in a raw way, in the mathematical model. **Page 2-3-9** The series of daily rainfall in Tripoli, Beirut and the Cedars cannot be chosen as pluviometric input in the model due to their bad quality, the lack of spatio-temporal homogeneity and the fact that they do not belong to the same statistic sample. These same remarks could also be applied to the 15 hydrometric stations.

		Page 3-2-14 What is the significance of these coefficients of rainfall correlation? **Page 3-2-16 to 3-2-18** The calibration of the model on the data presenting anomalies looses a lot of its justification. This should be reviewed. **Page 3-2-20** The limit of the SSM model is mentioned. It would have been un-doubtfully, more interesting to proceed differently by using another model. **Page 41-1 & Page 4--2-32** All the results of the simulation must be reviewed due to the lack of validation and due to the reasons mentioned in the remarks given on the Main Report and its Annex. Moreover, basing the simulation on the period extending from 1992 to 2001 is not reasonable because the basic data used as input has not proven. Therefore, serious conclusion cannot be made and used as a basis for the balance of the waters in Lebanon and especially not for the elaboration of a Master Plan
Hasbani Water shed	By Dr. Sélim Catafago	Concerning the Hasbani water shed, the study existing at the Ministry can be used as a reference. The period of simulation (1992 -2001) during which there is no outflow measurements, does not allow any serious validation, taking into consideration the anomalies on the basic data. Moreover, the different hypothesis on the geologic and hydrologic size, and the questions raised on the model itself make the results not very credible. Also, as for the results of simulation that put in evidence the underground water exchanges under the form of contributions coming from the East, as well as the underground water exchanges with the Litani water shed, it seems dangerous to take into consideration the unverified and invalid results that have no real basis and that can heavily distort the estimation of the water balances. These remarks are also applied on the Litani and Assi water shed especially concerning the underground exchanges with the extra border water sheds. The same is applied for all water sheds. Thus, the overall results are debatable and need to be reviewed. The section relative to the Legal Water Rights is inexistent. For this reason it is less probable that this study reaches through this structure an estimation of a balance and an elaboration of a Master Plan.